EXTENDED ARTIFICIAL MEMORY

Toward an Integral Cognitive Theory of Memory and Technology

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Abstract

This thesis introduces *extended artificial memory*, an integral cognitive theory of memory and technology. It combines cross-scientific analysis and synthesis for the design of a general system of essential knowledge-technological processes on a sound theoretical basis. The elaboration of this theory was accompanied by a long-term experiment for understanding [Erkenntnisexperiment]. This experiment included the agile development of a software prototype (Artificial Memory) for personal knowledge management.

In the introductory chapter 1.1 (Scientific Challenges of Memory Research), the negative effects of terminological ambiguity and isolated theorizing to memory research are discussed.

Chapter 2 focuses on technology. The traditional idea of technology is questioned. Technology is reinterpreted as a cognitive actuation process structured in correspondence with a substitution process. The origin of technological capacities is found in the evolution of eusociality. In chapter 2.2, a cognitive-technological model is sketched. In this thesis, the focus is on content technology rather than functional technology. Chapter 2.3 deals with different types of media. Chapter 2.4 introduces the technological role of language-artifacts from different perspectives, combining numerous philosophical and historical considerations. The ideas of chapter 2.5 go beyond traditional linguistics and knowledge management, stressing individual constraints of language and limits of artificial intelligence. Chapter 2.6 develops an improved semantic network model, considering closely associated theories.

Chapter 3 gives a detailed description of the universal memory process enabling all cognitive technological processes. The memory theory of Richard Semon is revitalized, elaborated and revised, taking into account important newer results of memory research.

Chapter 4 combines the insights on the technology process and the memory process into a coherent theoretical framework. Chapter 4.3.5 describes four fundamental computer-assisted memory technologies for personally and socially extended artificial memory. They all tackle basic problems of the memory-process (4.3.3). In chapter 4.3.7, the findings are summarized and, in chapter 4.4, extended into a philosophical consideration of knowledge.

Chapter 5 provides insight into the relevant system landscape (5.1) and the software prototype (5.2). After an introduction into basic system functionality, three exemplary, closely interrelated technological innovations are introduced: virtual synsets, semantic tagging, and Linear Unit tagging.

1. Introduction

> *It is easy to speak with precision upon a general theme. Only, one must commonly surrender all ambition to be certain. It is equally easy to be certain. One has only to be sufficiently vague.*
>
> (Peirce, 1931-1958, S. 4.237)

1.1 Scientific Challenges of Memory Research

1.1.1 Plurality of Theories

During the last decades, the productivity of scientific research has increased considerably. Following the paradigm of evolutionary epistemology, science has created a great variety of theories and facts, enabled by a fine-grained division of labor. In 1927, Karl Bühler (Bühler, Die Krise der Psychologie, 1927) could still plead for a cautious pluralism of theories in psychology. Bühler had to consider but a handful of *schools of psychology*. Though he rejected the theoretical stance of some schools, he would still recognize the partial truth of each. To Bühler, it was still possible to compare in detail to form a balanced judgment. Today, pluralism of theories is nothing one would have to vote for anymore. It is no longer a choice, but a seemingly unalterable historical and social fact, and a growing epistemological challenge of its own.

1.1.2 Plurality of Word-Senses

In his contribution to *The Oxford Handbook of Memory*[1], the distinguished memory researcher Endel Tulving talks about a source of frequent confusion in theoretical debate amongst memory researchers: their ambiguous use of words.

> *In the past, relatively little explicit attention has been paid to terms and concepts. As a result, problems have arisen. A frequent source of confusion lies in the use of one and the same term to designate rather different concepts.*
>
> (Tulving, Concepts of Memory, 2000, p. 42)

Tulving lists no less than six different scientific meanings of the term *memory*[2], the clear definition of which, of course, ought to be of central

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[1] (Tulving & Craik , The Oxford Handbook of Memory, 2000)
[2] (Tulving, Concepts of Memory, 2000, p. 36):

> […] *consider the term 'memory' that designates the central concept of all the chapters in this handbook. What does it mean - that is, how is it used*

importance to memory researchers. Tulving expresses a clear idea about the coming about of this problem: The terms and concepts *have evolved as natural by-products of the normal data-gathering and hypothesis-making activities of students of memory.*[3] Each strain of memory research tends to create its own, special reference field for word usage: theories re-use common words to describe specific methods, hypotheses and findings. A plurality of theories will thus inevitably also create a plurality of word senses of more or less central terms. A word having more senses does not necessarily result in it becoming more difficult to use. In most cases, it will be applied in *one* sense only, which is not meant to say that it will be used in a consistent manner, but rather that it will be used in one sense *at a time*. However, the more senses a word acquires, the more likely it will become that it will not be understood as intended. Any further theory therefore is likely to contribute both new knowledge and new ambiguities. As growing ambiguity tends to increase the number of misunderstandings, learning is affected, too. One could imagine the paradoxical situation wherein new scientific theories create more harm (by making it difficult to learn) than good (by new discoveries). The easiest and *natural* solution to this problem seems to be forgetting or ignoring theories by following the latest (for progressives) or dominant theoretical trend (for conservatives). Another, *critical* way is to find criteria to be able to condemn theories as a whole (for censors). A famous and controversial example is Karl Popper’s label *Pseudowissenschaft* (pseudo-science)[4] and his postulation of falsifiability as the demarcation criterion between science and pseudo-science.[5] The problem of theoretical ambiguity, however, is to stay, irrespective of whether we try to deal with it as progressives, conservatives, or censors. It is of such a serious kind that it stops us from a balanced assessment and integration of theories, and, consequently, prevents us from efficiently learning and applying scientific knowledge. It literally forces us to become forgetful, negligent scientists, whether we wish or not.

> *by students of memory? The term 'memory,' in addition to denoting a field of study, can designate a number of different concepts. Among the more frequently occurring meanings of 'memory' are (1) memory as neurocognitive capacity to encode, store, and retrieve information; (2) memory as a hypothetical store in which information is held; (3) memory as the information in that store; (4) memory as some property of that information; (5) memory as a componential process of retrieval of that information; and (6) memory as an individual's phenomenal awareness of remembering something.*

[3] (Tulving, Concepts of Memory, 2000, p. 42)
[4] (Popper, 1959)
[5] Ironically, Freud’s psychoanalysis, blamed as a Pseudowissenschaft by Popper, might be useful in explaining why Popper appears to have hidden the true origin (namely Otto Selz’s psychology of knowledge) of his *new* theory, as Hark (Hark, 2004) has uncovered.

1.1.3 Plurality of Sense-Words

There is a counterpart to polysemy (somewhat different word senses of a single word) and its sibling homonymy (very different word senses of a single word), namely synonymy (similar word senses of different words). Theoretical plurality, besides disadvantageously increasing the senses per word ratio, also leads to a variety of words per sense. Experimental paradigms, theoretical stances, goals, and, hence, scientific focus tend to differ across sciences, research fields, research groups, and individual researchers. However, all too often the subject of research will be the same, be overlapping, or, at least, closely related. Of course, some matters of research are more prone to this than others are, but the general principle still holds true. While plurality of word senses, i.e., polysemy, uses to cause misunderstandings (false positives), plurality of sense-words, i.e. synonymy, uses to cause lack of understanding (false negatives). The reason for this is that, especially in cases of neologisms, the listener or reader may not know the sense of a word that is used synonymously. Not because of not knowing the intended *sense*, but simply because of not understanding that the word is used to denote this sense. The problems of plurality of word-senses and plurality of sense-words are unquestionably closely interrelated. One can try to escapes word-sense plurality by neologisation – eventually causing sense-word plurality. Alternatively, one can try to escape sense-word plurality by re-using words – causing word-sense plurality. More often than not, both *strategies* will be applied, without, however, being aware of the possible consequences. Ultimately, the difference is only between creating more or less words and not between creating more or less understanding, efficiency of learning, or ease of practical application.

1.1.4 Growth of Knowledge at the Expense of Synthesizability

Thus navigating between Scylla and Charybdis, one could argue that, nonetheless, new, often surprising insights are being accumulated. Science is rapidly progressing; scientific knowledge is increasing, literally by the hour. And, indeed, this is undoubtedly true and represents a great achievement. At what cost, however? Not, as one is first tempted to believe, at the cost of less and less understandable science. For understanding can still be achieved. It only takes enticing people into over-specialization, following *single* lines of scientific evolution, ever limiting focus (and, thus, mutual understanding). Division of labor can attain this and has attained this in the past. The true cost of evolutionary epistemology, however, is in the ever-increasing cost of synthesis of knowledge.

1.1.5 Dense Views unequal Overviews

How is one to describe, interconnect and abstract the formidable findings of science, when there is no coherent language at hand (and obviously no incentive to create one), and when there is, as a result, no *common* understanding? To give a suitable example, I will indicate how Tulving does it in *The Oxford Handbook of Memory* (Tulving & Craik , The Oxford Handbook of Memory, 2000). Tulving compiles or stacks different lines of research. He uses a plausible order, having authors starting with historic and methodological contemplations, branching into specialized research fields, thus offering insights into different sub-lines of memory research. As an editor, he carefully sequences each individual contribution and adds a foreword. In other words, Tulving (and I am far from blaming him for doing so) does himself nothing for real knowledge synthesis. He leaves it to the contributors, who leave it to the readers, who leave it out, because it is too difficult with the information presented in the language(s) given. This is a pragmatic as well as typical solution, to be found in most handbooks of sciences rich in theories. A *dense,* often historic (research-oriented) view is provided without, however, providing an overview, or, rather, with just providing the illusion of an overview.

1.1.6 Theory for Technology versus Technology for Theory

The reader will pardon the author’s lamenting tone when he learns that the missing synthetic view of memory research from the example given poses an actual problem to his own work. As the author is to set out before the reader a theory of *extended artificial memory* (let it be enough here to say that this is meant to describe a technology and practice reflecting, supporting and augmenting remembering and thinking), it would have been rather helpful to be able to refer to and build upon a unified (integrative) theory of memory. Instead, the author is forced to refer to diverse, rather heterogeneous theories of memory and has apparently nothing completely coherent to build upon. Sheer practicality should move him to follow Tulving’s example, one would think, constructing his theory and technology along the lines of different memory theories. However, it is, above all, the author’s very wish for practicality that prevents him from following Tulving’s example. For the diversified state of the science of memory is somehow *reflected* in the diversified state of information technology, probably for some comparable reasons of evolutionary epistemological (technological) developments. Now, this very state of information technology is exactly the reason why the author’s endeavor started: the technological insufficiency to adequately and consistently support and extend human memory.One could argue that the construction and theorizing of an **integrative** memory technology depends on a unified theory of memory (to be translated into technology). Then again, there is another, rather bold way of thinking about this relationship: namely **that a unified theory of memory by now depends on a unified memory technology, which, in**

turn, depends on a unified theory of memory. If prominent memory researchers have to shy away from an *integrative* memory theory, it cannot be achieved easily. It seems to be impossible without technological support semantically coordinating the diverse lines of evolution of scientific knowledge of memory, thereby countering and economizing the before mentioned abundance of word-senses and sense-words. It is unpromising to wait for an ingenious scientist to appear on the scene and solve this or a similar problem by advancing a new, perfectly integrative theory. A proper solution, that is a unified field of theories of human memory **or** a unified memory/information-technology, cannot be achieved by a single person anymore.

1.1.7 Wicked Problem

In design theory, Horst Rittel[6] coined the term *wicked problem*[7] for a complex theoretical and practical problem such as the one we face here. A wicked problem is a problem that cannot be defined (theorized) in a way that all stakeholders agree on *the* problem to solve. It is even often unclear at what abstraction level the problem ought to be described. Managing to re-frame a wicked problem can lead to innovation, but for that to happen several people are necessary, because a single person cannot know or overlook all aspects of a wicked problem. Attempting to solve a wicked problem will change the understanding of the problem or even the problem itself. The latter is true not least because every solution tried comes at a cost and can have unintended consequences. However, one cannot understand a wicked problem until one has tried a solution (i.e., a practical approach enables further understanding and theorizing[8]).

Rittel thought of the process of argumentation as the adequate method for taming wicked problems. Every solution tried reveals aspects of the problem that cause a revision of the solution by means of argumentation (interpretation informed from all-around). It is for this reason that there is no right or wrong solution of a wicked problem, but only a *worse to better*. There are no clear stopping rules for the iterative process of solution development. The concept of wicked problems has gained importance in design theory, especially in agile software design[9], because wicked problems cannot be tackled successfully in a one-step solution. This thesis represents the first step in a practical and theoretical solution approach

[6] See en.wikipedia.org/wiki/Horst_Rittel (accessed on 01.08.2012).
[7] See (Rith & Dubberly, 2007).
[8] This is reflected, for example, in the growing importance of building simulators for understanding the dynamics of complex (artificial or natural) systems.
[9] In software engineering, the frequent failure of waterfall-model solution planning and solution development (and the like) in highly complex environments, such as the World Wide Web, has led to an *agile* software development movement. This movement's principles can be best understood as reactions to the rising number of wicked problems in software development.

to a wicked problem, namely the problem of a universal memory/information technology by (and for) memory theorizing.

1.2 Scientific Approach

1.2.1 Invitational Theory

In this thesis, *extended artificial memory* is being introduced; a theoretical and practical attempt to model a general information and communication tool to better fit the human cognitive apparatus. The reader should not expect to obtain a fully elaborated theory, though. Extended artificial memory and the respective software prototype is *work in progress*, an invitation to help further frame a complex theoretical and practical problem.

1.2.2 Meta-Theory

Due to the intricate nature of the problem tackled, neither is a narrow perspective taken, nor is the subject being dealt with in a *sufficiently vague* manner, so as to be able to maintain something with *certainty*. Precise general theorizing, at this stage of knowledge of the problem, would create nothing but premature, improperly reductionist formal certainty (or rather, in fact, uncertainty). In this thesis, therefore, the choice is to try to be *integrative*. I will try to outline the problem structure to the greatest extent possible under the circumstances given (at the risk of superficiality and a somewhat coarse-grained framing). Then again, I will try to integrate various details into the resulting holistic perspective, creatively hypothesizing / theorizing across gaps and ditches (inviting corrective and aversive refutation respectively). In exceptional cases, I will have to be precise *and* formal about details of the prototype created. This is simply due to the strictly logical nature of software code and database queries, as represented by the Artificial Memory prototype[10]. At no time, however, will my purpose be to describe technology in terms of software code and its *one-dimensional* formalisms. Technology has always to be described firstly in terms of cognitive information processes, as will become evident in the next chapter, in which I try to unveil the conceptual interdependency between cognitive and other informational processes in technology.

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[10] As of August 6, 2012, the Artificial Memory prototype comprises

- 132k lines of hand-written programming code
- 29k lines of hand-written SQL (structured query language) code
- 3k lines of HTML code and JavaScript code

Together more than 165k lines of handcrafted code, which represents a commercial equivalent of more than 10 person-years of programming efforts. Not to mention about 10 million database records of lexical entries, all extracted, loaded, transformed, and interconnected from a number of open sources. The Artificial Memory prototype is planned to be used for further scientific experimentation.

2. Cognitive Technology

2.1 Reframing the Notion of Technology

2.1.1 Human Technology

From a cognitive perspective, all technology (in the common sense) can be separated into two broad main categories, namely *content technology* and *functional technology*. Content technology stimulates sense organs, directly informing the human organism. It interfaces with the human sensory organs (often also affecting the organism as such[11]), directly replacing natural sense stimuli or changing natural/given conditions affecting the organism indirectly. Functional technology conducts operations (actual and cognitive) instead of the organism. Content technology and functional technology are closely interlinked. Any content technology is also functional technology (at least fulfilling a *cognitive* function), but not all functional technologies are also direct content-technologies, as becomes obvious, for example, from machine-to-machine (communication) technology. Any machine ever built, and, consequently, any machine action, however, can be tracked back to human knowledge and human creative actions.[12] In technology, therefore, something is informed by humans at some point, and is operating and informing at another point. A hunting dog, a machine tool, and a computer are all objects of technology. A hunting dog, for example, is both content producing and functional. Hunting dogs track game, thereby *disclosing* the whereabouts of the game (as in content technology). Hunting dogs also catch game, thereby *acting* on behalf of their owners (as in functional technology).

2.1.2 Humans as Machines

It is important to notice, though, that, according to this common description of human technology, humans become technological tools, too. They can be informed, be informative and operative on behalf of and for the benefit of others. A hunter, a toolmaker, and a human computer[13] turn all into technological *objects* when instructed to hunt, to make tools or to compute respectively, just as hunting dogs, machine tools, and computers

[11] Seeking refuge under a broad-leaved tree, for example, makes use of the tree as a technological tool to shield the body from inclement or sunny weather. The tree here is both a functional object (something shielding from rain and sun, thus affecting the body) and a content object (something *informing* the organism with the dry air and shadow belonging to it).

[12] To consider, for example, a thrown stone or a shady tree a technological object informed by humans does not mean that stone or tree are *changed* substantially. A stone thrown at an attacking animal is functional, affecting (stoning) the animal by *following* the intended thought operation. The thrown stone is informed only insofar as its location changes. The broad-leaved tree fulfilling the thought operation of shielding would be informed only insofar, as its immediate environment changes (by somebody searching for shadow). In this very broad sense, any technology tool is *originated* by informing it first.

[13] Initially, the term computer denoted real people doing mathematical calculations.

are technological objects. Well-educated humans are technologically near universal, only, in most cases, by far not as efficient as specialized artificial automats. It is at least safe to say that anybody and anything can serve multiple purposes, depending on how it is informed and, accordingly, becomes operative and/or informative. Furthermore, two things can serve the same technological purpose by being operative in the same way and being informative in the same way.

2.1.3 Natural Technology

Human technology and humans as automats are largely cultural accomplishments, in most cases instructed by means of some *natural* or artificial human language / sign-system respectively. Beyond human technologies (by objects like tools and servants), there are also quite *natural*, inherited technologies. Humans as technology (automats) serve group or societal functions, as do human technologies. Some other animals serve group or societal functions, too, without, however, first acquiring cultural technology tools (such as language) during their lifetime. This is closely related to a fundamental achievement of biological evolution: eusociality. The nature of human technology (and humans as technology) can best be understood by disclosing its likely origin in eusociality.

2.1.4 Eusocial Technology

In his book *The Social Conquest of Earth*, Edward Wilson (Wilson, 2012) defines eusociality as the characteristic feature of animal societies displaying *group members containing multiple generations and prone to perform altruistic acts as part of their division of labor.*[14] Eusociality *created superorganisms, the next level of biological complexity.*[15] The biological raison d'être of eusociality is that *even a little society does better than a solitary individual belonging to closely related species both in longevity and in extracting resources* […].[16]

> […] *an iron rule exists in genetic social evolution. It is that selfish individuals beat altruistic individuals, while groups of altruists beat groups of selfish individuals.*
>
> (Wilson, 2012, p. 243)

Such being the case, the rarity of its occurrence in animal kingdom (humans disregarded[17]) seems remarkable:

[14] (Wilson, 2012, p. 16)
[15] (Wilson, 2012, p. 132)
[16] (Wilson, 2012, p. 149)
[17] Depending on the exact definition of eusociality, humans and other vertebrates can or cannot be classified as downright eusocial. In this thesis, I follow a very broad definition of the socio-biological concept of eusociality. According to this broad definition, division of labor in groups of individuals of one species spanning generations

> *Eusociality arose in ants once, three times independently in wasps, and at least four times - probably more, but it is hard to tell - in bees.*
>
> (Wilson, 2012, p. 136)

Due to evolutionary limitations (namely the exoskeleton), insects cannot evolve massive nervous systems anymore that would allow them to learn complex cultural technologies. Instead, due to extreme epigenetic plasticity, insects such as ants are able to develop into highly specialized individuals, forming colony *casts* marked by distinctive sets of instinctive behaviors and specific organismic phenotypes. Eusociality means evolution by survival of the fittest group of individuals or of individuals (e.g. ant queens) extending into groups. Epigenetic plasticity is the evolutionary mechanism insects have to their avail in order to establish eusociality. Conversely, brain plasticity, brain growth, and brain complexity are the evolutionary lines of mutation that led humans to evolve eusociality.

Although the largely chemical communication devices of ants do not inform in the same manner as human gestural or spoken languages do, the effect of informing ant individuals, their operating on behalf [in Vertretung] of others and feedback activities are sufficiently similar to the human-technology process to be dubbed as *natural* technology. Even though, in the case of insects and most other animals than humans, the eusocial technology is restricted to hereditary behavior in vitally important situations, **technology, regardless, can universally best be characterized as a substituational information process based on the principles of division and orchestration of labor that mark full eusociality.**

The hereditary and cultural capacities for eusocial technological advancements, so far, have been crucial evolutionary success factors, leading to ants and humans dominating animal kingdom (each in their respective biological spheres). All crucial human technological achievements were only possible and beneficial in eusocial groups: The control of fire is only imaginable at campsite (nest), cooking for preservation of food necessitates fierce defense of campsite supplies, the efforts of primitive tool-making pay off best in groups (e.g. during group spear-hunting and subsequent collaborative processing of large game).

would be a sufficient criterion of eusociality. For more information, see, e.g., en.wikipedia.org/wiki/Eusociality (accessed on 9.08.2012).

2.1.5 Determinants of Technology

Referring to the convictions of Michael Tomasello[18], leader of the Department of Developmental and Comparative Psychology at the Max Planck Institute for Evolutionary Anthropology, which are based on experimental findings from child and primate research, Wilson concludes that

> *Humans* […] *are successful not because of an elevated general intelligence that addresses all challenges but because they are born to be specialists in social skills. By cooperating through the communication and the reading of intention* […].
>
> (Wilson, 2012, p. 227)

Following this assumption, technology appears as an integration of processes of communication and of cooperation or collaboration. This causes an individual's intentions, cognitions, and actions to be mirrored and, partly, dissociated into another individual. The basic unit of human eusocial technology therefore consists of, generally speaking, two interwoven cognitive processes in two distinct individuals (a double process), being in correspondence with each other. **The animism of early cultures demonstrates the generalization potential of processes of shared attention and shared intention to naturally occurring processes and their naturally causative objects.**[19] The immediacy and uncompoundedness of *animistic* Gestalt qualities[20] of inanimate objects bears further witness to the generality and force of this phenomenon. Perceived causality is coupled with the perception of intentionality. Thus stepping into the arena of beliefs sharpened the human mind for natural phenomena, by creating pseudo-explanatory, imaginary associations, by constantly looking for signals of an imaginative (godly or devilish) will. Superstition paved the way to scientific knowledge, functional objects, and cultural progress[21]. Whether the technological double process is based on two humans interacting, or on a human and an inanimate tool, or a human and a mechanized tool, does not affect the cognitive primacy and informational nature of the process. I shall now progress to define the crucial determinants of eusocially derived technology:

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[18] See, e.g., (Tomasello, Die Ursprünge der menschlichen Kommunikation, 2011).

[19] This idea is similar to the notion of an *intentional stance*, as promulgated by the philosopher Daniel Dennett. See en.wikipedia.org/wiki/Intentional_stance (accessed on 06.08.2012).

[20] The (somewhat dubious) psychological school of holistic psychology [Ganzheitspsychologie], which *replaced* Gestalt psychology in Germany during the Nazi regime, has stressed and elaborated this point. See, e.g., Hans Volkelt's *Grundfragen der Psychologie* (Volkelt, Grundfragen der Psychologie, 1963).

[21] The sociologist Norbert Elias, for example, gives a socio-historic view into the development of time and calendar categories in his book *Über die Zeit: Arbeiten zur Wissenssoziologie* (Elias, 1988). Elias exemplifies the close interlink between superstition and epistemic progress in Old Egypt: observing stars was a cultic act of priests that helped them improve their understanding of natural regularities.

2.1.5.1 Specificity – degree of informational correspondence

To start a substitution-process of human-based technology, the initial information process between the human informant and the information receiver has to ensure a sufficient degree of correspondence (mapping) between the sender's goal-directed (cognitive) information states and the receiver's matching (information) states.[22] The specificity of the resulting effects will depend on proper informational correspondence or overall mapping.

2.1.5.2 Adjustability – degree of functional correspondence

While it is easy to see that specific informational correspondence is a determinant of technology, due to it parameterizing and goal-directing the recipient process, it is a bit more difficult to understand why functional correspondence [Funktionskorrespondenz] is of importance, too. It is not that the operations of the technological process have to be the same as those thought up by the *instructor* or, more generally, *actuator*. Indeed, in this respect, there could well be no direct correspondence whatsoever. One can have a false idea of the workings of substitution processes without this limiting controllability and effectiveness. One might, for example, think of a ghost operating a machine or have a simplified or inappropriate metaphorical theory about its functioning that does not reflect the workings of the machine. Technology can be operative without following the causal patterns attributed to it. However, when functional technology becomes more complex, when there are more intermediate and parallel states in the technological process, and when the number of possible outcomes increases, it will become ever more important to further influence and steer the technological process, beyond its initial parameterization (if any). Complex technology that does not want to run the risk of *escaping* into decoupled, non-technological (as I would argue) substitution processes, has to be accessible (informative) and adjustable (inform-able), or, in other words, it has to correspond on a shared structural basis. Functional correspondence means *bidirectional* responsiveness within closely interwoven regulative structures. Complex technology imposes both a theoretical regulatory demand (on the side of the actuator's substituted process) and a functional regulatory demand (on the side of the substituting process). Adjustability allows regulatory information to be injected whenever needed.

[22] Even a tree, in order to serve as a technology to shield from rain or sun, has to be at the expected place (as part of its state) to be used as a shelter. The initial *informational correspondence* is not always based on a real (outer) information process, but can also be based on a memory-based informational mapping, or on a reverse information process (of the actuator being informed).

2.1.5.3 Effectiveness – overall correspondence

The real, factual result of a technological substitution process does not have to correspond to the intended goal to stamp it *technological*. Often enough, a technology will not work as expected. Still, if its functioning bears the marks of specificity and adjustability, it is usually acknowledged as technological. In this case, *expectations* are being limited to earlier or partial goal-directed states of the technological substitution process. This comes down to a shortening of the technological process. If, however, the unintended, non-corresponding tail end of a process were to persist and somehow be in force, the process, as a whole, would become non-technological. Arbitrary beginnings, progressions, or ends characterize degenerating technology (processes). Effectiveness is another determining factor of technology: in complex technologies, effectiveness is not only to be found in a final effect, any specific process outcome, but rather in *overall* correspondence in what is *realized* of what is expected to realize. Effectiveness, therefore, cannot be achieved without overlapping. Overlapping requires starting points and end points of the parallelized (information) states of a technological process unit to match.[23]

2.1.5.4 Determinants of technology and their respective eusocial skills

With regards to eusocial skills, *specificity* can be translated into, on one side, expressivity / expressive power (precise, unambiguous display) [Ausdrucksfähigkeit] and, on the other side, *impressivity* or receptivity (precise, correct impressions) [Begreifensfähigkeit]. Adjustability translates into reciprocal attentiveness [wechselseitige Zugewandtheit] and continuous expression and reading of (intentional) information states [Absichtserkenntnisfähigkeit]. Effectiveness, at last, translates into, on one hand, will to express and inform [Ausdruckskraft] and goal-orientation [Zielstrebigkeit] and, on the other hand, preparedness (or will to react) [Bereitschaft] and steerability [Steuerbarkeit]. Of course, these notions and, admittedly, somewhat vague concepts are thought here to but help us further comprehend the basic correspondence between fundamental human capacities and the vital roles they play in technology processes. This, in turn, will help us to see clearer what technology is not.

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[23] This is not meant to say that the substituting states have to be *at the same time* as the states being substituted. A technologically substituting process can be *delayed* repeatedly, thus taking place after its corresponding actuating or anticipating information state. A phase shift, however, does not affect the informational mapping (and respective overlapping).

2.1.6 What Technology is not!

One purpose of the description and the definition of technology here is to be able to draw a clearer borderline between what technology is and what technology is not. Reading the following sections, the reader may find that most of her ideas about technology are actually misleading.

2.1.6.1 Technology is not in nature

We have spoken of natural technology in the sense of eusocial specialization generating substitution by hereditary and cultural means. Oftentimes people speak of nature's technologies in a very different sense. They mean things such as, for instance, a spider's net, a snake's poison, or a bird's nest, etc. All these marvelous things have really nothing to do with technology. A complex *natural* system, its occurrence and progression, is not in itself already a technological process. It may appear as technology to humans as they develop an understanding of its complex functioning and start attributing it to an individual creator (such as the spider) or to a universal creator or process (such as *God, nature or evolution*). However, there is, as a rule, no anticipation or goal-determined substitution involved. [24] These are successful but, in a way, *blind* processes. A physical or, on a higher level, biological causality chain, though, is far too wide a demarcation criterion to grasp the distinctiveness of the eusocial cognitive-technological process.

2.1.6.2 Technology is not material (objective)

Most people think of technology as of something material: a tool, a computer, a car. These are all artifacts, possibly *playing a role* in technological processes. To call them technology is as misleading as it is common. The technological process is a process of cognitive-informational correspondence. If at all, an artifact can be named technology in the state of being a constituent of a technological process. However, I would prefer to reserve the term technology to denote an abstraction of the process itself and to use the label *technology xyz* to denote a subsumed type of technology, preferentially irrespective of its specific (volatile, easily to be virtualized) material (objective) foundation.

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[24] Hans Volkelt (and before him Thorndike) had demonstrated that lower animals (Volkelt experimented with spiders and wasps) do not (learn to) recognize objects as constant things [dinghafte Konstanzen] (Volkelt, Über die Vorstellungen der Tiere, 1914). In *lower* animals, there is no objective structure [dinghafte Gliederung] of perception or thought; and even if, in higher animals, there is learnt object-perception, eusociality, first and foremost, is the mechanism that breathes life into perceived *things*, revealing them as intentional, collaborative members of the same (or another) species or as pseudo-intentional, effective things.

2.1.6.3 Technology is not stable

Most people would think that *technology* is something rather stable. However, the specific relational character [Korrespondenzcharakter] of the technological process introduces several breaking points: both the substituted and the substituting process are prone to change and, hence, prone to uncoupling, potentially bringing the technological process to a halt. Nowadays, for example, one will find many historical mechanical devices nobody anymore knows how and what for to use. In a discontinued technology, the possibility for correspondence is lost. The technology (if not documented and for that reason reconstructable) has ceased to exist, remaining artifacts notwithstanding.

Technological processes change all the time, as the measures of degree of correspondence (specificity, adjustability, and effectiveness) vary. A race driver uses a different technology than a normal driver (both driving the same car), not just a different *technique*, but, literally, a different technology. The technological correspondence is one of two-sided potentiality: both sides tend to be more or less aligned with each other, and both sides might lose their capacity for the technological process to proceed. This makes technology an overly variable and fragile process.

2.1.6.4 Methods are not yet technology

Many people would think that a method (i.e., technique) to solve a problem is already a technology. In fact, *method* is often used to denote the process realized (solution method) [Lösungsmethode], as well as it is said to be the process realizing (execution method) [Ausführungsmethode]. In case of humans as technology, both processes are realized by cognitive processes in the brain. These are usually supposed to be closely corresponding (co-mirrored). Sometimes, when instructor and executor exchange roles, a *solution* method may turn directly into an *execution* method. However, the method alone does not yet constitute a technological process, be it manifested in a solution process or in an execution process. It is a necessary, not a sufficient condition. It misses the specific teleconnection and telecorrespondence [Fernwirkung] necessary to establish the collaborative division or extension of labor that earmarks eusocial technology.

2.1.6.5 Technology cannot be made

For it is a process! Therefore, technology has to be *arranged*. Thinking of technology as a product is a frequent misunderstanding. Material constituents of technology are produced, of course, but the technological process as such has to be organized.

2.1.6.6 Technology cannot be used

That technology cannot be *used* is, of course, surprising. Whenever we think we use technology, we are actually more likely to take part in it. We use (handle) a chair, a tool, or a computer, indeed. During a technological process (sitting, screwing, or programming), these things may all become important constituents of the technological process. Technology then, however, is not being *used*; instead, people and things are *engaged* in a technological process. Furthermore, oftentimes when we might think we are using technology, we are actually not or only distantly part of the technological process. Think, for example, of traffic lights. One might assume that one *uses* traffic lights (as an indicator system, for example, in order to decide when to start or stop one's car) and this somehow would mean *using* the traffic light technology. The truth is that the traffic authority is engaging the traffic lights in a technological process of teleregulating traffic (the drivers). Within this technological process, the driver is a (distant) receptor, not an effector. Talking about *usage* of technology, therefore, does not only conceal the process-character of technology, it also leaves in the dark on which side we stand in the intertwined double process of technology. Are we parameterizing, substituting actuators or are we but *tools*? All too often, the notion of using technology will give us a false impression of where we stand. People watching TV, for example, might think that they are using a technology to their avail. There are, indeed, a few buttons to press to manipulate the workings of the TV set and one, hence, is engaged in a minor technological process of choosing channels etc. TV-technology is, in the main, a process steered by broadcasting companies and advertising agencies, a massive perceptual manipulation. To put it pointedly, instead of thinking of one *using* the telly, it would be more appropriate to speak of *being used* by the telly. It is however, best to avoid the notion of *using* technology altogether. One should rather ask in which technological processes people participate in which roles. In terms of effectuation, technologies are perhaps best conceived as overlapping spheres of influence and interdependent force-vectors. The traditional object-oriented and, based on this, usage-oriented notion of technology [25] blinds us for the real complexities of technology and its double-processual characteristics of paralleled actuation and substitution.

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[25] A diffuse, but not untypical example is given in Wikipedia's definition of technology, en.wikipedia.org/wiki/Technology (accessed on 05.08.2012) as:

> […] *the making, modification, usage, and knowledge of tools, machines, techniques, crafts, systems, methods of organization, in order to solve a problem, improve a preexisting solution to a problem, achieve a goal or perform a specific function.*

The definition revolves around more or less concrete objects (tools, machines, systems, methods, knowledge) that are being made, modified, and used.

2.1.6.7 Technology cannot be controlled

When one thinks of technology as of objects, one easily gets to believe that technology can *be* controlled, that is it can be in a certain state labeled as *controlled*, because objects appear to be stable and persistent. Corresponding processes, by contrast, are occurrences, unstable and transient by definition, and always at risk of dephasing and mismatching. Therefore, technology cannot be said to *be* controlled. It can, at best, be said to be *being* controlled. The difference may appear to be marginal at first glance. It is, however, neither a trivial nor an unimportant difference. Whenever one attributes a stable feature to the technology process, one supposes stability of a constituent of the process, or the state of the process at a certain point of time, or of a specific instance of the process. Neither of these reference points, however, is appropriate to describe technology. Sitting on a chair is not safe because of the chair being made of stable material (for the person sitting could still be too heavy for the chair). It is not safe because one can sit on it now (for the glue may be of poor quality and the chair is thus destined to collapse soon). It is also not safe because person A sat on it successfully (for person B enjoys falling into the chair while person A, better-behaved, sits down).

2.2 Cognitive-Technological Model

2.2.1 Visualization of the Cognitive-Technological Model

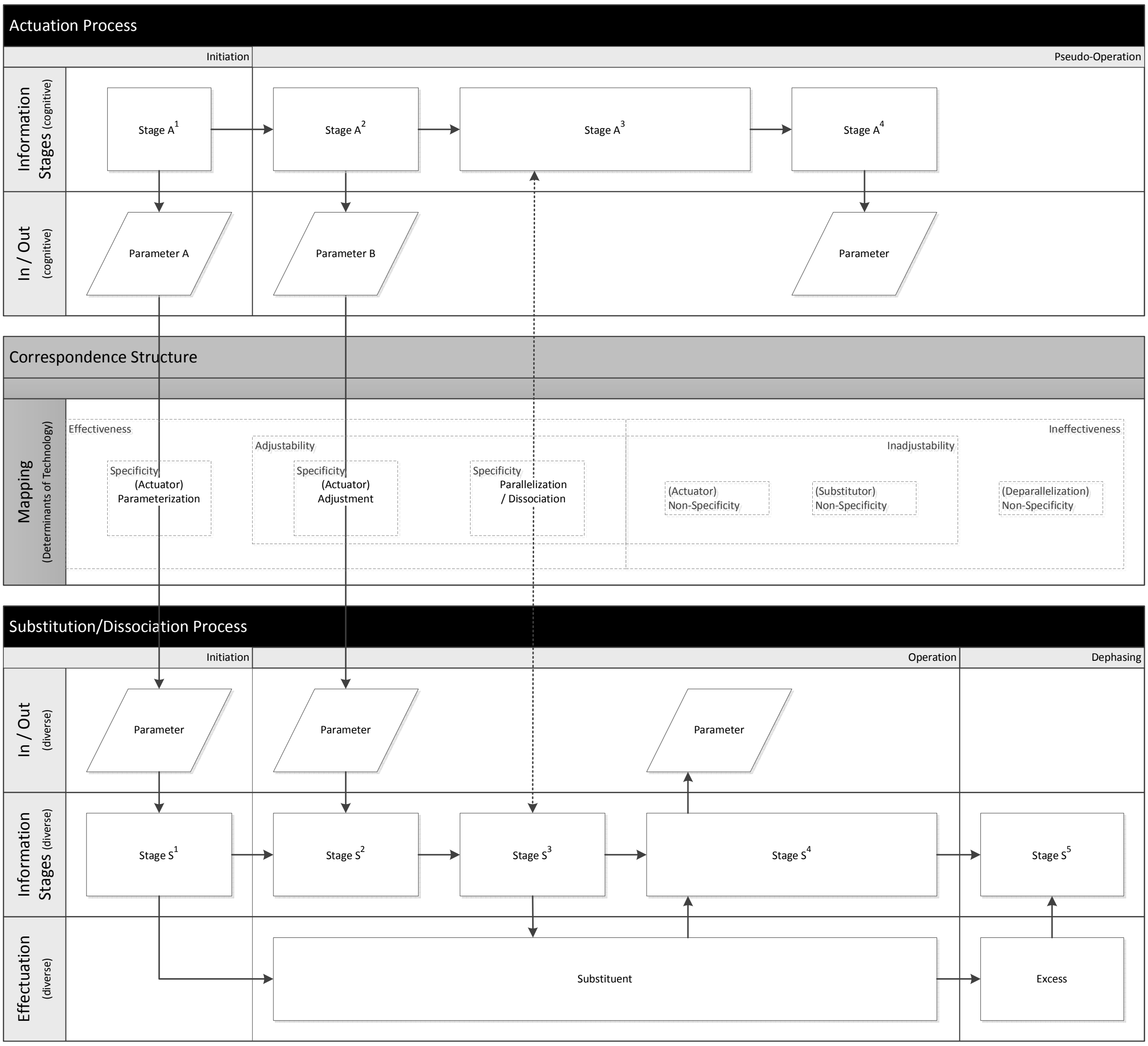

Figure 1: Exemplary visualization of an exemplary technological process along with its determining correspondence structure

2.2.2 Description of the Cognitive-Technological Model

2.2.2.1 Technological Framework

In **Figure 1**, an exemplary technology unit is visualized, integrating what has been said so far. The whole structure represents a **technological process**. It is always comprised of at least one *real* cognitive actuation process and one substitution (or dissociation) process. Each process undergoes different information stages. There are three exclusive process phases: initiation, (pseudo-) operation, and dephasing. Even though, in **Figure 1,** dephasing is put at the end, it can as well appear at the start (imagine, for example, a car rolling backwards down a hill before the driver manages to start it). Initiation marks the beginning of the actuation process. It creates the mandatory parameterization (parameter correspondence) of any technological double process. In **Figure 1**, the substitution process is initiated by the actuator. Conversely, the actuator process can be initiated by a substitution process (imagine setting the brake *after* the car started rolling backwards down the hill). Of course, one could as well maintain that a technological process can only be initiated by an actor (which would imply the exclusion of dephasing at the beginning of the technology process). By definition, based on eusocial division of labor, the substitution (or dissociation) process has to become operational on behalf of the actuator. In case of *total* dissociation, when there are no information stages corresponding to effectuation left in the actuation process, the pseudo-operational phase of the actuation process will be empty (imagine a husband making coffee for his wife, without realizing/remembering it, simply by turning on the coffee machine in the morning). If this happens, only the parameterization of initiation can create correspondence (the man will not see the coffee getting ready, he will not get to know if the water container was filled, etc.). In Figure 1, there is no distinct goal-phase, as technology does not depend on a definite goal. This is not to mean that actuation and substitution process use to be aimless, or even that there are no goal-like information stages. Analyzing the correspondence structure is crucial for understanding in how far actuation and substitution process harmonize with each other. Correspondence, however, is not the same as synchronicity (imagine, e.g., the time span between setting the alarm clock and the alarm clock going off). Mere phase shifting (response time delay) is different from structural de-phasing, that is, for example, deserialization or one-sided pruning or extension (think, e.g., of the alarm clock unintentionally going off the day after tomorrow). As process schemes, actuation and substitution seem very general, but most technologies *are* general (take, e.g., the process of sending a messenger to somebody: it might be a messenger boy, a horseman, a messenger pigeon, or, just as well, an e-mail). Technological division of labor entails a certain degree of permanence, and a minimum number of repetitions. A unique event cannot normally be termed a technology, as it tends to unfold in unforeseen ways. A unique event absolutely may establish a technology, though. Actuation *structures* have to *preexist* for the double process to be called *technological*. An actuation structure can be *learnt from experience* or be *thought up* in advance. The latter can be difficult in case of actual tool use, because using tools normally requires prior experience in order to be able to establish good correspondence. In conclusion, it can be said that **the technological double process is essentially based on the activation of memory structures.** [26] Technology is, in a way, **not the original** (unexpected, creative)**, but a reproductive process.** This is not to say that a technological process cannot be creative and unique in its specific instances, especially with respect to its unique instantaneous informational situation. Varying circumstances will evoke varying parameters having different effects. Due to the essential preexistence of the actuation scheme, however, technological creativity appears to be limited to its parametrical variables and respective information states (as compared to structural variables, which potentially *destruct* technology)[27]. Structural *mutations* (any form of deparallelization, rearrangement, extraction and injection) make up another type of technological creativity if they have a lasting (i.e., memory-) effect on the actuation structure. It is, however, important to mention that these *mutations* are rather unplanned, unsystematic (i.e., inessential) by-products of technology processes, which does not mean that they do not become essential structural components of their respective technologies, or that they would not be capable of originating new types of technology.

[26] In this chapter, I will (have to) use the term memory in the ways it is used in *folk* psychology.
[27] There are, of course, *meta*-technologies, which vary sub-technologies as parameters. In this case, however, the problem of technological creativity simply shifts up one level.

2.2.2.2 Technological Parameterization

At this point, I do not yet want to deepen my perspective on the discrete units of the technology model, coined *parameters* and *information stages* respectively. This will be part and parcel of later chapters, when I take a dedicated cognitive-psychological perspective with regard to informational memory units and cognitive states. Suffice it here to say that *parameters* of actuation have to be perceptual or behavioral/expressive units, and that *information stages* can be understood as distinct actual cognitive constellations, somehow glued together by the instantiation of the actuation (memory) structure. Parameters and information stages are units of systematization. The technology process cannot be finer-grained than these units, as they structure the correspondence between the involved processes. Parameters and information stages of the substitution process may well entail finer-grained sub-stages, indispensable for, say, digital computation or mechanical functioning, but these do not usually become part of the correspondence structure of a technology double-process involving, say, computers or precision mechanics.

The user of spreadsheet software knows how to sum up a column of numbers (which is a special technology). The software programmer programming this part of the spreadsheet software uses other technologies, for example calling a library-function summarizing an array of cell values. The programmer of the respective function library may apply certain loop structures in her programming language’s syntax, supported by her software compiler, to realize her function. And so on and so forth, all the way down to a very distant bottom, where we find inventors of logical notations and toolmakers with their very own basic set of expressive technologies. The **tools** and their automated workings get ever more complex. One will find a stack and history of technological processes involved in creating a tool like a spreadsheet-program running on an Operating System on a Personal Computer. The parameters of a technology like summing up numbers in a column of a running spreadsheet program, however, are things like defining start- and end-cell and stating or clicking the sum-function. Well, the corresponding substitution process does not substitute or dissociate all the before mentioned stacked processes leading up to the development of the tools used in the technology. The tools are historic physical manifestations or ongoing events resulting from other technological processes; they become part of an environment that allows new technologies to evolve and take place. Therefore, in our spreadsheet example, the information stages being substituted or dissociated have nothing to do with a spreadsheet program, an Operating System, or a Central Processing Unit, the technological origins of which are not widely understood (just like most young people, contrary to a widely held belief, and quite forgivably so, do not *know* computer technology or software technology). Software, OS, hardware are but necessary things that can be found in the before mentioned technological situation. **The substitution process is always derived from**

the corresponding actuation process, and not the other way around, however technologically advanced situational artifacts (e.g. hardware) and processes (e.g. software processes) may appear.

2.2.2.3 Technological Substitution

The substitution process, as part of technology, corresponds with the actuation process in two different ways: First, by direct information exchange (parameters) and, second, by structural correspondence, that is parallelization. Neither would it be fair to say that the substitution process is represented in the actuation process, nor, on the contrary, that the actuation process is represented in the substitution process. At best, one finds a closely co-structural development, with parameters exchanged as expected and as acceptable for the actuator (process). Goal attainment, in this model, where it is given, means nothing but the realization of an anticipated (i.e., pre-realized) information stage in the actuation process. Even though goal stages may be part of the correspondence structure of the technology process, they do not have to be based on any actual information provided by the substitution process. A *silent* substitution process, if this is what was expected, can be found acceptable. The effectuation [Bewirkung] of the substitution process is to indicate the possible non-actuator (*real*, if you will) effects of a substitution process. During the technology process, the effectuation is only *accessible* via the corresponding information stages of the substitution process. Exploring the distant effects of a technological process, *analyzing* its results, is not usually part of a technological process (as the correspondence structure will collapse when *focusing* on partial results, leaving but independent fragments of the substitution process). Analysis and theorizing about results will likely comprise technology processes and types of technology of their own, though. An interesting question is what effectuation means if the substitution process is grounded in a human substitutor. Beyond any direct action and its effects, effectuation will probably encompass effects on the substitutor’s memory, likely leading up to late (de-phased, unspecific) or altogether uncoupled effects. The substituent can take many forms. The substituent ought not to be perceived as objects. The substituent is itself a process, one that could involve many objects and material components. While, on the surface, it may appear easy to separate the substitution process’s information stages in case of a human substitutor, it is difficult to do so in cases where no human substitutor is involved. What are, for example, the information stages of a stick one uses in order to reach an apple high on a tree? Wherein do we find the *substituent* here? Well, the properties potentially leading up to the actuator’s perceptions (such as, for example, those that make up the stick’s grip or the stick’s weight building up tension against the apple) ought to be recognized as part of the substitution process’s information stages. In other words, features directly (dyadically) relatable to (or from) the actuator are to be dubbed as *stageable*[28]. Analytical properties (say, the molecular structure of the stick, its hidden growth rings etc.), i.e. features not directly relatable to the respective actuation process are not to be thought of as being part of the substitution process's information states. They are part of a wider, causal-analytical network with regard to technological pre-conditions. They, however, do not directly belong to a cognitively oriented model of technology, whatever there *indirect* effectiveness or physical process-criticality may be. It is, it cannot be stressed enough, a critical mistake to confuse the subordinated *causative situation* with the *technological process*, even if highly complex technological achievements (such as computers) were to dominate the causative situation. **The artificiality of such a situation ought not to lead us to believe in an analogous artificiality of the cognitively dominated technology process to be found in it.** With regard to the substitution process's effectuation, I would like to propose restrictions similar to those stated with regard to the substitution process's information stages. Effectuation comprises *substitution* effects and *side* effects. To be considered part and parcel of the technological process, effects ought to be relatable to actuation. Due to dissociative substitution, that is *pruning* of the actuation process, with substitutive effects *disappearing*, it becomes unclear whether certain effects are still covered by the cognitive lead-structure of actuation. In other words, the actuator may simply have forgotten some parts of what would normally happen when she, for example, instructs a friend to prepare a birthday party for her (e.g. forgetting to give her friend money to buy cakes or forgetting about that invitation cards will have to be prepared and sent out, etc.). In this case, from the perspective of the actuator, the actuation process will at best compress the substitution process into fewer information stages, basically only starting it rather than also accompanying and adjusting it, without changing the effectuation (leaving the substituent unchanged, that is generating results as planned), though. At worst, the substitution process will break down. In any case, due to pruning, substitution becomes unrelatable, because of there being no stage left for correspondence in the actuation process. In the technology model, the effectuation informs the substitution process's information stages. Effectuation is special because it is subject to anticipation (knowledge[29] about how the technological process progresses and what it results to). The substitution process's information stages, however, potentially collect

[28] Besides direct dyadic relations, any components of higher-ary relations involving the actuator might as well be considered stageable (i.e., they can become part of the substitution process's information stage. As an example of a triadic relation (thirdness), consider the intention of a substitutor to go and fetch something from outside to give it to the actuator. What he is going to fetch cannot be dyadically related to the actuator (for it being out of context). Still, the intention establishes a triadic relation directly involving actuator, substitutor and an object with each other.

[29] At this point, I use the term knowledge in a folk-psychological manner only. The same as with memory, we will sort this out in detail later (see chapter 3 and chapter 4.4)!

more information than from planned effects alone. For whatever grabs (or distracts) the technologically directed attention of the actuator, might be perceived as being part of the substitution process or simply have a technologically destructive effect. Foreseen and unforeseen situational circumstances and information stemming from the actuation process itself (leading up to *reflections*) will contribute anticipatorily *relatable* information.

2.2.2.4 Technological Correspondence

2.2.2.4.1 Definition of Technological Specificity

In Figure 1, the correspondence structure is outlined in a quasi-formal manner. This, however, does not aim at further formalization at this point. It is merely meant to illustrate different types of relatedness between actuation and substitution process. It also helps specify the terms used to describe the correspondence structure by conceiving them in their semantic word field structure. Correspondence is circumscribed by actual and potential information stages of the actuation process. Matching information stages of actuation and substitution exhibit *different degrees of similarity*, that is specificity. It is important to notice that similarity here does not first and foremost mean similarity as derived from a direct comparison between two matched information stages of actuation and substitution. **The similarity judgment arises from a comparison of two information stages of actuation, namely the momentary information stage and a respective potential information stage. This potential information stage is to be conceived as the momentary information stage of actuation if it were to come under the direct influence (parameterization) of its matching (corresponding) information stage of substitution.**

2.2.2.4.2 Types of Technological Specificity

From the definition of specificity, we can generate six distinct types of specificity:

a. Actuator specificity
b. Substitutor specificity
c. Parallelization (and dissociation) specificity
d. Actuator non-specificity
e. Substitutor non-specificity
f. Deparallelization specificity

ACTUATOR SPECIFICITY

Actuator specificity [see Figure 1] means that at this stage the substitution process is informed by the actuator. If the resulting information stage of substitution were to be fed back to the actuator stage and compared with the original actuator stage, the degree of their similarity would determine the specificity of their correspondence.

Substitutor Specificity

Substitutor specificity means that the substitution process informs the actuation process. The situation given with substitutor specificity resembles the condition of the similarity comparison/impression defining any technological specificity. This would mean that the specificity is always perfect, as the relatable features of the substitution process are to be thought of as already having been integrated into the actuation process's information stage under review. The specificity of the correspondence cannot surpass the relate-ability of the substitution process. Thus, the relate-ability of the substitution process is an important quality-criterion of technology in its own right, not to be mistaken for specificity of correspondence. A substitution process of insufficient relate-ability will either de-phase quickly (due to uncontrollability) or not meet expectations[30], both cases likely to result in quick discontinuation of the technology-process.

Parallelization Specificity

Parallelization specificity is a quite interesting theoretical type of specificity of great practical importance, as it describes correspondence *without* actual information exchange between the two constitutive processes of technology. For highest parallelization specificity to occur, the respective actuation information state has to be void of information not being part of the concurrent substitution information state, but, conversely, it does not have to be filled with any specific information given in the substitution process. In theory (as can also be predicted for practice), a mere placeholder or pointer would be sufficient to keep the correspondence structure in full force. Parallelization, however, ought to be bridged by the actuator being informed by the substitution process (substituational adjustment), as a succeeding non-informed actuator-parameterization will always get in a state of low specificity, at least unless the substitution process is in a state of low relate-ability, of course. These theoretical considerations explain the general (actuator-) principle, according to which one should strive to be informed before deciding to intervene technologically, without, however, demanding for an *ongoing* information-rich reflection of the substitution process's information states.

Actuator Non-Specificity / Substitutor Non-Specificity

Actuator non-specificity and **substitutor non-specificity** are both marked by failed parameterization. Actuator non-specificity is always at least non-specific to the degree to which the non-effective parameter (from the substitutor) contains new information. Substitutor non-specificity is

[30] Meeting and not meeting expectations are not yet part of the technology model and are therefore no further regarded at this point.

always at least as non-specific, as the non-effective parameter (from the actuator) would have been *new* to the substitutor.

Deparallelization Non-Specificity

Deparallelization non-specificity is characterized by one process not being in a relatable state anymore. The share of relatable features is an important measure with regard to the substitution process. However, it is also an important measure with regard to the actuation process. In the state of deparallelization, either the actuator or (exclusive or / XOR) the substitution process is marked by zero relate-ability (no relatable features). Another characteristic of this situation is that it is headed, followed, or enclosed by non-deparallelized information stages. A special case is given in a substitution process having zero relate-ability: the method of supposed substitutor adjustment (for the determination of the degree of specificity) is not valid in this case. Instead of concluding full specificity, no specificity at all ought to be set.

2.2.2.4.3 Measures of Correspondence

The types of specificity can be grouped into diametrically opposed sets: adjustability and inadjustability, effectiveness and ineffectiveness, as illustrated in Figure 1. From these groups, overall measures of specificity may be derived by way of aggregation. Until now, the Cognitive-Technological Model was destined to act merely as a counter-weight against the common (mis-) understanding of technology, illustrating a profoundly different approach to the matter. It is not fully formulated and by no means final. Its purpose will be to provide a fresh template to detect and re-interpret technology-problems. At this point, I will not delve any further into possible ways of aggregating specificity values. Such measures would be premature, but are still indicated in Figure 1.

2.3 Content Technology

2.3.1 Hot Media versus Cool Media

In our modern world, there are some very basic content-technologies, such as pressing the On-button of a TV-set (which even toddlers are capable of), or reading / thumbing through a book by turning pages (which preschoolers manage). The content presented thereafter is not usually perceived as part of a technological process involving readers/listeners/viewers as actuators, though. The respective actuator processes (like *reading*) are highly automatized, sub-conscious and, thus, *seemingly* unelaborate. They often do not reach beyond the next moment of attention or exposure to the medium (leaving aside diffuse senses of expectation such as being entertained, amused, touched, or getting tired, etc.). A medium does not establish a content technology by itself. It is, in the first place, a natural or artificially created environment or situation, into which one is *thrown*. Marshall McLuhan famously differentiated between hot and cool media.[31] Hot media, such as radio or movies, extend (specific or several) senses in *high definition*, requiring and allowing only low or highly automatized active participation from users, whereas cool media, such as comics, leave room for and even require constructive imagination. These two types of media can be associated to content technology (as defined in the notion of cognitive technology). Hot media tend to prevent technology-processes from happening, while cool media encourage technological processes.

[31] See (McLuhan, 1964).

2.3.2 Actuator-Triggered versus Substitutor-Triggered Technology

First, fully occupying a sense uses to mean occupying a sense *for some time*. Pausing is not an option for a hot medium. An **actuator-triggered** technology-process cannot (or, at most, only attentionally) influence a *constant* stream of information. One hallmark of a hot medium is its stimulus *rigidness* (i.e., non-manipulability). Rigidness, however, is not an exclusive feature of hot media. Cool media, too, can be rigid (and still demand involvement). Their attentive structuring tends to have more degrees of freedom. Rigidness and hot media are *essentially* correlated. It is important to notice that rigidness does not categorically exclude a content-technological substitution process. If one is interested to know the weather forecast, weather forecasts on radio and on television[32] are valid options. An advanced technology process might involve selecting the right time and the right radio station or television channel, and paying attention to the program at the right moment. However, even if accidentally listening to the radio or watching television when the weather forecasts are broadcasted, a substitutor-triggered content-technology process (paying attention to the hot medium to get to know tomorrow's weather) may start, in which a specific content-expectation (the actuation process) is set up on the fly and hopefully met by the *rigid* broadcasting (the substitution process). In other words, hot media are prone to substitutor-triggered content-technology processes; they are, in that sense, *passive* technology, at least if they were to be perceived as technological and not just as *experiential*.

[32] McLuhan saw TV as a cool medium. Here, it is treated as a hot medium, though, which the author thinks to be a more appropriate characterization for television nowadays, considering, on one hand, the development of far cooler modern information media, and, on the other hand, the incorporation of more and more (hot) movie theatre productions into television broadcasting.

2.3.3 Fragmentation of Classic Hot Media

A special case is presented by *interactive* (new) hot media. Being able to see an asynchronous stream of the weather forecast at any time offers a simple actuator-triggered technology for experiencing classic hot media. The hot medium will remain rigid. Its duration will shorten considerably, though. It will be *clipped*, clipped, at best, to match an anticipated information stage or process of actuation. This can be seen, for example, in the fragmentation or Youtube-ization of television broadcasts in digital media. Such fragmentation does not automatically imply a clear-cut content focus by necessity. This is due to traditional hot media still being *mass* media. That is, their content is limited to a few messages (one per channel). Different people (representing different expectations) have to conform their expectations to the general content available. Information of interest (matching expectation) tends to overlap with information of no interest (not matching expectation). The relate-ability of the fragmented content, as high as it may be, cannot disguise its generally imperfect technological effectiveness. For the general actuator's expectation (an anticipatory actuator information stage) will never be perfectly reflected and fully completed in the information state of the substitution process. To give an example, I want to point the reader to my frequent failure to get to know the weather forecast for Cologne, my hometown, when watching the national forecast. It does not change anything whether I watch it during live broadcasting of the evening news, or whether I decide to pick the short forecast section for asynchronous streaming anytime afterwards.

2.3.4 Attention-Grabbing Media

Classic hot mass media cannot fundamentally change to arrange for freely actuator-trigged technologies. The reason is that hot media monopolize the involved sense modalities, effectively paralyzing their non-perceptual reproductive potential. The two main modalities of human perception are sense of vision and sense of hearing, which were dominant during the time when our ancestors used to live in trees. Hot media replace a natural environment with an artificial environment, but not just any artificial environment. Hot media *grab attention*! The hot environment is one that changes constantly. A movie without or with little change, for example, offers an ambivalent, irritating experience.[33] During a movie performance, one is not prepared to actively (inwardly reproductively) think or act, because watching a movie is actually as if acting all the time, moving around, being addressed etc. The rigidness of hot media becomes effective only to the extent that it entails a quality of *as-if-acting*. *Outer*

[33] The author has vivid recollections of some of Andy Warhol's early experimental movies shown in the movie theatre of the Museum Ludwig in Cologne. In one of these films, one would see somebody very, very slowly smoking a cigar, which many people could not stand. They had to leave the theatre after some time, but not before first showing strong emotions of all kinds.

attention prevails over *inner attention*. Technological correspondence structures cannot (or, at least, not without difficulty) be initiated and sustained within a rigidly prescribed *passive* attention structure.

2.3.5 Interactive Hot Media

The *pseudo-activity* of hot media culminates in the virtual reality of computer games. A computer game has the attention-grabbing qualities of a movie. Well, to some extent, it can even be said to *be* a movie, only an unusual one. In computer games, the rigidness of the experience is not down to any particular sequence of information. The information *evolves* depending on the steps taken by the player. The rigidness of the computer game can also not be in any *as-if-acting* quality, as the player *is* indeed acting. Still, the computer game grabs the player's attention to the degree it would be grabbed by a movie (or even more so). In computer games, the *as-if-acting* of the film turns into an ***acting-as-if***. The player is *forced* to *constantly act within the game* and attend to it *as if the player were a figure* of the game (that is without being herself). In most games, there is a limited set of very short and simple technological processes the player can engage in. They are all more or less directly triggered by the virtual environment of the game. They are, therefore, for the most part, substitutor-triggered, not actuator-triggered. Furthermore, any technology-process occurring is limited, in structure and effect, to the givens of the endemic world of the game. Any technology process has to follow the *rules* of the game. **Computer games add the *illusion of acting* to the *illusion of action*.** Instead of acting freely, the gamer's actions follow the game's actions. Instead of pursuing a goal, the gamer is literally pursued by goals, engaging her in a never-ending stream of *attention-grabbing acts*. The gamer is instructed (and motivated) to follow the game. The gamer thus meets the demands of the game-maker. The gamer appears, so to speak, as an *active substitutor* more than a passive actuator. Games and *gamification* of life are manipulations of gamers and their lives.

2.3.6 Interactive-Media Technology

In this thesis, we do not deal with hot (manipulative) content technology, though. My focus is on cool (manipulable) media tools, which allow actuation processes to occur and evolve. By now, the reader will understand that it is not sufficient to attribute the coolness of a medium to it being interactive or non-rigid. So-called *interactive technologies* are really a hodgepodge. Observing the progression of the Internet, which is about to become or has already turned into the dominant electronic medium (replacing TV), it is not difficult to see that there is a huge effort under way to make the interactive, *manipulable* Web a *manipulative* Web. The most prominent *gaming* platform right now is Facebook; their game plot is their users' social life, skillfully substituting real, directed social interaction with virtual, unspecific social actions such as *liking* and *posting*. The Facebook *wall* is but a movie that is algorithmically optimized to serve a single purpose: holding attention for as long as possible to place advertisements. To be fair, Facebook, like all the other big advertising Internet-players, is really a mixed bag. However, the predominance of manipulative technologies over manipulable technologies and the growing proportion of the former cannot be overlooked.

2.3.7 INFORMATION-MEDIA TECHNOLOGY

So far, I have used the term *information technology* as it is commonly used, to denote digital software and network systems. Information is a term for both an abstract thing (information) and a process (being informed). Content technology here has been clearly defined as a technological double process stimulating the actuator's senses in a pre-structured, expectant manner. The cognitive valence of *information technology,* in contrast, is unclear. It may refer to the fact that making or usage of *information technology* somehow involves information (the process). Alternatively, information technology may denote systems that *hold* information (the thing) and inform other systems or users (the process, again). The development of the provisional cognitive-technological model has already helped us to see how problematic and misguiding these conceptions of technology are. Not all *information technology* can reasonably be counted as technology at all. In the cognitive-technological model [see Figure 1], the process of information is reflected in the in/out swimlanes. Information states are reached by different information processes: parameter inputs, previous states, and memory (as mentioned, but not yet explained). So far, the exact mechanisms are left unclear. From the model, however, we learn that substitution information states must correspond with the actuators information stages and must be relatable. In this sense, there cannot be an *information technology* holding information *independent* of any actuator.[34] It must be doubted that there is a world of *abstract* information (things) independent of cognition. The substituational information states are specific to the actuator's information stages.

Terry Winograd and Fernando Flores (Winograd & Flores, 1986) have pointed into a similar direction in their semi-philosophical book on *Understanding Computers and Cognition*, discussing the importance of Heidegger's famous concepts of thrownness [Geworfenheit] and being ready-to-hand [Zuhandensein] for the design of information technology. They note that Heidegger insisted on that it is meaningless to talk about the existence of objects and their properties in the absence of *concernful* activity. Every representation has to be seen as an interpretation. As observers, we may talk about the hammer and reflect on its properties, but for the person

[34] This is actually a very bold argument, sharply contrasting, for example, with model-theoretical ideas in logics trying to establish a dyadic link between models and reality, or Karl Poppers idea of an independent *World 3*, etc.

engaged in the thrownness of unhampered hammering, it does not exist as an entity[35]. Summing up Heidegger's concepts, Winograd and Flores remind us of a fundamental restriction of ontology: The structure of objects (as represented in and by technology in the classic sense) derives from their specific uses (actuation processes). They are, thus, not simply *within* the objects. In this, we disclose the reason why the cognitive-technological model states a clear primacy of actuation over substitution, expressed in a structure defining correspondence in terms of actuator-related specificity. Unfortunately, these philosophical ideas are not widely known in IT, and this, in turn, may explain why the conception and optimization of *information technology* as *holding* static information (thing) continues to misdirect the development of content-oriented *information technology*.

Winograd and Flores also adopted Heidegger's idea that thrownness of a person within language is an essential feature of language activity. [36] Tentatively applying this idea to the cognitive-technological model, we may say that perceiving (and perhaps even generating) language is a technological process wherein language appears as an integral corresponding information structure. Although, at first glance, this might seem strange, considering the *immutability* of language expressions, spoken and written language are obviously initiating and parameterizing a somehow corresponding cognitive process. One has to *read* written language and to *listen to* spoken language. Reading is more than a unidirectional transformation of letters into spoken words. There are, for example, different ways of reading (or expressing) the phrase *human problem solving*.

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[35] Here Winograd and Flores are obviously referring to a passage in Heidegger's *Sein und Zeit*:

> *Der je auf das Zeug zugeschnittene Umgang, darin es sich einzig genuin in seinem Sinn zeigen kann, z.B. das Hämmern mit dem Hammer, erfaßt weder dieses Seiende thematisch als vorkommendes Ding, noch weiß etwa das Gebrauchen um die Zeugstruktur als solche.* […] *In solchem gebrauchenden Umgang unterstellt sich das Besorgen dem für das jeweilige Zeug konstitute Um-zu; je weniger das Hammerding nur begafft wird, je zugreifender es gebraucht wird, um so ursprünglicher wird das Verhältnis zu ihm, um so unverhüllter begegnet es als das, was es ist, als Zeug.* […] *die Seinsart von Zeug, in der es sich von sich selbst her offenbart, nennen wir die Zuhandenheit.* […] *Das schärfste Nur-noch-hinsehen auf das so und so beschaffene 'Aussehen' von Dingen vermag Zuhandenes nicht zu entdecken. Der nur theoretisch hinsehende Blick auf Dinge entbehrt des Verstehens von Zuhandenheit.* […] *Der Umgang mit Zeug unterstellt sich der Verweisungsmannigfaltigkeit des 'Um-zu'.*
>
> (Heidegger, 2006, S. 93)

[36] E.g. (Heidegger, 2006, S. 80):

> *Zeichen ist nicht ein Ding, das zu einem anderen Ding in zeigender Beziehung steht, sondern ein Zeug, das ein Zeugganzes ausdrücklich in die Umsicht hebt* […]

One could read it as *human – problem solving* or *human problem – solving* or even as *human – problem – solving* or, simply, *human problem solving*.

The correspondence structure of written language is variable, depending on the actuator's actuation process. This is not only to say that one gets to understand these phrase variants in different ways, but also that one actually reads (or expresses) them differently, fixating and perceiving different sub-chunks as visual wholes [Gestalten]. I would go as far as to maintain that one is able to hear different word chunks listening to the same (static) audio recording, it does not matter whether we direct visual or auditory attention. The actuator's correspondence structure of perceived language is not just a matter of word chunking. Person A might understand *human - problem solving* in the same way, as person B understands *human problem solving*. Person A needs to combine two separate sign-wholes in order to derive at the concept/idea of *human problem solving* which is available to person B right away, by a single three word phrase. The meaning correspondence of expressed language is thus not fully defined by its composition (nor by its syntax), even if one postulated a somehow shared/agreed upon, defined or feature-like word meaning of individual words and phrases (a general lexicon).[37]

Heidegger noted that signs are not to be understood as something that is dyadically related to something else by pointing to it [*ein Ding, das zu einem anderen Ding in zeigender Beziehung steht*][38]. Even by explicating / marking the structure in which spoken and written language are to be understood, ambiguity, or, in other words, differing actuation processes, will occur. Any particular sign becomes literally meaningless if serving as part of a wholeness of signs (a chunk), which generates a meaning-Gestalt [Bedeutungsgestalt] or *concept* of its own, as it were. This, it appears, is difficult to accept for many people, as it would mean that expressed language does not simply *have* a meaning (as, for example, assumed in Tarski-dyads [39] or everyday psychology and school wisdom). There is no meaning of language expressions beyond what is *realized* in cognitive-technological processes. And there is a further peculiarity of language

[37] In our example, person A and person B might share the same basic vocabulary (containing *human* and *problem solving* and even *human problem solving* as a special concept). Still, person A might read the phrase *human problem solving* as *human - problem solving* deriving at the meaning of *human problem solving*, or person A might read *human – problem solving*, not deriving at the special combined meaning (particular concept) of *human problem solving*.

[38] *In zeigender Beziehung* is, of course, a relation of thirdness. It is meant as a dyadic relation here, though.

[39] A term I learnt from John Sowa, who used it in his noteworthy contributions to the Ontolog Community Forum news group - ontolog.cim3.net (accessed on 14.08.2012). He uses the term ***Tarski dyad*** to stress that *Tarski, Quine, and many other logicians ignored the top of the* [semiotic] *triangle and focused on the dyadic link between the sign and object*. Tarski, therefore, *had a clear criterion for truth, but no recognition of intention* (what somebody intends something to mean). Alfred Tarski's dyads are contrasted by Sowa with Ferdinand de **Saussure's dyads** that unite *not a thing and a name, but a concept and a sound-image*, where *the latter is not the material sound, a purely physical thing, but the psychological imprint of the sound, the impression that it makes on our senses*.

that I want to point the reader to: The technological double process of language perception turns out to be a *double* technological double process in human language communication. Because the production of language involves an actuation process, just as the perception of language does. Both language *production* and language *understanding* are actuator-led processes. The basic substitution process involved in simple language expressions aims at expressivity as such. That is, enacting meaning by signs that substitute this meaning in a language-perceiving substitutor(-*actuator*). A higher-order substitution process, speech *acts*, if you will, stem from one actuator process developing a determination to act on behalf of a language-expressing actuator or at least to somehow conform and agree to this actuator's ideas, beyond merely *mimicking* the expressed meaning.

Karl Bühler, in his famous triad of linguistic functions[40], distinguishes between three functions of (any human sign) language. The expressive function [Ausdrucksfunktion der Sprache] is unconscious and non-intentional (on the side of the sign-bearer or sign-expresser). In it, a sign is a mere symptom (such as, e.g., hereditary facial expressions or basic emotional and onomatopoeic vocal utterances). Language of this type is not yet language in the sense of a cognitive-technological double process, but much rather a mere precursor and constitutive element of more advanced languages. The descriptive function of language [Darstellungsfunktion der Sprache] matches the double cognitive-technological double process of language (sign) expression and perception. Bühler's third function, the announcement function of language [Appellfunktion/Kundgabefunktion der Sprache], extends a language sign to signal an intention toward a language recipient. It matches a higher-order cognitive-psychological process, in as much as it strives to institute an intention or trigger an action in the substitutor(-*actuator*). Such intentions and actions, however, cannot be said to be part of the *meaning* of any language sign, they are, much rather, part and parcel of an overarching intentionality, or, higher-order actuation scheme, destined to induce specific information states on the part of the substitutor (process).

[40] See (Bühler, Sprachtheorie: Die Darstellungsfunktion der Sprache., 1999), originally published in 1934.

2.4 Language-Content Technology

2.4.1 Speech Acts[41]

The announcement function of language, which can be tracked back to Adolf Reinach, Karl Bühler, Ludwig Wittgenstein, and Edmund Husserl, was further elaborated and popularized by John Austin[42] and his pupil John Searle[43] in their *speech act*[44] philosophy. Speech acts are classified into different *acts*. For example: The locutionary act (what we, in fact, say) reflects the literal (lexical) meaning of what we say. It is, however, very doubtful that any language utterance can be explained by *lexical definitions*. Lexical definitions contain themselves expressions that, in turn, would have to be explained by further lexical definitions. Language signs, however, form a close co-referential network[45] that has never been and can never be reduced to isolated basic terms of *meanings* ridden of interpretation and interdependence. In so far, in this respect, speech act philosophy is misdirecting us. The illocutionary speech act (what one intends to say or do by saying it) contrasts with the locutionary speech act. It resembles the actuator's actual, particular actuation scheme. The illocutionary act is therefore said to fall within the area of pragmatics, not just semantics (as the locutionary act allegedly does). The

[41] This passage goes back to (Ludwig, Speech Acts and Communication. Presentation given at the Digital Enterprise Research Institute, Galway, Ireland., 2005).
[42] See (Austin, 1962).
[43] See, for example, (Searle, 1975)
[44] A short definition of *speech act*, based on Searle, is provided in (Krämer, 2001, S. 60):

> *Ein Sprechakt ist die kleinste Einheit menschlicher Kommunikation, mit welcher der Sprecher gegenüber einem Hörer eine Handlung ausübt. Er besteht aus zwei Komponenten, aus propositionalem Gehalt und illokutionärer Funktion. Unter 'propositionalem Gehalt' versteht Searle Aspekte von Referenz und Prädikation, die 'illokutionäre Funktion' bezieht sich auf die Rolle, auf das, was ein Sprecher mit der Äußerung eines Satzes in einer bestimmten Situation zu tun beabsichtigt, ob er also eine Feststellung, einen Befehl, eine Frage oder ein Versprechen äußert.* […] *wenn der propositionale Gehalt zusammenfassend mit '(P)', die illokutionäre Funktion mit 'F' notiert wird, entsteht die Standardform eines Sprechaktes: 'F(P)'.*

[45] The idea of words forming a word field [Wortfeld] covering an idea field [Ideenfeld] originated with Jost Trier (Trier, 1931). Trier stressed the **fundamental interdependencies of word meanings** [Prinzip der Wechselbestimmtheit der Wörter des Wortfeldes]:

> *Und daß wir genau wissen, was mit ihm* [dem Wort] *gemeint ist, das liegt gerade an diesem Sichabheben von den Nachbarn und diesem Sicheinordnen in die Ganzheit der den Begriffsbezirk überlagernden Wortdecke, des lückenlosesn Zeichenmantels. Die Worte im Feld stehen in gegenseitiger Abhängigkeit voneinander. Vom Gefüge des Ganzen her empfängt das Einzelwort seine inhaltliche begriffliche Bestimmtheit."*
>
> (Trier, 1931, S. 2)

illocutionary act resembles the (wider, not only language-expressive) actuation-process in our cognitive-technological model. The perlocutionary act (what one thinks one does by saying something), in our model, would refer to higher-order actuator-anticipated information states referring to, or, better, hopefully corresponding to substitution-process stages. In speech act philosophy, illocutionary acts have been further classified depending on their illocutionary force. *Assertive* speech acts, for example, tell about the world (e.g. *Peter is tall.*). *Commisive* speech acts adapt the world by deeds (e.g. *I invite you to come!*). *Declarative* speech acts adapt the word by speech (e.g. *I pronounce you as man and wife!*). *Expressive* speech acts show one’s inner feelings (e.g. *I feel good!*). *Directive* speech acts let others adapt the world (e.g. *Please, answer the phone!*). If the auditor (substitutor) understands the speaker’s (actuator’s) intended illocutionary point (illocutionary force) in its relation to the propositional content, one can be said to have communicated, as speech act philosophy puts it. The problem with language expressions (propositional content) is that illocutionary indicators (or parameters) are often missing in them, especially so in language artifacts such as written or recorded spoken language. The intended meaning and purpose is often only to be understood by additional situational, cultural, and habitual knowledge, or knowledge about the speaker/writer. The (unconvincing to me) indicative (locutionary) statement in speech act philosophy, as compared to an intentional (illocutionary) statement, can perhaps only be understood as an illocutionary statement that was stripped off of most of its illocutionary indicators. In philosophical examples, this tends to be achieved by an explicit, imperative illocutionary force forcing the reader **to leave out the background information given to illustrate the difference between the illocutionary and the locutionary stance of an example**. The differentiation between locutionary and illocutionary acts is rooted in a false dualism, it seems. Speech acts are also misleading in another sense: They perceive communication as a single act. In the cognitive-technological model, on the other hand, any speech act is to be understood as a double technological double process. The difference becomes clearer when we imagine that the listener can have an agenda of her own, being an actuator with her own intentional/anticipatory actuation scheme. Communication does not necessarily and perhaps not even often depend on the intention (illocutionary point) of the speaker. The speaker’s *illocutionary act* may fail, while the listener’s *illocutionary act*-uation may succeed. And even if the auditor understands the intended illocutionary point, can one really be said to have communicated just because the other understood what one meant? In terms of correspondence structure, this would mean to cut an anticipatory (actuation-process) **whole** [Erwartungsgestalt] into two purportedly unrelated pieces: first, some *proposition*-related substitution stages and, second, any intended effects and reactions. There is another, as it were, basic phenomenological misunderstanding in this conception of communication. I have elucidated before that the definition of a term’s meaning is something else than the term's meaning. That is to say, these are different cognitive-technological processes. Heidegger's terminology [Zuhandensein, Zeugganzes] emphasizes this. Besides, Ludwig Wittgenstein's late philosophy of language points into the same direction. Now, I would claim that the auditor's actuation processes are fundamentally different (in terms of higher-order as well as lower-order correspondence) in the two cases of, first, merely understanding the illocutionary point and, second, sharing the illocutionary point. If the auditor really were to *understand* the speaker's illocutionary point, there must be a resisting or contrary intention (anticipation) scheme in operation, which would not only structure the auditors own (lower-order) actuation-process of language perception, but also affect the higher-order correspondence structure of the interaction between speaker and hearer. Therefore, I think, it is not viable to entertain the idea of a divisibility of the understanding of an illocutionary act into an understanding *with* and the *same* understanding *without* sharing of the illocutionary point.

Despite these problems, speech act philosophy represents an interesting and valuable contribution to the research on language communication. It clearly demonstrates pitfalls and shortcomings of an un-pragmatic, restricted conception of language and language meaning: *the naive view that takes language as conveying information about an objective reality.* […] *the basis for the meaning of words and sentences is not ultimately definable in terms of an objective external world* (Winograd & Flores, 1986, S. 61). Unfortunately, the philosophical quest for differentiating illocutionary factors never translated into a quest for software supporting communication formalizing and explicating these factors in a systematic way. [46] Impoverished, *de-intentionalized* language artifacts, devoid of emotional valences, however, carry many risks to human language-based interaction and disguise the eusocial origin and function of language-technology:

> *The rationalistic tradition takes language as a representation - a carrier of information - and conceals its central social role. To be a human is to be the kind of being that generates commitments, through speaking and listening. Without our ability to create and accept (or decline) commitments we are acting in a less than fully human way, and we are not fully using language.*
>
> (Winograd & Flores, 1986, S. 76)

If language production is embedded into speech acts (as a form of cognitive-technological process), language artifacts and language

[46] There is a single notable exception I know of, though: Fernando Flores founded a software company, Action Technologies Inc., which develops Business Process Management software (ActionWorkflow™) that improves communication processes by enabling the formal expression of intentions in interaction patterns of predefined communication types.

reproductions must be mimicking speech acts. If we want to understand the pros and cons of language-content technology, we must understand more about language and its use. Although this thesis is not the right place to delve into the mysteries of language, I will still try to give an idea of the importance of some of the characteristics of language to our theoretical endeavor.

2.4.2 Origin of Language (a historical excursion)

There are two basic ways of viewing language originating: first, as developing gradually and, second, as emerging abruptly. The latter way, presupposing a sudden huge jump in evolution, appears to be very unlikely, even though it is still promulgated (in ever weaker forms, though) by the prominent researcher Noam Chomsky (and his disciples) in the idea of a language module. George Mandler, in his history of modern experimental psychology (Mandler, 2007, S. 211), reminds us that this is an old question. In 1900, Wilhelm Wundt, the father of institutional psychology, had already (splendidly) characterized the abrupt stance as a miracle theory [Wundertheorie] in the volume on language of his *Völkerpsychologie (ethnological psychology)*, noting:

> […] *that 'language presumably developed out of the simpler forms of expressive movements.' And in his introductory text, Wundt comments on the power of the naturally occurring sign language of deaf and mute children, who, when raised without any deliberate instruction, communicate by means of 'a natural development of gestural speech, which combines meaningful expressive movement.'*

When considering the origin of language, it seems to be important to keep in mind that humans did not only develop a single language. There is a great variety of human languages, characterized by an astonishing huge number of different traits in different constellations.[47] Linguists have found many syntacto-structural ways of grouping languages. For an overview of syntactic traits of known languages usable for this purpose, see the World Atlas of Language Structures (Dryer & Haspelmath, 2011). The richness and variance of syntactic features of human languages mark them clearly as cultural achievements. Thus, language structures (grammars) are historic, cultural developments! Against the backdrop of the apparent language culture, the idea of a *universal grammar* seems absurd. The richness and variety of syntactic language features is very unlikely to be matched by a

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[47] See Daniel Leonard Everett's autobiographical notes (Everett, 2010) on the Pirahã people of Amazonia for a vivid example of a language (and culture) that seems to be at odds with many expectations on language taken for granted. The Pirahã-language is a zero-marking language (i.e., it does not use any syntactical markers at all) following the *immediacy of experience principle*, shortly summarized, e.g., in (Pavey, 2010, S. 323):

> *The Pirahã (Mura, Brazil) language does not have perfect (relative) tenses* […]. *All its tenses are absolute, which means the reference time is always the same as the time of speech. Everett makes the strong (and not uncontroversial) claim that this is because the culture of the Pirahã people actually constrains the structures of their grammar: in other words, they do not have relative tenses because they live within the time and space of their immediate environment, and relative tenses require one to metaphorically place oneself outside that world of immediate experience.*

great variety of syntax-specific inherited cognitive capacities or programs (to be turned on and off as culturally needed). With regard to language(-structure), it is likely that in it one is encountering the results of many non-language-specific, general cognitive capacities in conjunction with probably just a small number of specialized, possibly language-universal cognitive operations. Wilson links language development and development of thinking, following a path paved by cognitive archeology:

> […] *by new methods of analysis and experimentation, researchers have been able to conclude this much: abstract thought and syntactical language emerged no later than 70,000 years ago. The key to this conclusion lies in the existence of certain artifacts, and in deductions of the mental process required to manufacture the artifacts. Of special importance in the mode of reasoning is the hafting of stone points onto the ends of spears. The practice was begun as long as 200,000 years ago by both the Neanderthal people of Europe and early Homo sapiens of Africa. This in itself was a significant technological invention, yet still it tells us little about reasoning and communication. By 70,000 years ago, however, a major new advance had been achieved by Homo sapiens which, when recently analyzed, shed light on cognitive evolution. Hafting, the study concluded, had become far more sophisticated. A series of steps was used to build spears* […] *The artisans needed to understand the properties of their ingredients (e.g. cohesiveness), to be able to judge the effects of temperature, to be able to switch attention back and forth between separate rapidly changing variables, and to be flexible enough to adjust to the variability inherent in naturally occurring ingredients.*

(Wilson, 2012, S. 217-218)

The complexities of language seem to be closely interlinked with the complexities of action and action-related thought. Well, it is difficult to imagine that early language expressions could have denoted and structured complex meaning beyond the cognitive capacity of imagining and remembering complex actions and events:

> *A conscious mind able to generate abstractions and piece them together in a complex scenario might, it seems, also generate a syntactical language, with sequences of subject, verb, and object.*

(Wilson, 2012, S. 218)

The propositional structure (in whatever cultural order) is the earmark of a cognitive and memory event structure, which both have to precede it. Wilson advances additional arguments based on evolutionary theory:

> *The key properties of the mind guiding language evolution almost certainly appeared before the origin of language itself. Their wellsprings are thought to be in the earlier, more fundamental architecture of cognition.* […] *The multiplicity of pathways in the evolution of elementary syntax suggests that few if any genetic rules guide the learning of language by individual human beings. The probably reason has been revealed in recent mathematical models of gene-culture evolution constructed by Nick Chater and his follow cognitive scientists. It is simply that the rapidly changing environment of speech does not provide a stable environment for natural selection. Language varies too swiftly across generations and from one culture to the next for such evolution to occur. As a consequence, there is little reason to expect that the arbitrary properties of language including the abstract syntactic principles of phrase structures and gene marking, have been built into a special 'language module' of the brain by evolution. 'The genetic basis of human language acquisition,' the researchers conclude, 'did not coevolve with language, but primarily predates the emergence of language. As suggested by Darwin, the fit between language and its underlying mechanisms arose because language has evolved to fit the human brain, rather than the reverse.'*

(Wilson, 2012, S. 234-235)

Now, this re-embedding of language grammar into the general framework of cognitive competencies is important, because the practical effect of proclaiming and sticking to a universal grammar is the exclusion of psychological theorizing and psychological-empirical research from language research, ignoring findings of developmental psychology[48], of psychology of thinking, and of psychology of memory etc. **Within the cognitive-technological model, in contrast, language structure is but another group of types of anticipatory schemes of actuation processes, stressing the technological (anticipatory, substituting or extending) character of language use and its basis in general memory structures that are established by general mechanisms of memory development.** In a nutshell, in this thesis, I theorize that language is technology and that *information*

[48] Assuming a universal grammar module was certainly not helpful in disclosing the obviously **staggered learning of syntax** during the child's language development process. For more information on this, see, e.g., (Tomasello , Die kulturelle Entwicklung des menschlichen Denkens: Zur Evolution der Kognition, 2006).

technology is made up of (and ought to be treated as) impoverished artifacts of language expression.

2.4.3 Signs and Symbols

The first human artificial signs we know of are visual signs, namely stone and bone carvings, and cave paintings. In his book about art as a global language, the ethologist and anthropologist Irenäus Eibl-Eibesfeldt comments on the surprising abstractness of the first artifacts of art:

> *Wir halten gerne jede Abstraktion für das Schwierigere, weil ein Kürzel unserer Meinung nach die Kenntnis eines Ganzen voraussetz. Dem ist aber nicht durchwegs so.*
>
> (Eibl-Eibesfeldt & Sütterlin, 2007, S. 48)

The first pieces of art we know of are outline drawings. This is not an expression of a lack of artistic skills, though. According to Eibl-Eibesfeldt, what created the first signs might have been the joy to create something that leaves traces behind. These traces are, at least for oneself, loaded with meaning. This can still be observed in child behavior today. Hence, the first artistic images do not appear to have been social-communicative, realistic depictions; they must have been rather personal in nature, rather abstract, simple contours that must have provoked vivid recollections in order to become attractive. These earliest artifacts are based on a universal, biologically anchored human capacity for Gestalt-perception. This is the reason why they could and would turn into communicative signs. Pointing movements (which can even be found in great apes) very probably predate communicative visual signs. Artificial visual signs, however, are different, as they are icons, actually (and somehow magically) bringing about what they point toward and what itself is not present in any real way. In this respect, they surpass natural visual traces such as an animal's paw prints, which represent a mere extension of the animal in time and space, not forming an independent symbol of it. The importance of visual art lies in its very independence from the presence of what was depicted, not just because of evoking independent memories of distant things, but also because of serving as a tool for these things to be imagined, named, and discussed in their absence. Language symbols are powerful because of the ease and quickness with which they can be created and communicated, but they must be learnt first, and learning symbols can best take place in the *presence* of what they are destined to symbolize. Therefore, language development in children, cultural development *of* language, and cultural development *by* language all benefit from visual art. Visual art is a direct precursor of script, and a catalyzer of language development. Is there an equivalent to the role of Gestalt-perception in the evolution of (vocal) language symbols? Are early language signs abstractions similar to those of visual art? Are they memory-abstractions of natural interjections such as cries of pain or aggression? And if so, would not language emotions have to be based on a human capacity to feel with others? The communicative purposefulness, the intentionality of language symbols is deeply rooted in their origin as vocal co-signs of personal and social emotional conditions. The basic conviction of being able to create the intended (self-felt) emotional condition in the other must be at the core of each speech act. For there to be more and more specific language symbols, for language to open a window to the world of memories irrespective of the actual presence of things, fetish objects and depictions had to be created and cherished first. Things iconized are easy to symbolize, and icons symbolized come to symbolize the symbols of what they iconize, opening themselves up to further abstraction for easier reproduction. The transition from signal to symbol is the transition from directing outer attention to directing inner attention; it is the transition from perceiving and recognizing to reproducing and remembering. Icons and language expressions, as things of the world, are sign-tools, tools that directly affect their creator as well as indirectly affecting any other recipient. In the cognitive-technological model, the perception of these tools represents a substitution-process. At the moment of their creation, on the side of the creator(-*actuator*), the non-specificity of the resulting correspondence structure is defined by **the sign-tools' reverse capacity of evoking memories that differ from the information states that, in the first place, triggered the expressions of the respective signs.** Later, on the side of other recipients, the sign-tools establish a substitution process corresponding with an actuation process that is likely to be predominantly influenced by an ongoing process of anticipating spoken language (in reading or listening) and, hence, its meaning (in interpreting). In this case, the specificity of technological correspondence is based on forward-directed anticipation-comparisons, and not, as in the case of self-reception, on backward-directed comparisons (regarding the information states during the original language expression). I want to mention that self-reception benefits from objectified signs (images or written language), as persistent signs extend the phase in which self-reflection can take place [memory buffer function]. But even unexpressed, merely conscious signs (inner language and imagination) can have the same effects as expressed sign-tools. Signs are tools, nonetheless. The term communication is perhaps best to be reserved for the (higher-order) technological processes of *anticipatory interaction*, as, for example, in turn-taking conversations or complex, sign-tools-involving collective behaviors such as those signified in Wittgensteinian language games. These real human interactions are likely to comprise far more percepts than sign-tools only, and to involve further-reaching anticipations, framing and influencing those narrower and short-lived anticipations typically evoked by sign-tools.

2.4.4 Written Language

I cannot retell the fascinating story of the invention of script here. A richly illustrated and up to date account of the history of script can be found in (Woods, Teeter, & Emberling, 2010). The oldest artifacts of script date back 5.500 to 5.300 years, in Mesopotamia. However, nobody knows for sure that script did not exist before that time in other places. Any old culture of settling could have developed it easily. I have already pointed out the script-like function of visual art, which dates back about at least 40.000 years in Europe. The oldest artifacts of script suggest that script was used for trade and administrative purposes first. Ceremonial, religious script, however, is another possibility[49] of origin. From a psychological perspective, it is interesting to learn that it did not take long before the original pictographic scripts turned into semi-pictographic scripts. This happened in two different ways. First, by developing handwriting (on soft clay tablets, instead of engraving pictograms in stone or rocks, or using objects in a token system etc.), which caused a very rapid process of abstraction of logograms. Second, logographic script soon developed into a mixture of logographic script and syllabic characters and semantic and syntactical markers. To understand the difference between the (Old Egyptian) town Elephant and the animal elephant, one had to mark the difference, for example by *bracketing* logograms to form a perceptible word compound. Furthermore, many existing terms must have been difficult to visualize (and learn). Even though the earliest scribes used lists of logograms, sorted by topics, in order to be able to learn them and to look them up, names and abstract terms must have posed a great challenge to them. Fortunately, many names and abstract terms sounded like things that were easy to visualize. As soon as one started marking some logograms as *syllabic*, one had derived at an expressive *hieroglyphic* script. The use of logographic syllabic characters stimulated the development of new syllabic characters to fill in the gaps, sometimes reusing logograms associated with spoken words starting with the syllable needed, thus shortening their vocalization. Spoken language was very likely already highly complex at the time script systems developed. Agglutinative languages must have put pressure on scribes to reflect spoken syntactic markers in written language, bringing about fine-grained affix symbolization (entailing, e.g., syllabic onsets and offsets). At that moment of history, all it took for an alphabet to develop must have been an innovative polyglot (Greek) trader wanting to create an easy to learn script for his mother tongue, experienced in the relative ease of learning of syllographs as compared to logographs, and understanding the directly proportional relation between a character’s reusability and its phonetic granularity. Comparably isolated, monosyllabic languages (like Chinese), on the other hand, might never have felt the pressure to progress beyond the hieroglyphic or syllabic stage of

[49] See, e.g., (Haarmann, 1998) on the Minoan script Linear A.

script development, leaving them with a difficult to learn but perfectly usable historic script. Maryanne Wolf stresses the cultural importance of the Greek alphabet:

> *The classicist Eric Havelock and the psychologist David Olson assert the thought-provoking hypothesis that the efficiency of the Greek alphabet led to an unparalleled transformation in the actual content of thought. By liberating people from the effort required by an oral tradition, the alphabet's efficiency 'stimulated the thinking of novel thought.*

(Wolf, 2008, S. 65)

The development and use of script was not always hailed as liberation, though.

2.4.5 Plato's Criticism of Written Language

Well-known are Plato's comments on the use of script in his Phaedrus dialogue. In a history reported by Socrates, the Egyptian God Theuth maintains that his invention of script had improved wisdom and memory. This leads Thamus, King of Egypt, to answer as follows:

> *Those who acquire it will cease to exercise their memory and become forgetful; they will rely on writing to bring things to their remembrance by external signs instead of by their own internal resources. What you have discovered is a receipt for recollection, not for memory. And as for wisdom, your pupils will have the reputation for it without the reality: they will receive a quantity of information without proper instruction, and in consequence be thought very knowledgeable when they are for the most part quite ignorant. And because they are filled with the conceit of wisdom instead of real wisdom they will be a burden to society.* [50]

From this, we learn that there must have been a practice of mnemonic techniques in the old, script-less Greek culture. Literate people started to compete with illiterate people. The objections to script are, as it seems to me, eternally true: Those who tend to remember from script will probably neglect to try to memorize, even if what is to be remembered were presented in a form that is easy to memorize. In some way, an inscription of script seems to replace an inscription of memory. This is not exactly true, though, as we have already learnt that the self-reflective process of language expression benefits from persistent script. Furthermore, a writer tends to sway to and fro between two processes: writing and reading. Writing down what comes to mind, and reading what has (just) been expressed. Each intermediate episode of reading will start an actuation process (interpretation) of its own, potentially evoking new memories and new ideas. For the writer, the written sign layer is an inspirational source of its own, helping to refocus, to redirect and enrich the writer's original stream of thought. This, however, comes at a price. Inserting new phrases and sentences into a text after reading and rereading, destroys the concurrence of the original sequence of thoughts and the final sequence of text. A creatively written text is difficult to remember as a whole. It is, furthermore, difficult to remember what has been said where, because the episodes of writing do not match the sequence of propositions in the text. Of course, this is true only in general. There is always the possibility to note things in a strict regime, that is to note them exactly as remembered or forethought. In this case, however, there would be little difference

[50] (Plato, 1973)

between classic recitation or speech-making and writing. From the writer's perspective, writing, in the first place, is a *creative* and not a *mnemonic* technology. It is a creative technology that, on the surface and according to its organizational use, appears to be a mnemonic and communicative technology, because it creates an artifact that one might rely on *to bring ideas to remembrance or to pass ideas on*. The underlying value of *writing*, namely reflectively provoking new ideas, has been overlooked.

Plato understood the limited mnemonic qualities of text when he claimed that writers would *cease to exercise their memory and become forgetful*, which implies that Plato could not have thought of writing or reading as ways of exercising memory. Whilst indeed new ideas are created by writing, these new ideas are to fade into obscurity if memory is not exercised properly. In order to bring these new ideas to mind, it will often become necessary to reread what one has written. The conflicting sequences of utterances of thought, on one hand, and written thoughts, on the other hand, can make it difficult to find an idea (of one's own) in a text (of one's own). One might think that a properly structured text would solve this problem. However, the normal structure of sequential text just splits the text into smaller text containers. This, at best, diminishes the problem to some degree, but the problem will not be resolved by it. No typical creative, sequential text has the qualities of a highly organized memory structure, no such text, therefore, could replace exercising memory. Writing a text and learning a text are not the same. Neither is learning by a text the same as learning a text. A text structure, to be memorable, has to have a meter, rhymes, in other words, it has to be *epic* and *poetic*. Instructions do not easily translate into poetry, though. Of course, it is easy to object to the idea that the text itself had to be memorable. One could argue that what matters is the content of the text, not the text itself. An extreme position would claim that written language is just a medium of some language-less content or meaning. The question is, of course, why in this case one would have to memorize anything at all. As soon as one has read the text, one knows its content (in as much as one understands the language), and as language was the means to memorize the *content*, it also is the means to express it. One just has to remember the content. Language would be but a learning and communication tool. This view, however, neglects a fundamental function of language technology: being able to remember and directing remembrance.

When Plato fears that readers will *rely on writing to bring things to their remembrance by external signs instead of by their own internal resources*, the internal resources he speaks of are *internal* signs (in opposition to external signs), which are readily available in order to make available the things (content) to be remembered. In Plato's view, thus, language is more than a mere tool to acquire and express the content of language. Plato understood that language is a memory tool, a memory access technology. Moreover, this technology is believed not to be available from written texts, at least not at short notice. In Plato's critique, we encounter the implicit differentiation of two types of knowing: knowing as in having known once and, in principle, being capable of being reminded of it by external (language) signs; and knowing as in having known once and being easily available by a sort of (internal) language organization system. Plato couples the latter type of knowing with *wisdom*, whereas the former type is said to generate the *reputation for it without the reality*.[51] Another interesting point of Plato's critique is his stress on personal instruction of pupils. When reading, pupils *will receive a quantity of information without proper instruction*. Whatever instruction means exactly, it somehow involves pupils who are being instructed. That is to say that we can assume it to mean a dialogue between teacher and pupil, as compared to a one-sided lecture (which could easily be written down). The presumed quality of an instruction is that it is individually constructive in the sense that the teacher recognizes what the particular pupil does know, does not know, or does know, but does not understand, teaching the pupil accordingly. The static written text does not *know* and has no means to get to know what the pupil reading it knows, and it cannot know it as to restructure, to decrease, or to increase itself in order to meet the specific demands of an individual instruction. This poses a fundamental problem to the use of any written information in education. Then again, Plato did clearly miss the value of libraries of historic texts collecting the *world's knowledge* of all (literal) times. Texts containing information to an amount that no living teacher could teach anymore, that, perhaps, not even all the teachers of the world living at the same time could teach anymore or find pupils to study for. The information collected in these texts surpasses human memory capacities, or at least the time available to learn it. Plato's *quantities of information* have turned into an *information flood*. It is not anymore only ignorant to believe to know the information one reads; it is as ignorant not reading the information one ought to read. However, not reading is an impossible to avoid *factual* ignorance, while non-instruction is a possible to avoid *social* ignorance. Written language remains silent:

> *SOCRATES: The fact is, Phaedrus, that writing involves a similar disadvantage to painting. The productions of painting look like living beings, but if you ask them a question, they maintain a solemn silence. The same holds true of written words; you might suppose that they understand what they are saying, but if you ask them what they mean by anything, they simply return the same answer*

[51] In today's world, as *written knowledge* has become abundant and it is easy to search for any information on the Internet, the illusion of wisdom by written language got its 21st century name: *digital dementia*. People suffering from digital dementia are less and less able to remember things by their own, and they are less and less likely to form memories. This is probably caused by a lack of memory elaboration. See, e.g., (Spitzer, 2012).

> *over and over again. Besides, once a thing is committed to writing it circulates equally among those who understand the subject and those who have no business with it; a writing cannot distinguish between suitable and unsuitable readers. And if it is ill-treated or unfairly abused it always needs its parent to come to its rescue* […]
>
> (Plato, 1973)

Text is decoupled from its author's thinking. It is distributed in a way that it will be read by readers who cannot understand it. Their questions, however, remain unanswered, or they think themselves knowledgeable, when they are not, because written texts cannot be questioned and they cannot question. These are insights that are as simple as lucid and as valid today as they have ever been. Today, however, in view of the enormous advances of *information technology*, we may finally attempt to tackle the problems associated with them.[52]

It is interesting to learn that a later historic development can be added to the Platonic-Socratic critique of script. As long as script depended on handwritings, which were difficult to copy and thus as difficult to distribute (without losing the script and the *knowledge* in it), script often bore marks of structures aimed at assisting memorization. The printing press, however, put an end to this:

> *The schematic layouts of manuscripts, designed for memorisation, the articulation of a summa into its ordered parts, all these are disappearing with the printed book which need not be memorised since copies are plentiful.*[53]

Handwritten manuscripts were well prepared for memorizing, by a high degree of schematizing, by summarizing and by ordering of written thought. These meta-structures of text helped to increase the ability to remember text thoughts, by hierarchically indexing or summarizing them, in order to be able to teach the content of the text, as the author of the text or as another reader. For the author, the manuscript still had a memory-assisting function, as it could not just be passed forward. The manuscript structure represented an explicit ars memorativa, destined to degradation as soon as printed replications in large quantities allowed for mass distribution of texts, for then the originally limited communicative function of manuscripts started to outweigh their mnemonic function. The situation has not changed considerably since then. Strictly speaking, the structuring of most present-day texts is not aimed at aiding memorization. Text sections, titles, tables of content, page numbers and chapter numbers etc. all serve another purpose: orientation in the text. They are ways of supporting

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[52] A fruitful combination of the social advantages of teaching and the economic advantages of written language can be encountered in *blended learning*.
[53] (Yates, 1974, S. 124)

(re-)finding or looking up information in the text, they are not usually tools of memorizing it or reflecting on it. As means of reference, they presuppose the unrestricted availability of the text, and imply that a text is no longer destined to be taught or remembered, but only to be either fully read or first searched and then partially read.

2.4.6 Overcoming Defects of Written Language

Overcoming the defects of written language is one (distant) aim of *extended artificial memory*. Plato's critique of script has not been discussed without hindsight. I want to derive from it a number of main requirements and major goals of an extended artificial memory system that all information systems (to be discussed) will have to be measured against. An information system overcoming simple script in texts would have to:

> **Requirement 1: Present propositions only insofar as they can be understood by the reader.**

Each textual statement would thus have to be related to the knowledge of the reader. In order to achieve this, one would need a system that does not only contain the text to be read, but also the actual knowledge of the reader.[54]

Text should further …

> **Requirement 2: Allow the reader to advance beyond its surface into the field of the author's knowledge.**

Not only would the system have to comprise each reader's knowledge, it would also have to contain the knowledge of the author, so that the reader could deepen his knowledge of the author's thoughts as far as these thoughts reach, and not only as far as they are presented as written language. This would allow the reader to question the author's thoughts beyond what is presented at reading.

For the author …

> **Requirement 3: The text should do more than reminding the Author of what he already knows. It should be a creative tool.**

Moreover, as if all this were not enough …

> **Requirement 4: The text should help to build up a memory structure improving instantaneous knowledge.**

Text should, on the other side, …

[54] The reader of this thesis is asked to pardon the author for sweeping away nearly all knowledge management systems with his first requirements. It is as simple as it is sad: All current knowledge management systems ignore Plato's critique of written language, and do not seriously try to design written language systems tackling the problems of written language.

Requirement 5: Support instantaneous, thought-accompanying and thought-complementing information retrieval.

I know that to most readers these requirements must appear lunatic. They strive for nothing less than **a technological combination of the advantages of the culture (traditional technologies) of dialogue and the advantages of the culture of script.** (They are, however, not as fantastic as, say, the struggle for artificial intelligence and its absurd promises and forecasts from many decades ago, which, it is fair to say by now, has totally, but successfully failed into a few useful machine learning algorithms. Another, related attempt also failed[55], this time not at all successfully, though: expert systems. Terry Winograd disclosed the similarity of these two attempts when he wrote *calling a program an 'expert' is misleading in exactly the same way as calling it 'intelligent' or saying it 'understands'*.[56] I'll discuss this in some detail later.)

[55] *It is fair to say that the vaunted potential of expert systems has never been realized.* (Davenport & Prusak, 1998, S. 126).
[56] (Winograd & Flores, 1986, S. 132)

2.4.7 Mnemotechnics

We heard Plato talk about the importance of exercising memory. We might therefore be tempted to think that mnemotechnics hold the key to knowing. Oral language culture developed an art of practicing memory, ars memorativa (a.k.a. mnemonics). As texts were not on hand, or, for the longest time, at least not in sufficient numbers, other signs than letters and words were used for remembering. In this respect, one can distinguish roughly between visible and invisible signs. The Greek poet Simonides of Ceos established a mnemotechnic that made use of visual-spatial-verbal structures as memory aids. Simonides is the first known advocate of a Greek tradition of ars memorativa that must have reached farther back in time.[57] The first and simplest form of mnemonics was perhaps given by associating a to-be-remembered word with a visual imagination, whereby a visual symbol, a logograph or ideograph, is created in mind, which could also easily be externalized if needed. Wherever such symbols of imagery were applied, a very simple, more or less idiosyncratic form of pictographic, imaginative script was developed.

The mnemonic system of Simonides of Ceos is called method of loci. Simonides found that things are easier to remember if one *places* them at locations, not actually in reality, but merely in mind. The mental locations should be well known, in close neighborhood to each other, and directly next to each other, but also sufficiently distinct as to be able to remember them individually. These locations could then be visited in mind (or even in reality), one by one, in the intended (or reverse) sequence, finding the things that were *placed* at the locations. Elaborations of the method of loci recommended improving results by fantastic arrangements at the loci, by adding, for example, very emotive images (such as a splendid crown or a devil etc.). Furthermore, remembering should be exercised repeatedly visiting the locations in mind.[58] The method of loci is still known today. Its techniques have become scientifically researched memory improvement strategies: emotional and visual elaboration, besides frequent repetition. The method of loci uses a very general principal: signs (the locations) and symbols (the imagination of things placed at them). The more modalities are being involved, the likelier it will become that the to-be-remembered words or things will indeed be remembered. Each modality acts as a sign layer of its own, together forming a multimodal, multilayered association network that benefits from being able to be accessed from different directions. The location signs and emotional signs can be very effective. However, this should only appear impressive to the psychological amateur or the self-fascinated memory artist (or the experimenting memory researcher), because such ars

[57] Readers interested in the history of ars memorativa will benefit from reading Frances A. Yates' *The Art of Memory* (Yates, 1974) .
[58] (Yates, 1974, S. 10)

memorativa is restricted by the potential number of signs available. Due to a limited number of location signs and emotive signs, the number of things to be remembered at any one time is limited, too. As soon as one starts to reuse signs, confusion is likely to occur. The same is true for any mnemonic technique using simpler / shorter signs to denote complex information (e.g. a letter-code for complex sequences of numbers). This works only as long as the number of information complexes to be denoted does not surpass the number of signs available. The practical applicability of all mnemonic techniques of this type is therefore limited to sporadic (demonstrational) use of a small number of signs for a small array of things or secondary-signs (like longer number strings). Sign-substitution is nonetheless astonishing because of the therein-obvious human capacity of chunking (lower-order) information for (higher-order) signification. **Still, substituational indexation is applicable only to a limited extent, because of the polysemy stemming from reusing signs.** Spatially static reference systems, on the other hand, have yet another disadvantage: If an element happens to be added into a to-be-remembered sequence, one of three things can happen. First, an additional location would have to be added (destroying the *natural* organization of the locations). Second, one location-sign would have to denote two or more different things (a form of homonymy). Third, the new thing would have to be inserted into the location sequence (potentially causing considerable recoding costs). None of these *solutions* is anyway attractive. Thus, a supposed advantage (sequenced recollection) can easily turn into a disadvantage (unsequencable encoding). Yates cites an additional disadvantage of the method of loci, which may come as a surprise:

> *The formation of the loci is of the greatest importance, for the same set of loci can be used again and again for remembering different material. The images which we have placed on them for remembering one set of things fade and are effaced when we make no further use of them. But the loci remain in the memory and can be used again* […]
>
> (Yates, 1974, S. 7)

But as well as the direct remembrance of things fades and is therefore to be supported by signs, the remembrance of the association between the signs and the things is also destined to decay, especially so as the signs are being reused (which strengthens only the signs as such in memory). - Even a simple imaginative, iconographic sign (a visual elaboration), used to remember a sign (such as a word) rather than a naturally visible object, does improve recollection only at a long-term cost. If applied to remember abstract words or abstract issues [abstrakte Sachverhalte], it becomes ambiguous (homographic) relative to its original sense and relative to any newly assigned sense. All classic ars memorativa (besides repetition) remains limited because of its inner mechanisms. The practical use tends to be (domain-)restricted and short-termed, applicable only in special cases (memory games or necessarily seldom occasions in which a limited set of information has to be quickly learned and/or quickly reproduced (without being able to take notes). **No ars memorativa, however, could ever replace *natural* language's towering memory function, especially given the powerful means of transcription of oral language.** Even the seemingly trivial technology of writing and using a list uses to surpass the effectiveness of any ars memorativa, practically endlessly *extending* memory. Language itself, it appears, is the greatest human ars memorativa. But why then did Plato object the idea of script? If it was not for any special mnemonic technique (something that wouldn't be worthwhile considering any further), was it because script would seduce people to stop reusing language by rethinking thoughts, that is by repeating what one knows. Script appears physically dead and therefore impossible or difficult to reorganize. In remembrance, however, one is able to bethink what one knows, practicing knowledge means to vary it, to network it, to refine it, to ever further infer from it and thus enrich it. The availability of text turns dynamic memories into static signs, leading to the double-mistaken conclusion that, first, signs themselves are not vivid (i.e., not recipient-language-technology as introduced in this thesis) and that, second, the thoughts that generated these signs are as static as the signs make them appear, while they are actually as vivid as interpreted signs are. Knowledge preservation is founded in *reproductive* thinking, not in script production (which may count as *productive* thinking). Closing this short critique of the art of memory, it should not remain unmentioned that even today the role of artificially arranged knowledge representation as memory aids, as a general mnemonic technique, is grossly overrated, while the mnemonic power of the seemingly simple *natural* language is grossly underrated.[59] General critique of ars memorativa is not new. The author is not the first to come up with it. Yates cites Albertus Magnus' critique of the metaphorical-imaginative mnemonic language of the antique rhetoricians in order to support her own doubts:

> *But might it not have been easier to remember all this through the actual facts (propia) rather than through these metaphors (metaphorica)? We salute Albertus Magnus across*

[59] A typical example of the Zeitgeist can be found in (Reinmann & Eppler, 2007), which list a plethora of knowledge visualization (and thus, at least supposedly, also imagination) techniques, that, certainly, all may become valuable under particular circumstances for particular purposes, but which are certainly all not geared for general use of knowledge practicing. Mainly because of their small sign repertoire (usually some predefined locations, some shapes, colors, lines, etc.). These supposedly mnemonic techniques rely on the same superficial sensationalism as any classic ars memorativa. The more often and the more of these tools one uses, the less effective they become as mnemonic tools, up to total uselessness and even harmfulness, because the rather arbitrary visual arrangement, the artificial emphasizing and separating, tends to turn into a mere distraction from the main things, namely the language signs and their meaning, and the interdependencies between the former and the latter and between the former amongst each other and the latter amongst each other.

> *the ages for having had worries about the classical art of memory so like our own.*
>
> (Yates, 1974, S. 65)

Yates adds that images can be valuable memory aids and that a few images may suffice to memorize a lot (a dense form of indexation, with all the problems mentioned by me before). Furthermore, Yates remarks that metaphors, even if less concrete, can be emotion-filled and therefore easier to remember than the to-be-remembered thing (providing a kind of affective reference system, which would be, of course, loaded with problems as only a small number of emotion-filled metaphors are available, which limits their general usability as mnemonic tools). The once popular idea of ars memorativa transformed into an occult art [60], as soon as printing letters took effect, only to, in the end, be rejected as exactly such, an occult and antiquated matter.[61] Today, ars memorativa is still alive in form of, *in general*, ineffective, overgeneralized experimental findings of memory research (such as *to visualize or emotionally charge the to-be-remembered thing*) and in form of some similarly misguiding recommendations by the science of knowledge management. Popular strategies and recommendations to memorize things focus on memorizing particular things for limited purposes, they do not look further ahead; they do not envision *wisdom* as the goal of their practice, *wisdom* that is created by creative reflections, by (re-)examining one's thoughts in (daily) practice (instead of letting them rest in a once written state), or, in other words, by **productive reproductions**. The only human technology that seems capable of serving this broader goal is the general sign system of *natural* language, from which most other sign systems (e.g. mathematical, logical notations etc.) were derived.

[60] (Yates, 1974, S. 127f)
[61] (Yates, 1974, S. 159)

2.4.8 Historic Origin of Artificial Memory

In order to make better use of natural language, one would have to answer a seemingly simple question: **How does natural language relate to memory?** Ars memorativa, especially the method of loci and its likes, creates an imaginative scenario. **The to-be-remembered things are assigned to separate memories. This does not just improve remembrance; it actually creates an *artificial* memory (a term first used in ars memorativa).** Assigning the to-be-remembered thing in itself does not yet constitute artificial memory. Artificial memory is only created by the arrangement of signs or symbols to form new constellations, together with their denotations. These constellations deviate from what was originally experienced in that they **arrange the assigned (to-be-remembered) things in the memory structure of the sign system**, and vice versa. It is easy to see the artificial arrangement of (say, originally unordered) things by the method of loci, but it is much more difficult to see and understand the arrangements effectuated by the tokening use of human natural language. Generally rejecting the technologies of ars memorativa, I still have to recognize the powerful general cognitive principal manifested in them, that of ***artificial memory*, a memory and thought system established by the co-structural mapping of a sign array and an array of experiences denoted and restructured by it.** It is important to notice that this is different from *fantasies*, which combine experiences into new *artistic* memories, but do not necessarily establish any co-structural sign system. It is also different from any alleged singular or basic (language) sign, which is perceived to tokenize the world in an isolated manner. Such independent signs may exist, but they would not yet form an artificial memory. As **the core function of an artificial memory is in the parallelization of a sign structure and an experiential structure**, however, **artificial memory will comprise a wide range of human cognitive technologies, harvesting given (language) structures to encompass a plethora of inrushing episodic experiences, constructing new *artificial memories*, and thereby re-, co-, and destructing originally episodic *experiential memories*.**

2.4.9 Language Being (not Representing) Thoughts

In our discussion of ars memorativa, we have won the idea and notion of artificial memory, based on ***co-structural* cognitive technologies**, restructuring experiential memories (and, consequently, also being restructured by experience), explicitly and purposefully given in the art itself, but, as I presumed, also, only this time implicitly, given in natural language. This suggests the idea of individual artificial memory as the major (knowledge) structure formed by language. Language is normally perceived in a very different way, though: as a collection of more or less complex signs, each having a single or a number of static meanings (a lexicon), used to express or understand a thought, following syntactical rules, which represent another part of the language. Given some idea to be expressed, the necessary lexemes are *looked up* in the cognitive lexicon, arranged, and modified according to the syntactical rules of the respective language. In this model, there is a language with its signs, their meanings, and the language production rules, on one side, and something to be expressed or understood on the other side. It is a model of direct translation or conversion of a given thought using a tool named *language*. I have to admit that I believe that this model has many fundamental shortcomings. Some become obvious when we begin to contrast the traditional view of language with some alternative or side views of language. An alternative view of my own, however, will depend on a further elaboration demonstrating *language* to be a multitude of cultural cognitive (artificial memory) technologies *realizing* (not just translating) special processes of thought. It goes without saying that, in this thesis, especially as a non-specialist, I am unable to provide anything but a short, incomplete and more or less superficial critique of the traditional idea of language. I still do not want to shy away from such a critique, because I have the impression that at the bottom of many linguistic theories there is the same **old idea of distinguishing and *extracting la langue* from *la parole*** (which will be discussed in the next section). An idea that I find unappealing and misdirecting, even more so as it resembles and probably even strongly influenced another common differentiation, namely that between *knowledge* (in the sense of *la langue*) and *knowing* (in the sense of *la parole*). The latter distinction, however, is of great theoretical importance to this thesis.

2.4.10 Questionable Separation of Speech and Language

We first have to deal with a historically important idea of the linguist Ferdinand de Saussure, important because it split the *language topic* into several areas of science or perhaps even into several sciences. I am talking about his distinction of la langue and la parole, in other words, between language and speech:

> *Die Sprache besteht in der Sprachgemeinschaft in Gestalt einer Summe von Eindrücken, die in jedem Gehirn niedergelegt sind, ungefähr so wie ein Wörterbuch, von dem alle Exemplare, unter sich völlig gleich, unter den Individuen verteilt wären. Sie ist also etwas, das in jedem Einzelnen von ihnen vorhanden, zugleich aber auch allen gemeinsam ist und unabhängig von dem Willen der Aufbewahrer. Insofern kann das Vorhandensein der Sprache dargestellt werden durch die Formel 1 + 1 + 1 … = I (gemeinsames Vorbild).*
>
> (Saussure, 1967, S. 23)

The mathematical formalization sums up instances of personal vocabularies into a single, supraindividual common vocabulary. This appears to be very dubious: Is it possible that even only two people share the exact same vocabulary? This position is unrealistic to such an extent that it can only be defended and understood by claiming that there are different (partial) languages and thus different vocabularies that one does or does not share with each other. Such partial or specific languages could be separated by factors such as school of thought, region, class, profession etc. Another obvious problem of this formalization is that it is not open to change. The slightest variation of vocabulary would have to establish a new language and, correspondingly, a new language group [Sprachgemeinschaft] to fit into the equation. Furthermore, individual language development is excluded from the view, because the *1*s in the equation are probably meant as full vocabularies, not vocabularies developing (in children or second language learners). Thus, this and any idea of language as a common vocabulary raises at once the three fundamental problems of, first, language demarcation, second, cultural language evolution, and, third, individual language development. All three problems are united in one aspect: they can only be understood as *processes* of language *application*, in groups, in historic and individual development. Saussure establishes a prototypical language as an object of study, deliberately excluding any dynamic, any social and individual aspect of language. In Saussure's formula, a single individual equals a single language, but this is misleading. To support the idea of a language group, the language group must be thought of as an abstraction of people who overlap in a particular vocabulary, not as people who fully match in a vocabulary. The presence of additional language vocabularies, however, is likely to affect the one commonly shared vocabulary needed for defining the language group. The overlapping is unlikely to separate the vocabularies in a clear-cut manner. Homonymy and synonymy, for example, will appear individually, depending on the availability, use and reuse of language signs in the vocabularies available to the individual. Thus, the idea of a language group and the formulation of it sharing a single vocabulary are fundamentally conflicting and, thus, downright paradox. The only remedy would be to seek refuge in yet another abstraction of language: understanding it as supraindividual, in the sense, of course, that it cannot be valid in any single case. Nonetheless, one would have to give up Saussure formula and simply state and claim *I* (the prototypical vocabulary). One might think that Saussure's *I* is, after all, something to work with. However, a de-socialized, de-historized, de-individualized and de-developmentalized science of language or grammar has a huge problem: in all its nomothetic dealings, it must either shy away like hell from any empirical meat or abstract it beyond all recognition. It can only work with paradigmatic examples of language, such as well-built sentences, in order not to spoil the impression of *la langue*. In all its theories, it will be doomed to search for rules and language *realizers* as abstract and static as it is itself and is to remain as long as it sticks to Saussure's definition and idea of language as an abstract object of study. In other words, this science is in a hopelessly self-restricted position, similar to, say, behaviorism. Instead of following linguistics on its theoretical main path, therefore, I think it to be far more interesting and revealing to follow some of its side paths (and aberrations it has caused), where it is confronted with the realities of language (use) that it otherwise tries to abstract away.

An alternative to a very common vocabulary, such as a full *national language*, is a small-group or individual vocabulary. It is quite understandable that until recently personal and small group vocabularies did not attract too much attention in linguistics, because it would have been difficult to capture the relevant language artifacts before they could be individually recorded or derived from so-called user-generated, digital content. Grimm's dictionary took more than a lifetime to create. A specific, manually annotated corpus was not reasonable before the advent of computer technology, and not fully usable before the development of refined relational databases with their powerful query and manipulation languages. The age of print simply did not have the tools to record and analyze a multitude of individual vocabularies, because at that time it took a multitude of individuals to record, analyze, and replicate a single vocabulary. The image of language must have been dominated by the artifacts and tools then available to deal with language, that is to say, by *books*. A dictionary, a treatise, or an encyclopedia was all one could strive for reasonably. The former tools of language predefined the idea of language, and they continue to have an ideological effect long after they ceased to limit language analysis in practical terms.

2.5 Beyond Traditional Linguistics and Knowledge Management

2.5.1 Side Paths of Linguistics

At all times have our tools of insight determined our understanding of the things of the world. That is why, in science, one has to attempt to create new tools of perceptual and, consequently, intellectual extension, such as prototypes (as was chosen for this thesis), as means of improving understanding. This can be observed in …

2.5.1.1 Computer Linguistics

In Computer Linguistics[62], huge corpora are automatically recorded. These corpora provide far more syntactical variations and examples than were possible to take into consideration in classical treatises on grammar. They show a by far more variable use of language than could have been constructed from traditional syntax rules. This is made easy by automatically calculating probabilistic indicators, separating likely from unlikely phrases, having regard to constituent word and compound frequency. Thus, a continuum between a new type of probabilistic, context-free grammar and the traditional, *catholic* rule-based grammar was created, in-between covering richer frame-based approaches.

2.5.1.2 Computer Lexicography

Computer lexicology[63] represents an important extension of print-based lexicography; there is no pressure to filter lexemes in order to keep a selection of lexemes printable anymore. In addition, there can be far more cross-references and other types of information, which had to be omitted before. A computational dictionary has literally no limits. Only the right holders (publishing companies) are preventing a total integration of all historic human efforts of creating dictionaries. Instead, new, machine-readable resources are being created, such as, for example, WordNet[64], which relates lexemes, concepts, and synonyms spanning different word categories, besides including some semantic thesaurus relations.

2.5.1.3 Limits of Computer Linguistics and Computer Lexicography

Computer linguistics and computer lexicography are but extensions of the traditional means of the science of language. They extent rules and lexicon, but they do not overcome the basic limitations of the conception of language as an abstracted object of study. Still, both represent important steps into the right direction, as they can be applied in

[62] See (Bod, Jannedy, & Hay, 2003) for an accessible introduction into the field.
[63] See (Kunze & Lemnitzer, 2007).
[64] See (Fellbaum, 1998).

individual language studies and recordings. They, hence, strongly influenced the Artificial Memory prototype. However, computer linguistics and computer lexicology did not yet arrive at the idea of individual language and individual grammar, in terms of their social and individual development. Indicators such as conditional probability (joint probability) of words are still void of dimensions of developmental change, as are, to the best of my knowledge, all grammars, be it computational or hand-crafted ones. The final state of *post-language* computer linguistics or one facet of a post-linguistic cognitive science would be the real-time tracking of syntactical and lexical aspects in language performance across different dimensions of change, focusing on language-based thinking. That we do not yet have the means for it, should not restrict us from seeing (and stating) this clearly and from striving to gradually overcome the limitations of today's conceptions of language and language sciences. I have already pointed out the parallels between the traditional notion of language (la langue) and the traditional idea of *knowledge*. The concept of a *language* dictionary is only one step away from the concept of an *encyclopedic* dictionary; the idea of a catholic set of *grammar rules* is not too far away from the idea of a limited set of *inference rules*, and probably for the same reasons. If the current *subject of language* ought to turn into a ***subject of language-thought***, it would represent the same subject that the current *subject of knowledge* ought to turn into, were it to overcome its comparable limitations of a static and de-individualized conception. In other words, **the future means of individual knowledge management might (I would even argue *will*) be the same as the future means of language-based cognitive science, as much as the current means of knowledge management (printed documents) formed the basis of current linguistics.** The attempts to overcome traditional linguistics are thus to be found in *language* science as well as *knowledge* (i.e., often synonymously: *information*) science.

2.5.2 Toward New *Vocabulary*

2.5.2.1 Linguistics: Language Acquisition Recording

An interesting exception from the rule is given by the leader of the Media Laboratory of the MIT, Deb Roy. He recorded more than 230.000 hours of audio and video in his private home to cover the language acquisition of his son. Each of his son's language utterances was recorded and documented, including a number of context variables (Roy, 2009). From these recordings, Roy can mine interesting data, e.g. how a single word is slowly acquired, with its pronunciation gradually improving and its usage/meaning becoming more specific.

2.5.2.2 Knowledge Management: Life-Recording

Roy's method resembles roughly the known idea of *life recording*, a long-term and life-accompanying recording of an individual's perceivable acoustic (spoken language) and vision fields (as well as digital artifacts). Life recording creates a *life-log(-file)*. Life recording tools are called *life recorders*. There are (limited) special video life recorders, photo life recorders, audio life recorders, and social life recorders. Social life recorders record activities (not necessarily language-based) in social networks, keeping a kind of diary or historic log-file. The idea of life logging is originally based on a rather simplistic view:

> *Digital storage is cheap and plentiful. Why not keep a record of everything we have encountered? Digital storage can hold not only conventional kinds of information but also pictures, photographs, music – even films and full-motion video.*
>
> (Jones & Bruce, 2005, S. 5)

Thus, life recorders often pride themselves of the number of information object types they may store: *supports 25 item types* […] *but arbitrarily many could be added*.[65] The dominant access technology was originally thought to be query/search technology: *sources are monitored, and their metadata are integrated along with the full text of each item to enable optimal search*.[65] The trend toward technically less literate, consumption-oriented users on the Internet, however, has led to dominantly visual, *hot-media* access tools such as photo(-enriched) time-lines and fast motion movies of pictures, or slide shows. These modern-day life-logs archive activities by their digital artifacts. They deliver behavioristic records, because they do not perceive the past as alterable memories, but as immutable, historic artifacts. They are therefore also not understood and designed as dynamic information manipulation tools, but as static information accumulation, retrieval and representation tools.[66] Hence, they differ considerably form the technological conception of the Artificial Memory prototype, as I will demonstrate in chapter 5 of this thesis. Another, less obvious, but nonetheless important difference is to be found in the restriction of life recorders to *perceivable* information. For a life-recorder, it is not relevant what one thinks, but only what one perceives (more precisely, what one is presented with) or expresses. Not

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[65] (Gemmell, Bell, Lueder, Drucker, & Wong, 2002)

[66] One of the most advanced Life Recorders is Microsoft Research's MyLifeBits project, popularized by Gordon Bell (Bell, 2007). The project is discontinued [personal notice by Gordon Bell]. The last notion of MyLifeBits stressed its memory-support function, following a keep everything strategy, though, not distinguishing between attended and unattended information, that is not distinguishing between potentially memorized information and clearly unmemorized peripheral information. - Another example of a life recorder is Forget-Me-Not (Lamming & Flynn, 1994), which states a memory-support function.

all what is thought, however, is also being expressed, and life recorders do nothing to support and encourage thought expression. Even social networks tend to limit thought expression to social communication (i.e. commercially exploitable content). In most cases, however, a *life recorder* will not even overlap with a *thought recorder*, as recording *what* is perceived does not reflect *how* it was perceived. For this, life recorders would have to support powerful content-enrichment and content-manipulation functions.

2.5.3 Toward New *Syntax*

2.5.3.1 Linguistics: Linear Unit Grammar

An interesting theoretical work is provided by the late linguist John McHardy Sinclair, a renown pioneer of computer linguistics. His last book, on *Linear Unit Grammar* (Sinclair & Mauranen, 2006), appeared in 2006. It is based on an analysis of everyday spoken language, which is rather uncommon for a grammar, as spoken language is considered defective and saltatory, just normally not properly and completely built and, therefore, not appropriate to be used in the definition of a proper grammar. This opinion means that the normative character of a given grammar is allowed to define what is proper to be taken for any new grammar to be defined, which, of course, results in an endless perpetuation of the same old (idea of) grammar. Sinclair deviates from this linguistic-science schema. He creates a classification system for chunks of spoken language, called linear units. Linear units split and reconstruct the flow of expressions of spoken language in a form that is indispensable to be able to apply an automatic syntactical analysis. Hence, Linear Unit Grammar is derived from applied computer linguistics, far from any theoretical ivory tower. It bridges, for the first time, the gap between the analysis of discursive speech and heavily standardized written language. In other words, it reintegrates *la parole* and *la langue*. Aware of himself breaking a scientific taboo, in order to avoid ignorance and minimize critique, the late linguist Sinclair uses rather simple, convincing examples. He also writes in a very conciliatory tone; as when he stresses that his grammar is only a supplement to the existing models, or when he mentions the high inter-rater reliability when having speech segmented into linear units (as, basically, the impression of compound-ness or chunked-ness is the only criterion for segmentation). This gives the impression, as if Linear Units were, in an inter-individual effective way, rule-based or normative, that is in any case within the agreed limits of the linguistics of supraindividual language. This impression, however, is misdirecting, taking into account what Sinclair is actually doing. Even if complexes of (rearranged) Linear Units show syntactical structures, as known from *single*-language research, Linear Units are, in essence, *individual* language performances (in language expression as well as in language interpretation) opening the floodgates to ambiguity. For the Linear Units of the speaker do not have to match the Linear Units of the listener, thus destroying the idea of a nomothetic science of *language*. To make this clear, the reader may imagine a simple word categories pattern: Adjective-Noun^1-Noun^2 (say, *tacit knowledge management*). Depending on whether the adjective is referred to Noun^1 only (*tacit knowledge | management*) or to a compound of Noun^1 and Noun^2 (*tacit knowledge-management*), one could end up with 2 or 1 linear units. This is, by the way, not about language-semantic or language-syntactic differences, it is about *perceptual* differences, and we are not only speaking about inter-rater reliability, we are also speaking about intra-rater reliability. **The boundaries of Linear Units cannot be fully explained by any syntactical, syntacto-semantic or any other surface-form-based rules, they are, as I will argue, individual memory-perceptual (ecphoric) units, which tend to not be perfectly reflected in the syntactical (marker-based) or prosodic (stress-based) structure of language and which anyway may differ from person A to person B and from time A to time B.** Therefore, in (memory-perceptual) Linear Units, personal *structural language interpretations* do *replace* or *subordinate*, and not just supplement, *language rules*, demonstrating to all of linguistics that without this step (*individual language segmentation* or, in a broader sense, *individual language interpretation*) unambiguous language analysis and explanation are impossible. **The Linear Unit Grammar is consequently not a typical grammar of the *shared language* science, it is, at its core, a *cognitive* analysis, leading up to *cognitive categories* of language production units and language interpretation units.** The core construct of Linear Units is to be understood as a missing (or rather ignored) *individual* link between language manifestations and the language thoughts they were derived from or that are derived from them. The Linear Unit Grammar's deceptive-seductive packaging signals the difficulties Sinclair must have faced when developing his empiricist theory. On a higher level of reflection, Sinclair's theoretical case gives some meat to what Martin Kusch calls a communitarian epistemology of scientific knowledge. Sinclair clearly had some problems feeding his excellent knowledge back into *his* community of linguists.

2.5.3.2 Knowledge Management: Artificial Intelligence

In knowledge management, human *natural* language syntax was reduced and abstracted into formal (logical) language rules and syntaxes, somewhat similar to their reduction into syntax rules in rule-based grammars of traditional linguistics. The consequences were similar, too. Dogmatic (i.e. pedagogical) grammars blind out the historic-cultural and developmental changeability and variety of syntactical forms (using diachronic linguistics as a fig leaf). Logics, on the other side, blind out the respective changeability and variety of language-thought. This dependence of logics from natural language is not a common conviction of logicians. They, on the contrary, tend to think of language syntax as an insufficient realization of logics. Not unlike grammarians who tend to see spoken language as insufficient (not well-built) realizations of proper grammatical language. The logician John Sowa sees this clearly when he points out:

> *Instead of assuming that NL semantics is based on formal logic, I believe that all of mathematics, including formal logic, is based on a subset of the same semantics we use in using ordinary language. To use Wittgenstein's terminology, mathematical notations and rules of inference are specialized "language games". They use a *subset* of the mechanisms that people use when they talk and listen.*
>
> (Sowa, 2009)

I would even extend this view, as Jerry Fodor does, and state that *the semantics of thought is prior to the semantics of language.* [67] In his representational theory of mind (RTM), Fodor thinks of this relation to be *performative*, while I would rather see it as historic-evolutionary and individual-developmental, basing this view on the nature of the underlying memory mechanisms, as will become clear in chapter 3 of this thesis. Fodor, (this shall only be mentioned here in parenthesis, for it represents a common misunderstanding) believes that …

> *It is a very bad idea to confuse psychology with semantics: psychology is about what goes on in heads. Semantics is about constitutive relations between representations and the world (between representations and what they represent). THERE IS, AS A MATTER OF PRINCIPLE, NO SUCH THING AS A PSYCHOLOGICAL THEORY OF MEANING (just as there is, as a matter of principle, no such thing as an epistemological theory of meaning; and for reasons that are not dissimilar).*
>
> (Fodor, 2008, S. 198)

Fodor here thinks of semantics as of **Tarski-dyads**[39]. This is an idea of conservative logicians that Sowa rightly criticizes, for, in the practice of ontological engineering, this idea has proven to be as unrealistic as the idea of a rule-based objective language. In ontological engineering, endless debates and disagreements use to arise when working on a common definition, and, after a common ontological definition or standard was found, it uses to be interpreted in different ways, often, ironically, with people believing that they share the same definition and ideas. Signs have to be interpreted. They, hence, establish a relation of thirdness or higher-ary relations, not of dyads. **There is, as a matter of fact, no such thing as a *non-psychological theory of meaning*,** as the nature of the

[67] (Fodor, 2008, S. 198)

relation between sign and significatum is its instantiation in an interpretation. For reasons that are not dissimilar, **all theory of meaning has to be epistemological**. In this thesis, I therefore argue (contrary to Fodor) that **it is a very good idea to combine psychology with semantics**, as I have tried to show that the very principle of separating psychology and semantics, of separating language performance and interpretation from language artifacts, is a misdirecting, obsolete historic principle. Rule-based grammars and formal logics, without any doubt, have their great merits, but this should not stop us from acknowledging their given and future limitations. So far, any attempt to understand natural language by automatically translating it into logics has failed, for different reasons. First, as with grammar, the de-individualized, de-contextualized sign layer appears as ambiguous (another word for differences in interpretation between individuals, being reflected in conflicting *rules* and *concepts* applicable at the same time). Second, there is no appropriate general logical structure available to automatize or reproduce natural reasoning. There cannot be a *complete grammar*, and there cannot be a *complete logic*. There is, of course, no lack of general formalizations for different aspects of natural language expressions: argumentation logics, deontic logics, epistemic logics, probabilistic logics, predicate calculus, multi-valued logics, fuzzy logics, quantifier logics, modal logics and so on, and so forth. All these endeavors are quite interesting and instructive, in the same way that specific theories of grammar are interesting and instructive, the latter highlighting aspects of language generation, and the former stressing aspects of knowledge generation.

I have stated before that I am trying to stay away from the main paths of linguistic theorizing, as I perceive them to stick to an outdated model of objective language (and this thesis anyway could not host such a discussion). For a similar reason I will try to stay away from the main paths of logic, as I perceive them to stick to an outdated model of objective knowledge (and this thesis anyway could not host such a discussion). What I am interested in are not the sweet spots of over-generalized (i.e. artificially consistent) theorizing, but the sore spots of theoretical failure and impotence at the very points where language and knowledge systems and theory have to face cultural and individual reality. The practical problem of whatever variety of logic is that for any relevant (non-tautological, not yet axiomatically pre-given) logical inference, its axiomatic rules have to be applied onto an actual *knowledge* base (here, ontology), which has to conform to the logic’s syntax used in order to be interpretable. Translating natural language syntax statements (thoughts) into a logical (artificial) syntax, presupposes knowledge of the logical syntax and the ability to express the knowledge in question in this syntax, without devaluating it by an eventual reduction. Any particular logic, however, represents, as such, ways of thinking and expression that have to be learnt first.

2.5.3.2.1 Manual Ontology Engineering

Expert knowledge is normally considered the most valuable (ontological) knowledge. Experts, however, have little time to learn syntax of logic. Unfortunately, natural language syntax cannot automatically be transformed into logical syntax (as remarked before). Therefore, neither are language artifacts of experts available to inform the respective axioms and ontology of logic, nor are experts likely to start contributing their knowledge in the form needed for machine reasoning. For expert knowledge-systems to work, therefore, domain experts must be interviewed by logic experts in order to have the domain experts' knowledge translated by the logic experts. Historically, this led to some serious restrictions[68]: Expert systems cover only a narrow domain of expertise (as broadening of the domain increases the costs or decreases the level of completeness of knowledge covered). Another problem is the limitations faced when trying to express facts and relations in a formal language. The translation of a relatively short natural language proposition into a logical form often results into a great number of logical propositions or a relatively complex statement that can be difficult to read, interpret and understand. In other words, translating a set of formal propositions back into natural language propositions, in order to have the expert check the correctness of the formalization, is often not possible, so that the whole process is not without hazards. The logic expert might easily formalize the domain expert's statements incorrectly, without anybody noticing. The plentifulness of formal propositions should not belie the fact that all formal languages work on the principle of semantic/syntactic reduction of natural language statements, notwithstanding the possibility of formal languages here and there surpassing the set of syntactic constructs available in natural language (for example by combining *naturally* known basic operations into new, artificially complex operations). Without proper and efficient back-translation, however, an evaluation of the discrepancies between reductionist formalizations and the underlying richer natural language expressions is practically impossible.

Another, more general problem is posed by implicit learning generating implicit knowledge being used implicitly by experts. Ikujiro Nonaka introduced the term *tacit knowledge* into knowledge management.[69] A term originally coined by the philosopher Michael Polanyi. Davenport and Prusak believe that:

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[68] (Buchanan, 1982, S. 283), mentioned in (Winograd & Flores, 1986):

> *Buchanan, […] lists some characteristics of problems that are suitable, including: 'Narrow domain of expertise; limited language for expressing facts and relations; limiting assumptions about problem and solution methods; little knowledge of own scope and limitations'.*

[69] See (Nonaka I. , 1994).

> […] *tacit, complex knowledge, developed and internalized by the knower over a long period of time, is almost impossible to reproduce in a document or database.*
>
> (Davenport & Prusak, 1998, S. 70)

The idea of an unbridgeable gap between tacit and non-tacit knowledge, however, conflicts with Markowitsch's (Markowitsch, Dem Gedächtnis auf der Spur., 2002, S. 143) conviction that *explicit and implicit recall do not reflect distinct memory systems, but rather represent different levels of consciousness*. [70] In their popular SECI-Model [71], Nonaka and Takeuchi, theorize tacit knowledge transfer as either by socialization (tacit knowledge to tacit knowledge transfer by observation and copying of behavior) or by externalization (verbalization of expressible tacit knowledge). Only the latter option is available in the dialogue between domain expert and logic expert. Externalization of implicit knowledge, however, presupposes reflection by self-contemplation or discussion, neither of which would be affordable or appropriate in a knowledge formalization interview. Externalization also requires a good command of language and introspection (self-observance), which is certainly not at the avail of all domain experts. I have discussed before [see 1.1.7 Wicked Problem, p. 13] the notion of *design as discussion*. Collective remembering, collective reflection, and collective reasoning are part and parcel of group decision-making and group design by collectives of experts. In my humble opinion, the collective creations and inferences of experts represent a level of complexity and system dynamics that cannot (easily) be emulated by simply formalizing individual experts' knowledge and reasoning from *individual* belief systems. Automating decision-making by expert systems more or less restricts reasoning to individual (or aggregated, i.e. pseudo-collective) ontology reasoning, thus only inappropriately imitating the possible *social* dynamics of collective human reasoning. Roger Schank points out another deficiency of expert systems:

> *Expert systems do not learn, indeed cannot learn, because they are systems of rules and not systems of experiences or cases.*
>
> (Schank, 1999, S. 225)

Undeniably, the idea of translating expert knowledge into the logical form of axioms and ontology echoes the belief of persistent and immutable

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[70] (Markowitsch, Dem Gedächtnis auf der Spur., 2002, S. 143):

> *Expliziter und impliziter Abruf stellen keine eigenständigen Gedächtnissysteme dar, sondern sind Abrufformen auf unterschiedlichen Bewusstseinsebenen.*

[71] See (Nonaka & Takeuchi, 1995).

knowledge, freezing acts of knowledge in the same way that written language freezes acts of language. A static dictionary and a static grammar may simply appear as incomplete or inappropriate, whereas a static expert system will appear erroneous:

> *Who would have respect for someone who consistently made the same errors and never improved? Nevertheless, rule-based expert systems must have this property.*
>
> (Schank, 1999, S. 230)

Logic experts might think that it is possible to add new rules to a rule-based expert system and to extend the corresponding ontology (schema and data) by repeating the interview with the domain expert. The domain expert would just have to provide new insights. From this procedure, however, one would not learn which beliefs were given up in the meantime. For this, the domain expert would have to check all prior formalizations with regard to their belief-status. This does not only pose the before-mentioned problem of back-translation of formal language into natural language, but would also represent an (increasingly) inefficient procedure. The expert's belief-system represented by rules and ontology cannot simply be continued by adding new rules and new knowledge, though. For soon enough conflicting states would arise.

An even more fundamental objection would be raised if one understood learning not as something final, something of the past, as in *Lessons Learnt*, but, rather, as in*formation* that defines the *creative potential* of an individual to design or infer further new knowledge in the future. A consistent logical system can automatically draw all possible conclusions from facts given at any time. Most of these inferences use to not be perceived as useful or reasonable: conclusions such as, say, that atoms are part of clocks[72], which result from long, de-contextualized chains of automatic reasoning uncommon in human reasoning; or inferences derived from

[72] This is an example used by Helbig, who clearly saw the limits of automatic reasoning as set by (perceived/cognitive) functional contexts (Helbig, 2001, S. 54):

> *So kann man zwar feststellen, daß die Unruh Teil des Uhrwerks ist, das Uhrwerk Teil der Kichturmuhr, letztere wieder Teil des Kirchturms und dieser Teil der Kirche. Man würde aber nicht sagen, daß die Unruh Teil der Kirche ist (obwohl das im formalen Sinne gelten mag). Das Beispiel zeigt, daß die Transitivität der PARS-Relation über größere Zusammenhangsketten verlorenzugehen scheint (Fading-Effekt). Wichtig dürfte auch die Forderung sein, daß zwischen Teil und Ganzem kognitiv zusätzlich ein bestimmter Funktionszusammenhang bestehen muß. Dies erklärt auch, warum man gewöhnlich keine PARS-Beziehung zwischen einem Makrokörper (z.B. einem Baum) und einem Mikroteilchen (z.B. einem Proton) herstellt, obwohl das physikalisch zweifelsohne zutrifft.*

underspecified upper-level ontology types such as, say, that Mozart is a *thing*.

Other inferences might not even be perceived as true, as they will contradict with knowledge not yet, not completely, or not correctly formalized. Furthermore, I can say, based on my own experience of ontological engineering, that categorizing or instantiating something new (as examples of generating formal knowledge) will cause more than just an addition of a piece of new knowledge and belief into an ontology. It may create a productive area of tension between the *neighboring* ontology objects, provoking further ontological additions that cannot be gained through (automatic) inferences. A good example for this is Aristotle's method of Genus and Differentiae. Given a Genus (a supertype of the category to be defined) and a Species (the subtype that is being defined), the Differentia is a property or attribute that distinguishes the species to be defined from other species of the same genus. Now, oftentimes, the Differentia is not obvious right away. One has to think about what features of the Species do actually contribute to it being subcategorized by the Genus. The Differentia is therefore not directly inferable from the ontology. It is given in the form of a question, i.e. a productive *language technology* that stimulates processes of remembrance, thinking and judging. The Genus creates a field of siblings for the Species. The Species' Differentia has to be a sufficiently distinct feature to justify the Species' stand-alone existence. Sometimes a whole system of Differentiae and their corresponding Species may become unstable by the addition of the Species to the respective Genus. In the same way as we have found writing a text to be a genuine creative process, ontology engineering is, too. A knowledge and belief state, as reflected in ontology at a certain point of time, may be more or less stable, resulting in the ontology to be more or less stable in relation to the state of knowledge it ought to represent. The logic expert translating/formalizing pieces of new knowledge and adding them to the ontology may or may not start and support a reflective-creative process together with the domain expert. If the logic expert and domain expert neglect creative reflections on the state of the ontology during the interview, chances are that the domain expert would (later) come to different conclusions than the expert system, because the expert might stabilize her views outside of the interview with the logic expert, perhaps during solving a problem or writing a book. If, however, the logic expert tries to stabilize the domain experts' knowledge and ontology by stimulating a creative-reflective process, the endeavor may soon become quite inefficient (as it is somewhat doubtful that a knowledge state can ever become fully stable). The domain expert's knowledge does not only rest on what she actually knows, but also on her capacity to re-stabilize and *develop* her knowledge in problem situations that trigger (and inform) a process of reflection that cannot be emulated/substituted by automatic inferences from an *unstable* ontology. Not all new knowledge is logically inferred, some is simply experienced, and knowledge itself can be re-experienced (remembered and re-perceived) to be re-formed. Ontological engineering (a way of philosophizing or, more generally, learning) embraces, but is not restricted to ontological reasoning. It cannot astonish that expert systems and, in a broader sense, artificial intelligence systems failed and keep failing whenever the rules of the game and its facts are initially unknown, unstable, and social. At least not unless they are artificially stabilized by (social) dogmatization, the same way language artifacts (such as, for example, scientific or religious theories) are dogmatized to shield them from deviating interpretations. Ironically, dogmas change, too, for dogmas must be interpreted (which is often a rather slow, generational task), too. Artificial intelligence experts, of course, have tried different ways of tackling the wicked problem of formalizing knowledge and thereby automating thinking.

2.5.3.2.2 Automatic Ontology Learning

At present, one popular method is *automatic ontology learning*. Staab (Maedche & Staab, Ontology Learning for the Semantic Web, 2001), for example, argues that the proliferation of ontologies depends on constructing domain-specific ontologies quickly and cheaply (hence implicitly confirming the logics community's general problem of ontology engineering or ontology creation). Ontology learning could be arranged from free text, dictionaries, reverse engineering of ontologies from database schemata, or XML documents. Defining mapping rules between these structures would allow importing and reusing existing ontologies. Staab thinks that syntactical relationships between terms yield considerable descriptive power to induce the semantic hierarchy of concepts related to these terms. Verbs are to be modeled as relations. In my own words, the idea is simply that of an ontology engine (as an analogy to a search engine). That is instead of collecting documents and indexing them into search words and search phrases, the ontology engine collects propositions (derived from syntactic surface-patterns) into a huge database and lets one query it. The database cannot be considered an ontology anymore, as it may and will contain conflicting statements and ambiguities (one should not forget the heterogeneous contexts the information is taken from and the general ambiguity of language artifacts). Statistical means (as with search engines) and common-sense rules, however, could be applied to generate a formally consistent ontology from the data, excluding unlikely (i.e. infrequently found) facts and avoiding categorical circularity. It is said that Google is about to extend their infrastructure and search results with such an automatically learnt ontology. There is also the popular success of IBM's *Watson* [73], using IBM's Unstructured Information Management Architecture (UIMA), which creates a huge, automatically learnt ontology, constantly enriched by automatic *Annotators*, modules that discover new

[73] See, e.g., en.wikipedia.org/wiki/Watson_(computer) (accessed on 27.08.2012).

types from language resources. To a technically naïve person, Watson must appear as an intelligent machine. Watson can answer supposedly difficult questions, which would normally require expert knowledge. It can acquire new facts automatically. It has a natural language interface (one can ask it questions and gets answers). The technologies used are not in any way new or surprising: crawlers, parsers, pattern recognition, data mining, semantic querying, inference-engine, parallel processing, result ranking etc. It is their combination together with a huge knowledge base, that causes Watson to appear as a breakthrough into a new dimension, because the scope of Watson's *knowledge s*omehow surpasses that of any single expert. It is *ontology* at Internet-scale. Another semantic or fact search engine of Internet-scale is Wolfram's Alpha, which also makes heavy use of automatic ontology learning. I think that these two examples of knowledge computing based on automatic ontology learning are indeed very valuable contributions to the finding of simple, stable facts. Keyword-based search falls short at fact question answering: it delivers links, not answers; and it cannot handle circumscriptions and synonyms, which should pose no problem to semantic query engines. Fact queries, however, represent only one out of many forms of query. While search engines decontextualize keywords for indexation, knowledge engines decontextualize *facts*. With search engines, the document allows for a re-contextualization of an individual keyword or keyword phrase. With knowledge engines, such a re-contextualization is **not** included, because the fact will normally represent an aggregated or *data-mined* concept. The idea of (quick) automatic ontology learning is not to try to finally understand natural language text, so that a fact could be understood in its specific field of ideas (its context), but to collect information whenever a supposedly unambiguous, simple to parse syntactic structure allows for it. A fact-learning engine would normally only look for phrases like *A is a kind of B*, or *A is part of B*, or *A was born on B*. The rest of the con-text has to remain unused, as it cannot be interpreted by simple semantic-syntactic patterns anymore. Therefore, fact engines do not replace search engines, and they do not even solve all their problems. I will demonstrate this shortly by reporting a personal experience that strongly influenced my view of search technology. When working as a consultant for PricewaterhouseCoopers, I observed that many of my colleagues would not use the organization-wide search engine, even though it allowed a universal search across thousands of internal project databases and delivered a high number (indicating good document recall[74]) of relevant results (indicating good document precision[75]). The reason was that in Consulting documents are often re-used, serving as templates for the creation of new documents. For example, some slides of customer presentation A will be used as the foundation of a new customer

[74] Document Recall is calculated as the ratio of the number of found relevant documents divided by the number of relevant documents in a document corpus or database.
[75] Document Precision is calculated as the ratio of the number of found relevant documents divided by the number of found documents.

presentation B. Others slides from A will be omitted. Anyway, new slides and changes will be added to B. Now, reading a few top-ranked presentations about topic XYZ would familiarize one quickly with most of the frequently re-used slides. However, after some time, the proportion of new information relative to known information would become too small to continue efficiently anymore. Thus, PricewaterhouseCoopers' search engine did not provide means of learning relevant information in an efficient way, at least not beyond commonly available information. For that to improve, it (as any search engine) would have had to know what its users (already) knew. Fact engines do not provide means of learning information in an efficient way either, as they omit the (syntactically) complex thought/fact and skip infrequent simple thoughts/facts if they cannot be found in the form of a syntactically interpretable statement. Thus, neither does automatic ontology learning replace thorough ontology engineering, nor does it replace reading the original texts, or offer an easier or more efficient way to access them. Fact engines do not replace search engines. Quick automatic ontology learning adds but an admittedly usable brick on top of the text technology stack, without, however, actually confronting the many before-mentioned fundamental problems of text and ontology at its base. The questions one cannot ask are the questions that search engines and fact engines do not *answer*. The question of how one can know more and improve one's knowledge, is the question neither one can answer. The question of what another person thinks or would think, or, more generally, of what is thought and would be thought, may be answered in some aspects, but the fact-information has to remain doubtful, as it is incomplete, decontextualized, and will often be obsolete[76]. Quizzing simple, general, stable facts, however, has become easier by automatically learnt ontologies. Regarding the method of creation, automatic ontology learning has a counterpart in Douglas Lenat's Cyc project[77]. The Cyc ontology is a very huge and very sophisticated handcrafted ontology of common knowledge (meaning that logic experts and domain experts were the same people). It is said to be the world's largest body of knowledge represented in logic. And it was quite expensive to produce[78]. As *common knowledge* ontology, it presupposes stability of facts and rules. Cyc is criticized in the AI

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[76] Tom Mitchell, a famous machine-learning expert, for example, recently admitted (Mitchell, 2012) that his NELL (Never-Ending Language Learner) ontology learning tool has even problems in deciding who is the present president of the US. Not that this were a difficult problem to solve for a machine-learning expert, but it reflects the low semantic dimensionality and the effects of de-contextualization of beliefs collected by extraction patterns and machine learning algorithms.

[77] For an overview, see en.wikipedia.org/wiki/Cyc (accessed on 28.08.2012).

[78] Börner (Börner, 2005), for example, notes that …

> *The Cyc project was funded over 20 years with $25 million Artificial Intelligence research dollars. It is a 600 person per year effort that assembled a knowledge base containing 3 million rules of thumb that the average person knows about the world, plus 300,000 terms or concepts nodes (a typical person is assumed to have about 100 million concepts).*

community for not having delivered any useful applications. It lacks the variety of automatically learnt facts of Internet-scale ontologies, which, in turn, lack its (micro-)theoretical/logical depth. Cyc did not fulfill the dream of natural language understanding. It cannot just start learning from texts or conversation. But combining simplistic automatic ontology learning and Cyc could certainly improve automatic fact learning (e.g. by local/micro-theoretical consistency and plausibility checks) and help to represent (more complex) facts in more complex (i.e. adequate) structures[79]. The fundamental issues would not disappear, though. Neither methodology is capable of offering an alternative to domain-expert ontology engineering. That is to say that they do not provide a solution to knowledge (base) management and the use of knowledge bases in expert/AI systems. They, therefore, do also not overcome the practical and theoretical problems of written/objective language.

2.5.3.2.3 Semantic Annotations[80]

Another idea of deriving at machine-readable knowledge bases, i.e. knowledge bases in a formal syntax, in order to achieve machine intelligence on the Internet, is to formalize natural language Web texts, by having them manually *annotated*[81] with metadata. A *Semantic Web* crawler could then read the well-structured metadata without having to try to understand the actual natural language text. From my theoretical point of view, annotations are language interpretations and their artifacts. Consequently, different interpretations in annotations had soon to be perceived as *mistakes*, categorized, for example, into *too general classifications, miss-classifications*, and *missing classifications*.[82] The missing classifications are due to eclectic annotations: Some documents will not be annotated at all, and perhaps no document will be fully annotated (formalized). Therefore, there have to be *dark spots*. Texts result from language performances. One can assume (for the ease of argument) that texts do reflect knowledge structures. Annotations would then reflect knowledge structures, too. Manually annotating texts to gain a knowledge structure, however, can never be an efficient way of creating a formal knowledge base, as knowledge structures that are expressed are

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[79] Doug Foxvog (Foxvog, 2011) remarks that …

> *It* [Cyc] *distinguishes linguistic components from the classes, relations, and individuals which they may denote. A single word/phrase may denote multiple terms in the ontology and a single term in the ontology may be denoted by multiple words and/or phrases.*

This structure allows for recognizing cases of synonymy and homonymy that are very difficult, if not impossible to learn automatically.

[80] This section is based on (Ludwig & O'Sullivan, Deploying Decision Support Systems Using Semantic Web Technologies., 2010), a paper that I originally prepared at the Digital Enterprise Research Institute in Galway in 2005.

[81] See, e.g., (Handschuh & Staab, 2003).

[82] (Erdmann & et al., 2000)

likely to be expressed, on average, more than once. Instead of annotating texts, it would be more effective and more efficient to *annotate* (formalize) knowledge structures directly, maybe supported by reading a text, if memory needed to be aided. An annotation is a reference structure, referring a natural language word or phrase to a corresponding formal concept or statement. If the metadata (i.e. the formal data describing the natural language text) is already given, one does not first have to create it. It would suffice to select it or even apply it automatically (which presupposes natural language understanding, though; that is it is not feasible without errors and ambiguities). To escape the inefficiencies of annotation, the idea of a *semi-automatic* annotation[83] was quickly born, and greeted with understandable skepticism:

> *Will* […] *metadata have to be annotated manually, or will they be derived automatically? A fashionable answer to this dilemma is semi-automatic annotation, i.e. a combination of automatic derivation and manual annotation. But unless the exact division of labor between manual and automatic processes is specified, it is difficult to judge the feasibility of this approach.*
>
> (Quantz & Wichmann, 2004)

An automatic pre-annotation will need evaluation and (manual) verification of the metadata referenced. A manual annotation, on the other hand, might use techniques such as *auto-complete* or *auto-suggest* of inputs, generating (parts of) metadata automatically during search or direct expression. In other words, no single annotation can be fully automated in semi-automatic annotation. The promise of semi-automation can only be one of increased efficiency *per annotation* (if it wants to avoid the drawbacks of fully automated annotation). The ratio of knowledge structures referenced in annotation to knowledge structures *expressed* (in the underlying ontology), however, is likely to be greater than one. The inefficiency of annotations increases by this factor. This does not even take into account that creating an ontology by annotations, per se, consists of a double workload: first writing and then annotating (which prevents most text authors from annotation in the first place). To be fair, the early *Semantic Web* movement, an incarnation of the AI movement in the Internet age, initiated by Tim Berners-Lee[84], had dreamt of being able to search the World Wide Web semantically. They did not perceive of annotating as of a means of ontology engineering. However, for several reasons, it turned out to be unrealistic to think that a few central standardized ontologies could provide the means to formalize the knowledge encapsulated in all of WWW’s documents. First, the annotator is forced to become an ontology engineer, if he is not to be

[83] See (Erdmann, Maedche, Schnurr, & Staab, 2001).
[84] (Berners-Lee, 1998)

limited by the limited views of a few centralistic engineers and their ontologies or ontology schemata. Second, using an existing ontology (schema and/or data) would presuppose that the annotator knows about the ontology (perhaps even selecting it from a choice of alternative ontologies first), has access to the ontology, understands the ontology, shares the ideas and beliefs expressed in the ontology, is able to extend the ontology if needed, and is able to combine the ontology with other (prescribed) ontologies as needed. Due to these practical problems, it became clear that many decentralized ontologies would (have to) be created in different knowledge-domain communities. Accordingly, soon, manual (and, of course, semi-automatic) ontology-mapping[85] and ontology management systems[86] were perceived as important infrastructural components to manage distributed ontologies. Merging different ontologies poses the same (often-insurmountable) problems as creating a shared ontology. Ideas and convictions do not always and do not even often match. It became clear (and I think Plato/Socrates would have appreciated it,) that ontology management systems ought to support forms of actual debate.[87] The embedding of such a debate in trying to agree on ontologies for Web document annotations, however, was unfortunate, because the idea of annotations on the Web never took off. It was flawed from the beginning (creating annotations, as I have tried to explain) to the end (using annotations). To use annotations in order to query/search documents, as Stefan Decker had pointed out[88] early on, one has to actually know and understand the ontology (schema/data) used for indexation in order to be able to formulate a semantic query. Unless one is happy to be reduced to a keyword-search-box interface, which reduces semantic search to keyword search, though. **Now, I think that, logically, any (Web) ontology used for annotation or indexation has to resemble or actually *be* a personal (or fully personally shared) ontology, in order to be used in semantic queries.** The seemingly paradox consequence would be that this, more or less, reduces semantic querying to self-annotated (pre-interpreted) resources, because only if a text is annotated (interpreted) in the way one implicitly interprets it in one’s semantic query, one would be able to use one’s own semantic knowledge structures as tools for reliably selecting external resources (from the Web). In all other cases, we are thrown back to forms of a more or less ambiguous matching of language artifacts. Therefore, it cannot astonish if we learn that semantic querying based on annotations lives on in combinations of personal ontology management and personal document management, namely in personal semantic wikis[89] and personal semantic desktops[90], while the bulk of Semantic Web

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[85] See, e.g., (Maedche, Motik, Silva, & Volz, 2002).
[86] See, e.g., www.artificialmemory.net/artificialmemory.aspx?ID=4902 (accessed on 29.08.2012) for a selection of different ontology management systems.
[87] For an early example of a Web ontology discussion tool, see Tadzebao (Domingue, 1998).
[88] (Decker, 2002)
[89] For an overview on (Personal) Semantic Wikis see en.wikipedia.org/wiki/Semantic_wiki (accessed on 29.08.2012). Semantic personal knowledge management using the Artificial Memory prototype was discussed first in (Ludwig, O'Sullivan, & Zhou, Artificial Memory

research moved on to Linked (Open) Data[91]. The latter promises quick wins (as does automatic ontology learning), working around (or, rather, ignoring) the unsolved problems of ontology engineering that stem, as I have argued, from a traditional misconception of language that seems to be effective in conceptions of document technology and Artificial Intelligence. Linked Data does not require annotations, because it reuses existing databases (which are, basically, technically enforced, artificially stabilized, and therefore, in practice, often very problematic ontologies[92]). Thus, *knowledge* management is given up in favor of *data* management. In the same way that huge collections of simple facts by automatic ontology learning can be useful, linking (integrating) data can be useful. But the lack of actually *knowing* (the meaning) of the data will have to be concealed in endless simplifications, more or less arbitrary standardizations, abstract data aggregations (perhaps using artificial descriptive measures), or in de-labeled, bird's eye view visualizations. All of these *de-semanticized* outputs and respective systems will have their merits, but all of these outputs, at the same time, will restrict and have to redefine their use in natural-language-based cognitive-technological substitution processes. Information technology enforces its (or, more precisely, others') structures and functioning due to a lack of *ontological* correspondence. Technological usability, at its core, is an ontological endeavor. Intended technological functions are based on actuation correspondence, often to be best achieved by natural-language-based parameterization.

2.5.3.2.4 Artificial Intelligence

The dominant vision of the Artificial Intelligence movement within the information sciences is an autonomous, intelligent agent, acting as if human. A typical presentation of these ideas can be found in Stan Franklin's *artificial minds* (Franklin, 1997). However, after decades of research, there is, to the best of my knowledge, no generally intelligent agent software achieving anything beyond the ELIZA effect[93]. The term Eliza effect goes back to Joseph Weizenbaum's 1966 chatterbot Eliza[94]. Eliza mimicked a psychotherapist, by presenting phrases as answers to user

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Prototype for Personal Semantic Subdocument Knowledge Management (PS-KM)., 2004). A recent discussion of *personal* knowledge models using semantic technologies can be found in (Völkel, 2010).

[90] See, e.g., Leo Sauermann's Ph.D. thesis (Sauermann, 2009), who, together with Stefan Decker, is a pioneer of semantic desktop research.

[91] See, e.g., en.wikipedia.org/wiki/Linked_data (accessed on 29.11.2012).

[92] Static databases are known for serious issues because users tend to use fields (concepts/properties) for other information than originally intended if *things change*; or they re-use obsolete fields for new purposes without this going noticed; or they introduce unstructured, inconsistent metadata into data fields, which prevents the information from being filterd and aggregated. A basic idea of semantic technology is (or, rather, was) that of bridging the information-technological gap between *knowledge* in structured databases and *knowledge* in unstructured documents.

[93] See en.wikipedia.org/wiki/ELIZA_effect (accessed on 30.08.2012).

[94] See en.wikipedia.org/wiki/ELIZA (accessed on 30.08.2012).

inputs, phrases that would pretend empathy and taking the perspective of the computer user. The software, basically, is a swindle, parodying a psychotherapist, without any serious attempt to understand the text input. Weizenbaum, however, noted that Eliza induced *delusional* thinking. Well, the delusional conclusion of actually talking to *somebody* is easy to understand, as Eliza used sophisticated natural language statements (not actually produced by the program) that were interpretable and consequently interpreted, which, as I argue, is a cognitive-technological process of commonly very strong correspondence. The Eliza effect is, therefore, but a natural language-technology effect, which is not actually a weakness, but an essential strength of humans and an amazing thought-creating memory-effect of language (artifacts). The people *communicating* with Eliza showed empathy with the writer of the phrases (Weizenbaum) and took *his* perspective. That this was a more or less pre-thought dialogue between Weizenbaum and whoever was to read his language-thoughts, did not become obvious because Weizenbaum made strong use of questions in order to avoid being questioned. One is fully entitled to attribute intelligence to the creator of questions such as *Do you think coming here will help you not to be unhappy?*[93]. The misattribution is simply due to being deceived about the true origin of the phrases, creating a form of animism that I have marked before as demonstrating the generalization potential of processes of shared attention and shared intention to naturally occurring processes and their naturally causative objects [see 2.1.5 Determinants of Technology, p. 19]. This time, however, the animism refers to artificial objects and processes, which leaves the original creator in the dark. Weizenbaum’s own and others’ misconception of the Eliza effect was that they attributed Eliza to create the delusion, while it was actually created by Weizenbaum in a cognitive-technological substitution-process. The conception of the Eliza effect is mistaken at the same level as the misconception of people *communicating* with Eliza. Any language (or, more generally, cognitive-technological) artifact capable of creating a technological process of correspondence, created or could have created this illusion before. Generalizing this, one might simply name it *artificial epistemic uncertainty* (instead of calling it *Eliza effect*). We do not know who really wrote the euphoric newspaper article about the latest generation of insecticides that allegedly will help stop the hunger in the world’s poorest countries. We may be tempted to assume it comes from an editor of the newspaper, while it is more likely that it stems from the PR-department or PR-contractor of an agrochemical enterprise. We do not know who really wrote the text that the radio speaker pretends to originate, and that most people will believe to be his own. And we do not know who thought up the table calculation function that lets us sum up the numbers in a column. To computer-illiterate people it will appear as if *the computer just does it*. In a digitized world, a world in which cognitive-technological substitution-processes and artifacts are reflected digitally, that is to say, in a (near-)future world generating an *Internet of things and functions*, society should require that any artifact apt of raising cognitive-technological processes ought to be marked epistemically as to enable to track back who enabled or intended the respective cognitive-technological processes, not only direct-causatively, but along the complete historic causal chain.

With regard to content technology, for example, text should indicate where it was taken from and who originally authored it, or, even better, it should be transcluded[95] instead of being copied or cited. The interesting idea of transclusion does not have to be limited to content. Web Services can be seen as a form of *functional* transclusion. Complex networks of Web Services can be built. However, there are problems to this, as Fensel observed:

> *Web services can be accessed and executed via the Web. However, all these service descriptions are based on semi-formal natural language descriptions. Therefore, the human programmer must be kept in the loop, and the scalability as well as economy of Web services are limited. Bringing them to their full potential requires their combination with Semantic Web technology.*
>
> (Fensel, 2003, S. 126)

The idea of *Semantic* Web Services is to describe the modular functions given by Web Services in a machine-readable form (as a formal ontology), so that they can be discovered, parameterized, orchestrated, and executed automatically.[96] This is very similar to the society of task-specific, more or less autonomous agents that Marvin Minsky imagined[97], inspired by Selfridge's Pandemonium theory (Selfridge, 1959). Instead of a *stimulus-driven bottom-up process*, however, the orchestration of Semantic Web Services is an *instruction-driven top-down process* that has to start with the expression of a formal intention at one point. It represents, in terms of the cognitive-technological model introduced in this thesis, a formal-language-based cognitive-technological actuation process. Semantic Web Services are, indeed, *services*. - The problem with AI agents is that it is unclear how artificial, non-living agents, without natural drives, should

[95] Ted Nelson's original conception of hypertext included the technology of transclusion (Nelson, 1995), i.e. binding small pieces of text/other digital artifacts into different hypertext documents, in a way that when a transcluded content element changes, it will change in all respective documents). In modern Internet technology, transclusion is only given as rectangular frames within web pages; it is not part of the technology-infrastructure of the Internet/WWW, and, thus, cannot be used efficiently for epistemic marking. I think it is a misfortune that the great societal importance of epistemic markers for enabling eusocially corrective, de-manipulative actions is overshadowed, in particular, by the ambitions of a pre-digital copyright industry, and, in general, by strong resistance from *private* organizations which are used to disguise their activities by lobbying and marketing. The chains of cognitive-technological processes need to become visible in content and functional technologies before the eusocial senses of justice, of empathy and cooperation can be applied effectively.

[96] See (Fensel, Triple-based Computing (DERI Research Report 2004-05-31), 2004).

[97] See (Minsky, 1988).

acquire intentions and goals if they were not first *given* to them (at least in a basic form). If agents were *given* goals, however, it would be wrong to consider them autonomous. In the worst, they will become cognitive-technological substitution-processes out of control, originated from abstruse, shortsighted ideas of inventors. Traditional AI agents are technological risks, and not something one should strive for. They give up the actuator-substitutor correspondence of the technological double-process, which can give way into a harmful (substitution) process. **The *autonomy* of such a process is just another *artificial epistemic uncertainty*, which unmasks AI as a form of animism, irrespective of whether one considers symbolic, connectionist or another strain of AI.** Keeping correspondence up is also a challenge to Semantic Web Services. Whether a particular sub-service is available, or not, whether an alternative service would still be acceptable, whether the result of the Semantic Web Services substitution process can match the expectations, all these questions and their answers need be reflected in actuator-substitutor correspondence, to keep the technological double-process intact. Semantic Web Services (or, more generally, goal-given systems of interacting agents) are defined as *self-contained, self-describing, semantically marked-up software resources that can be published, discovered, composed, and executed across the Web in a task driven automatic way*[98]. In the use cases of Semantic Web Services (SWS) research, the *task* is normally dealt with as *a given task*, meaning that the task is pre-formalized by the researchers, even if the contrary is claimed:

> […] *the Customer specifies its request in natural language and the request is translated into machine-readable form and processed* […] *automatically.*
>
> (Stollberg & et al., 2004)

In consideration of the limitations of natural language processing, what this claim actually does, is that it ignores all problems of ontology engineering (to which I have tried to give some prominence). A SWS/AI researcher might admit the discrepancy between claim and fact, but, at the same time, stress that it is good scientific custom to isolate a problem (i.e. SWS) and to deal with it in isolation of other problems. This would be correct, given that the problems can be separated without changing the nature of the problem, which I doubt. **The reason why the problem of formalizing a task and executing a task cannot be separated is that the essence of a *task-driven* technological process is it *being task-driven*, which presupposes a high degree of correspondence between an actuator process and the corresponding substitution process, which, in turn, presupposes a certain degree of ontology-based synchronicity.** Thanks to programming languages, it is not (anymore, or, at least, not all too)

[98] (Stollberg & et al., 2004)

difficult to design a technological substitution process to deliver the programmer's knowledge and to act out the programmer's thoughts. The difficulty of designing tools enabling cognitive-technological substitution processes is to have these processes act according to other people's knowledge and thoughts, in cognitive-technological double-processes of close correspondence. Therefore, **the problem of SWS (more generally, AI-) automaticity should not be separated from the problem of ontology engineering.** It is a big step forward, but not enough, to have things act as one wants or as one thinks others want them to act. The gist of *artificial* intelligence (functional substitution) and *artificial* knowledge (content) is to conduct substitution processes and present content as expected; that is in accordance with the memory states and, based on these, states of thought and will of the actuator. AI services, therefore, must indeed be *dialogues*. **Optionally, they may as well *substitute* dialogues, which is a less obvious, but more powerful option; an option, however, that would require accessing the actuator's memory structures and inferring potential responsive thought structures.** AI, thus, is really about creating the knowledge and intelligence of an actuator in artificial forms. Today's programmers can create and momentarily invoke artificially intelligent processes, following the programmer's path of thoughts as given at the moment of their expression; but the tools programmers create are not artificially intelligent, not even for themselves. Software-code text does not *automatically* update to reflect the programmer's thought and memory changes. At present, artificial intelligence is restricted in two ways: first, to the programmer, and, second, to the moment of creation and enduring correspondence-able [korrespondenzfähig] conduction of the respective software-enabled substitution process. That software sources are given as normal (though very formal and formally restricted) text, raises the same difficulties and offers the same advantages as any other written language artifacts. One accomplishment of the Semantic Web Service idea is to stress the importance of formalizing program/service descriptions for better service mechanization. In this thesis, so far, I have re-framed the problem of artificial intelligence in such a way that it leads me to believe that it has to be tackled from the side of artificial content, regardless of whether the actuator is a programmer dealing with programs (i.e. creating artificial intelligence tools), or some other actuator corresponding with other content. Substituting technological dialogues, which I identified as the core challenge and main chance of artificial intelligence, would require a formal, explicit memory of any eligible actuator at any time. In other words, if we are willing and it proves to be possible to equate explicit memory (which is to some degree explicit artificial memory) to ontology, the problem of AI would demand for up-to-date personal ontologies. This brings us back to the problem of ontology engineering. And it reminds us of attempts of language acquisition recording and life-recording that we have discussed before [see 2.3.1].

2.5.3.2.5 Controlled Natural Language

An alternative to ontology engineering assisted by logic experts are approaches of *Controlled Natural Language* (CNL)[99]:

> *Controlled Natural Languages are subsets of natural language whose grammars and dictionaries have been restricted in order to reduce or eliminate both ambiguity and complexity.*
>
> (Davis, Handschuh, Cunningham, & Tablan, 2006)

Logic syntaxes tend to make heavy use of short abstract symbols (primarily for logical operators) that have to be learnt and remembered in order to be able to read a logic statement. The short operator symbols are thus easy to read by logic experts (who will use them frequently), but not by domain experts (who would use them infrequently). However, if symbols are translated/translatable into natural language expressions, and if syntactical structures of logic notation are aligned with natural language syntax structures, then it is easier for the domain expert to read and express them. In this case, a computable form is gained by an exact mapping of natural language statements to logic statements. Thus, CNL becomes a *formal notation* for logic. Even though the natural language statement has to be parsed and *interpreted* (due to the discontinuation of logical syntax markers in CNL and due to possible *degrees of freedom* in the syntactical structure of CNL), translating back (by reverse mapping) from the computable form gained by parsing and interpreting the original natural language statement, an *independent* natural language statement can be generated for translation verification by the domain expert, without any intervention by a logic expert needed. The approach of CNL is similar to formalizing familiar/*natural* diagram types to make them machine-readable/machine-interpretable. Controlled Natural Language does not solve the problem of reductionism in logics. It still has to be learnt in order to avoid misinterpretations on the side of the domain expert. And it does not tackle the problems of synonymy, polysemy and homonymy prevailing in human natural language expressions. Neither does it imply any usable presentation form of complexes of CNL statements. Even if it seems possible to present CNL statements as sequential text, the specific (restricted, reduced, verification-demanding, interactive) form of CNL statements makes it unlikely that they will be used in the context of or even instead of normal (rich) human natural language text. It seems more appropriate to use CNL in task-specific or presentation-specific human computer interfaces, i.e. in command forms (for instructional text) or diagrammatic (e.g. tabular, hierarchical, graph) forms (for diagrammatic reasoning and knowledge representation).

[99] See (Sowa, Controlled Natural Languages For Semantic Systems, 2009) for a broader discussion.

2.5.3.2.6 Visual language

Formalized visual language is a type of CNL. Syntactical structures are supported by visual structures (instead of using symbolic-character markers). Natural language is allowed in form of labels of spatial entities (e.g. shapes, fields, frames, 2D/3D objects) representing syntactical entities (e.g. subject, object, predicate, quantifier, operator/connecting words etc.). Current UML diagrams in software development, for example, are aimed at bridging the gap between software engineers (logic experts) and requirement engineers or subject matter experts (domain experts), forming a kind of *project ontology*. UML diagrams represent specific (partial) ontology schemes that are instantiated in specific (partial) graphical interfaces. Because of their purely diagrammatic origin, their late formalization, and their limited domain of application, they are not normally recognized as an instance of CNL, and, therefore, not normally associated with problems of ontology engineering and static language artifacts. Argumentation Support Systems[100] are further interesting examples of visual CNL. Complex debates, forming networks of arguments and counter-arguments, of supportive and non-supportive evidence, of supporters and opponents, are difficult to *track* in free sequential text. Their visualization in graphs (nodes-and-links diagrams) by natural-language-labeled nodes and natural-language-labeled links demonstrates a simple triple-structured CNL. Visual triples of *node-link-node* structure represent controlled-natural-language *subject-predicate-object* structures. Semantic triples are often-used structures that can be matched with propositional or predicate calculus. [101] If graphically represented entities and relations come unlabeled, iconized or expressed in spatial complexes, the *naturalness* of visual CNL will suffer and visual CNL will start resembling a *graphical* logic notation. Charles Sanders Peirce’s existential graphs (and their different successors) are examples of such a graphic notation, which is supposed to be visually intuitive. The differences between a visual CNL and a graphic notation may appear marginal at first glance. Both graphic formats may show labels and shapes. In case of a graphic notation, however, the meaning of the shapes goes beyond marking vocal language entities and syntactical structures. A graphic notation cannot be read in the way a

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[100] See (Kirschner, Buckingham Shum, & Carr, 2003).

[101] However, Hermann Helbig, an expert in natural language processing, had some serious doubts about being able to, in general, formalize natural language statements by *simply* relating them to predicate logic (Helbig, 2001, S. 86):

> *Dieses Vorgehen hat aber verschiedene Nachteile logischer Art: 1. Stelligkeit: wegen der unterschiedlichen Anzahl von Konstituenten, die zu einem Verb treten können, müßten die Verb-Relatoren variable Stelligkeiten besitzen, was in der Logik nicht zulässig ist. 2. Stufigkeit: wegen der sehr häufig vorkommenden Referenzen auf Satz- bzw. Gliedsatzinhalte müßten deren logischen Bedeutungskonstrukte durch Namen benennbar sein, die wieder als Argumente von Relationen auftreten dürfen.*

visual CNL is read, which, in the main, enables de-sequential, dynamic reading patterns; it has to be *visually interpreted*, integrating natural language labels and a distinct visual object layer. Graphic or spatial arrangements can simplify perception and internal computation, offering the chance of an intelligent, shared use, as Andy Clark puts it:

> *Human language is itself notable both for its open-ended expressive power and for its ability to reduce the descriptive complexity of the environment. Reduction of descriptive complexity, however achieved, makes new groupings available for thought and action. In this way, the intelligent use of space and the intelligent use of language form a mutually reinforcing pair, pursuing a common cognitive agenda.*
>
> (Clark, 2008, S. 65)

In a hierarchical organization of labels, for example, the spatial relations could directly express category membership, without any explicit verbalization needed. The category tree is a graphic notation forming a word-associative field, re-arranging (and reducing) sequential *verbal* syntactic structure of natural language propositions into an overview that can be used to traverse pathways of category sub-, cross- or co-membership. **The crucial advantage of de-sequential (de-verbalized) word-arrangements is that new (sequential) relations become obvious (such as those between siblings / co-members of a category) and, therefore, also associable. Graphic notations, thus, have a high creative potential. The momentary** (i.e. existing only during the graphic representation) **artificial co-structure between a natural-language-word structure and a particular semantic spatial structure can lead up to a perceptively restructured field of word-to-word-associations and a correspondingly restructured sense-field. The depicted category hierarchy (and any similar graphic notation), therefore, forms a momentary, <u>perceptible artificial memory</u>.** This co-structural artificial memory is not imaginative, as were those artificial memories created by ars memorativa, but directly *experiential*. Compared to artificial memories created by mnemotechnics, their function is not restricted to improved remembrance. The representation of semantic spatial relations in a graphic notation may result in the implicit creation of new, *meaningful* (and more *or less* useful), discoverable spatial relations. In that reflective-creative respect, graphical notations resemble text. In the method of loci, it is necessary to imagine locations and their spatial sequence, which represents the sequence of the things that are to be remembered. Loci can be learnt. A category tree, as an example of a useful graphic notation, is not to be learnt by imagining a particular tree with branches, as a variation of the loci in the method of loci. It would be impossible (or at least very inefficient) to accommodate such a concrete image to fit the different requirements of category hierarchies. A good graphic notation is learnt by *understanding* the syntacto-semantic values of its spatial organization (a kind of graphic-notation literacy). An instance of a graphic notation, that is a graphic using the notation, does not represent a learnable (memorable) graphical unit. The effect of *reading* (and interpreting) the graph is on both the word-field and sense-field level, and not on any *graphic* level. There would be no (or little) use in memorizing graphs. Graphic notations are a combination of framed sequentially written language (labels) and syntacto-semantic visual relations. They are not iconographic or pictorial (such as most proprietary infographics), even if they make use of icons and non-character symbols to thin out the natural language proportion in a graph in order to increase its reading efficiency (by increasing the effort needed to learn the notation, though). By now, we understand that the main purpose of visual language, be it visual CNL or graphic notations, ought to be the formation of *inner language-based artificial memory*, besides serving as a text-like (although desequentialized, networked, spatially organized) *outer* memory-aid. One should not forget that visual language, like vocal or sequentially written language, depends on codification. The difference between, on one hand, visual, depictive art (even if involving written language elements), which often mimics or abstracts complex situational or sequential visual perceptions, and, on the other hand, visual language is that depictions are, first and foremost, directly, experientially perceptible and interpretable, whereas the meaning of visual language *has to* be perceived indirectly, by means of the spatially organized language, which makes the formation of co-structural engrams more likely. In practice, this difference often uses to blur, demanding for *semantic fusion*[102] of visual language elements and pictorial elements, which may involve complex memory- and thought-processes to resolve conflicting interpretations or to *make sense* in the first place. The fundamental cognitive difference between both forms of visualization is not normally understood and taken into consideration. And so, supported by a general tendency for using eye candy to attract and keep attention, what I call visual language, more often than not, is destroyed by integrating numerous images and *relaxing* the necessarily strict semanto-syntactic spatial organization of graphic notations, thus rendering the results unusable for efficient, learnt technologies of artificial memory creation and memory aiding. Even though Robert E. Horn, who is one of the few people who dealt specifically with integrating language and images (what he calls *visual language*), remarks

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[102] A term coined by Robert E. Horn (Horn, 1999, S. 97) in his book on visual language:

> *We know a lot about cognitive processes involved in making meaning, but we do not understand fully how semantic integration takes place in thought.* […] *How does the brain combine all the different elements of the message to create an integrated meaning? I call the process of making meaning out of the tight integration of words, images and shapes 'semantic fusion'.*

that without an integration with words and/or shapes, images are only conventional visual art, not visual language […] (Horn, 1999, S. 7), visual language, in my definition of visual CNL and graphic language notations, best exists without an integration with images, at least if it were to be understood as an advanced tool for language-based artificial memory, aimed at overcoming the restrictions of sequential text. Horn's visual language, in contrast, is a hot medium, with images and written language occupying the visual sense, leaving less room for memory re-structuring by indexical language-co-structuring. His visual-language *diagrams can be better representations* […] *because the indexing of this information can support extremely useful and efficient computational processes* (Horn, 1999, S. 124). It seems that the usefulness of integrating images and written language lies primarily in avoiding pictorial ambiguity for improved *visual* inference, which is a form of pre-language(-indexed) and language-independent thought. This leaves us with a more *visual* visual language (for *visual* inference and visual memory-indexation) and a more *language* visual language (for *language* inference and language memory-indexation).

2.6 Language-Knowledge Structures

2.6.1 Semantic Networks

2.6.1.1 Common Semantic Network Components

Helbig characterizes terms [Begriffe] by three components[103]: 1. a word or phrase label. 2. A set of relations to other terms. 3. A perceptual (in most cases: visual) pattern. Semantic Networks comprise component (1) and (2), but not (3). Neural networks do model component (3), but not (1) and (2).[104] A combination of (1), (2), and (3) in knowledge representation is still missing and would be, according to Helbig, a great leap forward. The meaning of (2), the set of relations amongst terms, is left unclear. Are these relations between (1), words (forming vocal patterns), or are these relations between (3), perceptual patterns. If the relations can be labeled (termed), they must be between (3), as a relation-term (perhaps a verb or a property name) has itself a meaning. However, what would be the relation between a term and the *semantic* relation that binds it to another term. If one were not to invent yet another term (which simply would perpetuate the problem of relations between terms), **one would have to admit (eventually) that it can only be (or have the meaning of) a *direct* relation between two words by a direct relation of their concepts**. Hence, words can be directly associated *or* indirectly associated. Consequently, there must be a **word field of semantically directly associated words** and a **word field of semantically indirectly associated words**. Correspondingly, there must be a sense field of directly and indirectly associated word senses corresponding to directly and indirectly related words. If two words were directly

[103] (Helbig, 2001, S. 19):

> *Begriffe und ihre Beziehungen zueinander sind wesentliche Strukturelemente des kognitiven Apparates und damit auch der Bedeutungsreprӓnsentation natürlichsprachiger Informationen. Ein Begriff lässt sich im allgemeinen durch drei Komponenten charakterisieren:*
>
> *1. ein Wort oder eine Wortgruppe, die den Begriff bezeichnen und die ihn nach außen, d.h. in der sprachlichen Kommunikation vertreten (das sogenannte Wortetikett);*
> *2. eine Gesamtheit von Beziehungen zu anderen Begriffen;*
> *3. ein komplexes Muster perzeptuellen (meist visuellen) Ursprungs.*

[104] (Helbig, 2001, S. 19):

> *Semantische Netze versuchen gerade die ersten beiden Komponenten zu beschreiben. Neuronale Netze sind dagegen sehr gut geeignet, den dritten Aspekt zu modellieren. Ihnen fehlt aber weitestgehend die Einbindung der ersten beiden Komponenten. Aus der Vereinigung dieser Entwicklungslinien, die zur Zeit noch aussteht, ließe sich ein wesentlicher Fortschritt auf dem Gebiet der Wissensrepräsentation und der kognitiven Modellierung erzielen.*

(vocally, as a rule) associated, they could correspond to a single sense pattern. In this case, the two words represent a single term, as the term is defined by it representing a singular concept. At the same time, the two words might also represent two separate concepts. Two associated words, representing two different terms, implies that their senses are associated, too. As long as the two respective sense patterns share qualities (are concept-wise interrelated or relatable), the two concepts could be differentiated by relational terms, that is they would if the associated words would be indirectly related. Now, there are two interesting cases: First, two associated words *without* their concepts being related in any way, besides perhaps being evoked at the same time by their *associated* denoting words. One could argue that this conceptual coincidence would or could establish a (weak) concept-association, following the Aristotelian idea of association by contiguity. Second, two associated words with their concepts being *directly* related (i.e., in a non-differentiable way), because differentiability would mean relatability by differentiation. One could argue (from a logical point of view) that two *different* concepts are always well differentiable, namely by all their (non-shared) qualities (in the sense of property a of concept A not being part of concept B). This, however, is a phenomenological and, consequently, cognitive-psychological misunderstanding. Such a logical property comparison and relational *negation* is a creative, constructive thought-schema that first has to be applied before cognitively taking effect. This means that, de facto, *cognitively*, at any *pre-logical* or *pre-analytical* moment of instantiation of different concepts by associated words, the differences can only form around actual similarities (something both concepts relate to) between two concepts/sense-patterns[105], if it does not yet exist by prior experiential *contiguity*. Association by dissimilarity is, thus, the same as association by similarity. We will later discuss Richard Semon's unifying concept of *homophony*, which reduced different types of association to a single memory-mechanism (even rejecting similarity as a form of direct association, as it takes effect indirectly only). The impression of similarity may stimulate semantic differentiation. However, there are as well concepts that associate without explicitly differentiating. *Opposition* is a good example. Hot/cold, wet/dry, dark/white are all antonymous pairs of words and concepts that are directly associated (word-wise *and* concept-wise), forming extremes of a more or less gradual *continuum*. One cannot be understood without the other, and, oftentimes, one directly contrasts with the other. This special direct-associative quality of *neighboring perceptual patterns* can also be found in, for example, whole-part concepts, or transformative processes with distinct (conceptual) states. What is important to note is that even though it is possible to differentiate these qualitatively

[105] This would also explain why not all *non-analytical* judgments seem not to be based on exhaustive feature comparison. False sentences, for example, can be quickly rejected, which contradicts with Smith's (Smith, Shoben, & Rips, 1974) Feature Comparison Model.

neighboring concepts and connect them by a relation, this relation is not distinct in the same way an actual similarity or difference is distinct. From a phenomenological point of view, there are qualities of perceptual patterns (concepts) appearing at the same time (or nearly the same time) which develop a specific emergent quality or tension. It is possible to put an abstract relation between the two respective words, saying, for example that *hot is the opposite of cold*. In my experience, this would at the same time name and, to some degree, destroy the emergent quality, which can be felt well in the direct word-combination *hot-cold*.

Summing up, systematizing and thus extending this discussion, one can postulate a couple of basic word-related association types between (for the sake of simplicity: up to two) concepts. These semantic association structures can be considered as basic building blocks of semantic networks (representations).

2.6.1.2 Alternative Building Blocks of Semantic Networks

2.6.1.2.1 Contiguity Associations

Word Association

A (perceived) word association [see Figure 2: Word Association] is an association of contiguity between two meaningful words (that is their written and/or verbal symbols).

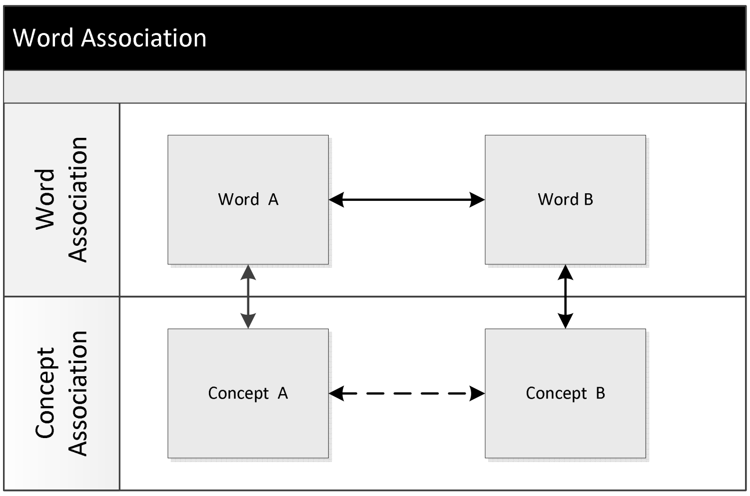

Figure 2: Word Association

Due to the symbolic function of individual words, a word association establishes a likewise conceptual association of contiguity (given reference to two separate concepts). Once experienced, a word association may (or may not) form a single conceptual unit or a holistic conceptual complex, and it may (or may not) establish a lexical unit. The lexical unit comes either as a word compound (single-word complex), which is or is not related to a conceptual unit/complex, or as a chunk (separate words-complex), which, for the moment given, has to be thought of as referring to a conceptual unit - by necessity, as it would otherwise not be different to the (contiguous) word association introduced here.

Concept Association

Concept association [see Figure 3: Concept Association] means the association of words by contiguously experienced, already lexicalized or lexicalizable concepts. A semantic network containing a sense field (as compared to a word-field-only semantic network representation), might establish word associations in as much as the given sense field is interpretable as a meaning field, that is in as much as there are words already symbolizing the (non-word) sensual impressions given.

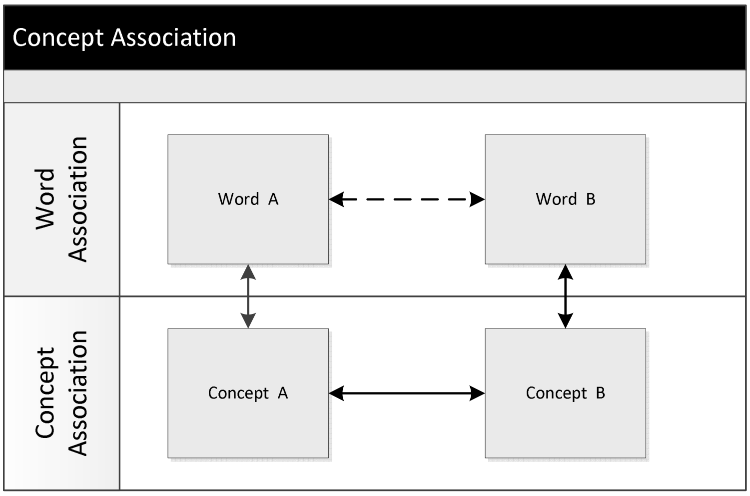

Figure 3: Concept Association

2.6.1.2.2 Ambiguity Associations

Homonymy Association

A homonymy association [see Figure 4: Homonymy Association] here is the association that can be established between two distinct concepts that are symbolized by the same (homonymous) word or word compound. If this distinction were not to be restricted to the conceptual level, at least one synonym (for concept A or concept B) has to be found, in order to be able to differentiate symbolically between concept A and concept B.

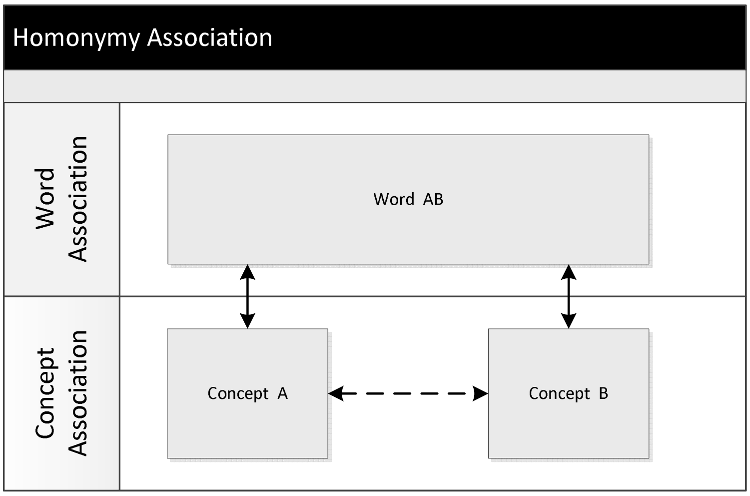

FIGURE 4: HOMONYMY ASSOCIATION

SYNONYMY ASSOCIATION

A synonymy association [see Figure 5: Synonymy Association] is established between two words that refer both to the same concept. This word association is concept-induced, while the conceptual homonymy association was word-induced. A synonymy association is necessary for a homonymy association to become expressed symbolically. Synonymy is often created by extending word A to also mean what word B means, while word A has another, distinct (but often conceptually related) meaning. The synonym Word B can thus be used to distinguish the polysemous word A relative to Concept AB. Word A could (at the same time) have the same function relative to word B, if it also were to be polysemous.

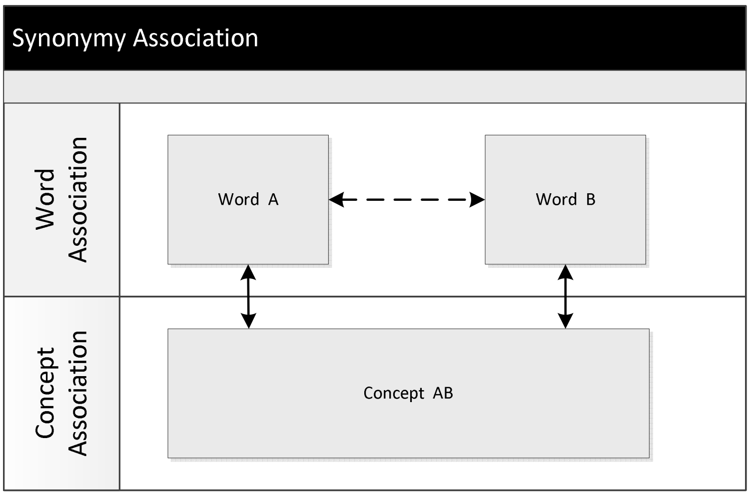

FIGURE 5: SYNONYMY ASSOCIATION

2.6.1.2.3 Analytical Associations

WORD COMPOUND ASSOCIATION

A word compound association [see Figure 6: Word Compound Association] is established between two distinct words that together form a compound word. A word association may form a word compound with a single, synthetical or a complex meaning. If the two words are separated again, their individual meanings may be reinterpreted to form a new, (slightly) different concept unit. Thus, there may be cycles between word compound association and word association leading to polysemous (re-interpreted) word compounds, in the same way as the compound word as a unit is prone to directly meaning-induced polysemy (e.g., via generalization, specialization).

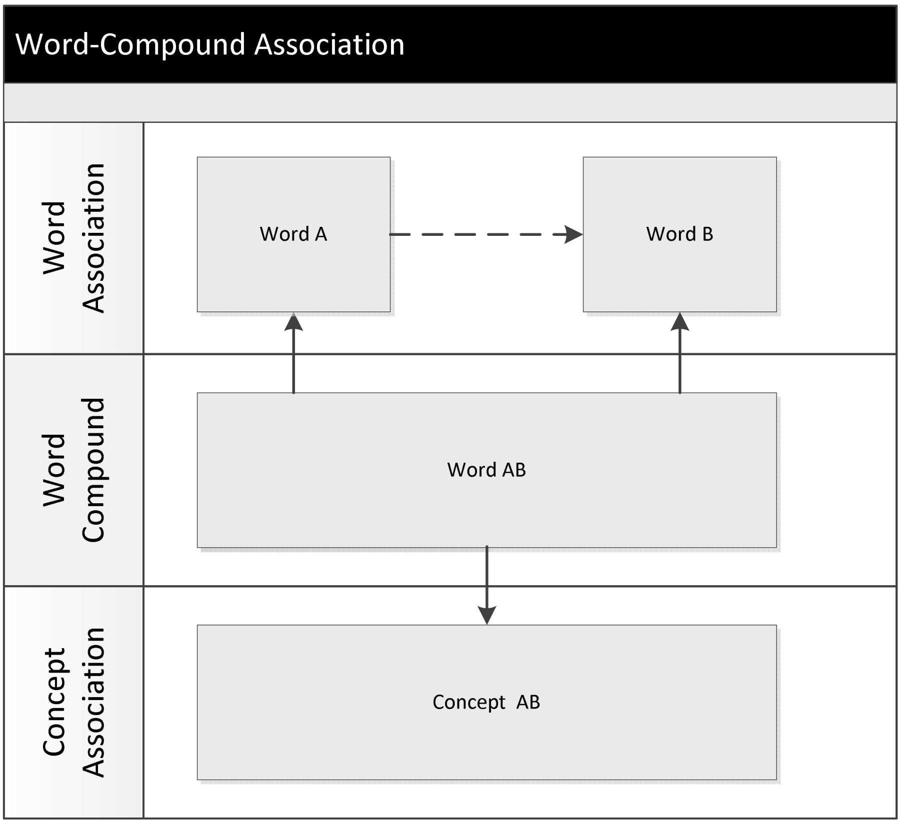

FIGURE 6: WORD COMPOUND ASSOCIATION

CONCEPT COMPOUND ASSOCIATION

A concept compound association [see Figure 7: Concept Compound Association] is established between two words if a complex sensual field in the semantic network (representation) is perceivable as a composition of two concepts, A and B, which are denoted by word A and B respectively. Word A and word B become associable via a conceptual compound that was not established by a word association before and is representationally different from the temporally distinct concepts of a concept association.

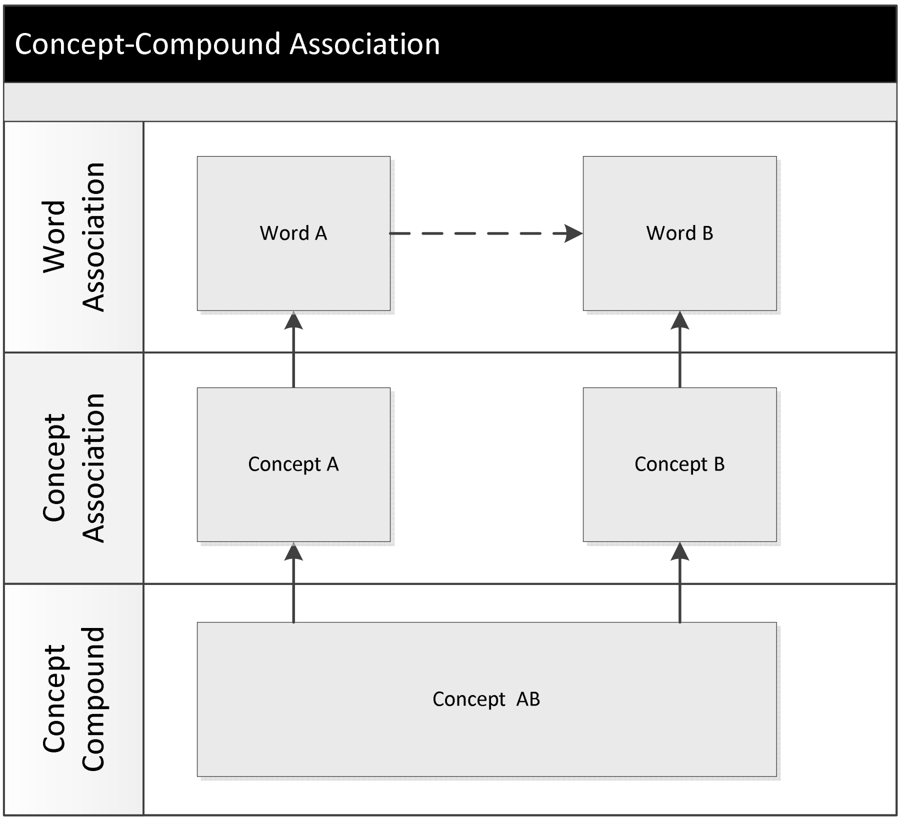

FIGURE 7: CONCEPT COMPOUND ASSOCIATION

2.6.1.2.4 Similarity Associations

WORD-SIMILARITY ASSOCIATION

A word-similarity association [see Figure 8: Word-Similarity Association] is created between two phonologically similar words and between their concepts. It is a word association not created by mere contiguity, but by a third, the similarity, the shared word fragment (or a phonological similarity pattern if there is no shared word fragment, or if there are several shared word fragments). For example, the words *doable* and *doing* both share the word stem *do*. They are thus also directly and conceptually associable (as in this very example). The word association results from the generative power of the shared fragment. If the fragment were directly perceivable (as an intermediary), there would be first an analytical association established (from word A to the shared word fragment AB), before a generative-associative word fragment completion could take place (from word fragment AB to word B). The word-similarity association, however, is not to be understood as a series of associations, but as an actual direct association, that can be analytically *bridged* by a word fragment for explanation. The shared word fragment could be a syllable, a single morpheme, or a whole word root. It therefore may or may not have a meaning of its own. We will have to deal further with similarity associations when discussing the concepts of ecphory and homophony. A special case of a word-similarity association would be the association between word A and word B, where word B is fully contained in word A. This association is implicitly given in any word compound association (as the relation between word AB and word A, and between word AB and word B). A double word-similarity association is thus implicitly assumed in each word compound association.

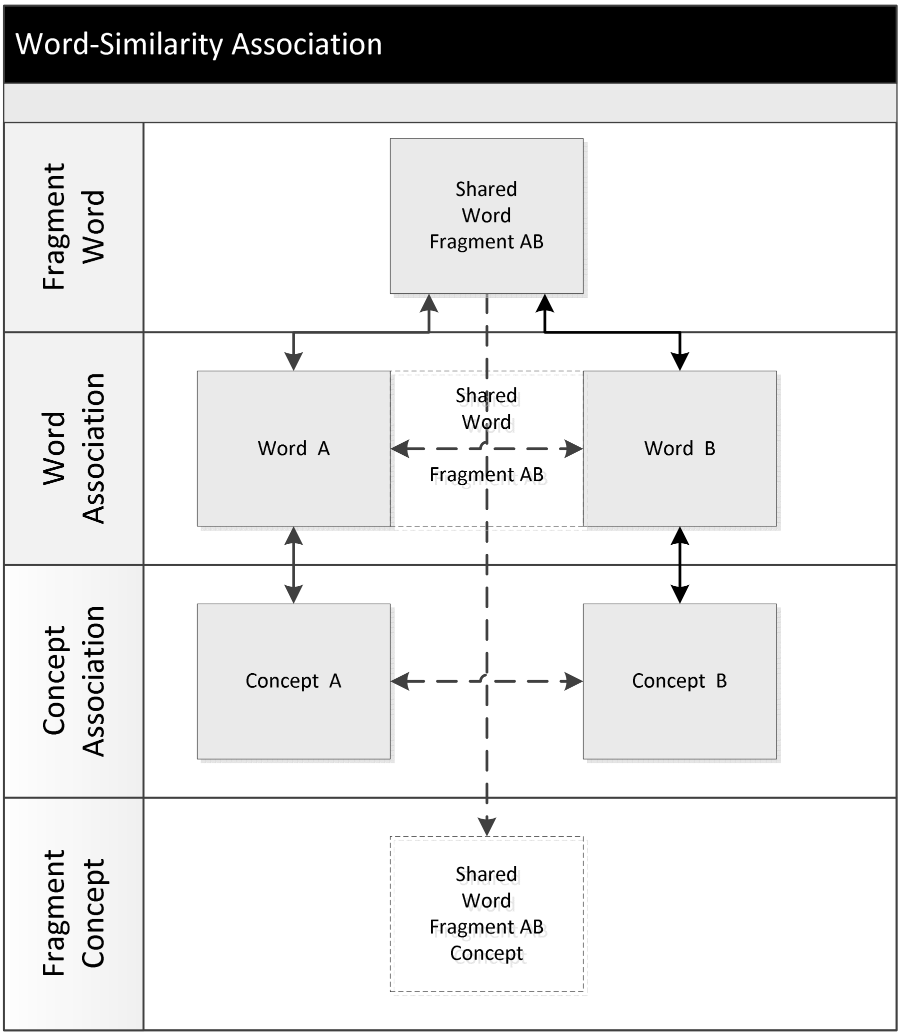

FIGURE 8: WORD-SIMILARITY ASSOCIATION

The word-similarity association, in comparison, is explicit and can be more diverse in type, as it is not restricted to being a full word stem of a multi-word compound. However, in cases of meaningless syllables, of non-independent word-roots/morphemes or general syntactical markers, an *analytical* word-similarity association is unlikely to be established. Instead, a regular word-similarity association to a similar word with a stronger semantic valence (i.e., between overlapping words) appears more likely. Word type variations such as that between *doable* and *doing* will often be perceived as direct word-similarity associations because of a co-variance pattern (relating *do* to *do* and *able* to *ing*) to be frequently found in other word-similarity associations (e.g., *changeable* and *changing*).

CONCEPT-SIMILARITY ASSOCIATION

The concept-similarity association [see Figure 9: Concept-Similarity Association] establishes a word association by conceptual similarity. Concept is here simply understood as what is symbolized by the (phonic/graphemic) words. If, in a simple case, a word in graphemic form were to symbolize a word in phonic form, a phonic similarity would become a conceptual similarity, not simply a word-similarity. For example, two homophones might establish an association between two homographs by concept-similarity association.

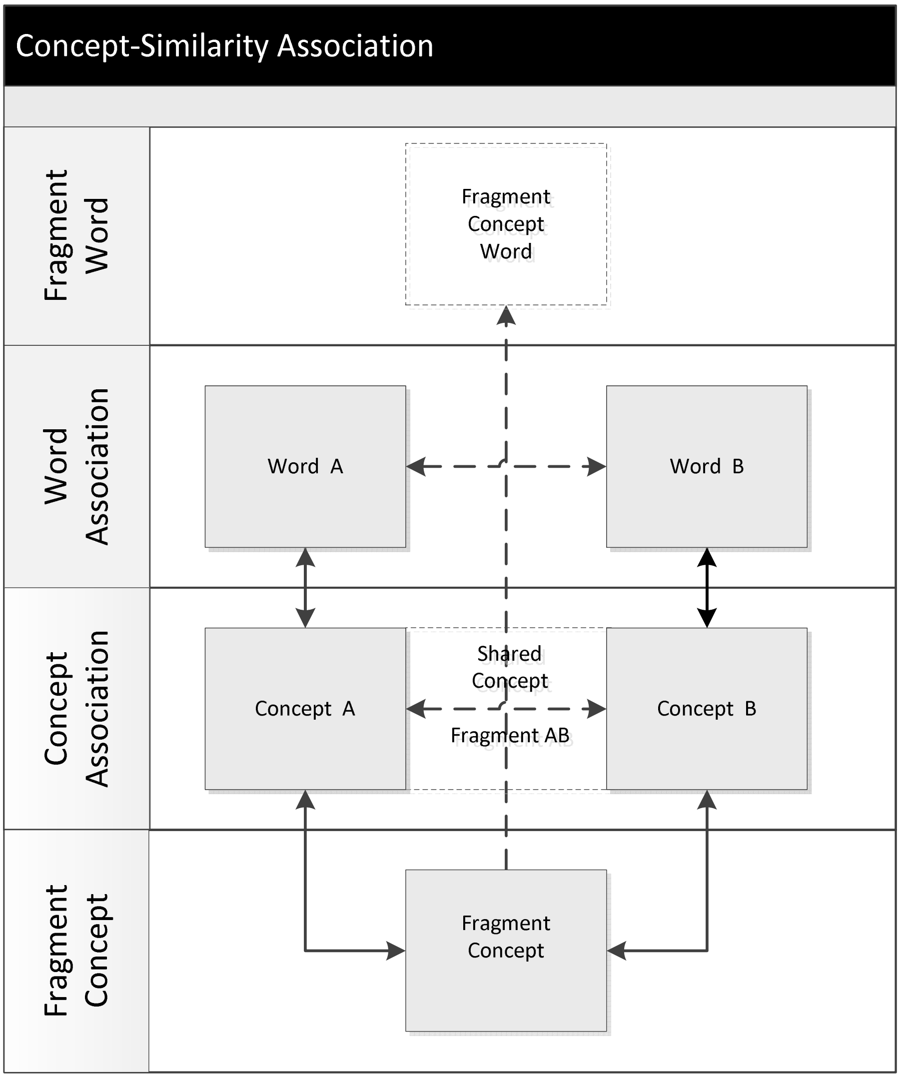

FIGURE 9: CONCEPT-SIMILARITY ASSOCIATION

The more complex or manifold the meanings of words become, the more points of contact and shared properties will be available between them, enabling first a conceptual and, subsequently, a word association. It is important to bear in mind that the similarity associations are not associations based on temporal-spatial contiguity, and they are not analytic associations based on any experienceable word- or concept-compound. They are also different from non-associative cognitive operations such as a generalization (which one would expect to be based on cognitive similarity/overlapping, too).

2.6.1.2.5 Emergent Associations

Emergent associations are normally overlooked, even if they seem to be very important in the semantic-associative realm. At first glance, they may appear as mere contiguity or similarity associations. However, the special binding power between them is based on a third quality that is not simply shared. They are also not to be confused with Aristotle’s association-principle of dissimilarity, which is confusing and therefore unusable, as it resembles the similarity-principle whenever dissimilarity is relative, not absolute. If, however, as in cases of *natural* oppositions, dissimilarity is absolute or nearly absolute, the emergent quality of dissimilarity is but one of many possible emergent qualities of opposing qualities (or oppositions). At this point, I do not want to develop a classification scheme of emergent oppositions, but simply point out the fundamental importance of this association type as a basic building block of a semantic network (representation).

Word-Emergent Association

As word-symbols use to be either vocal or abstract-graphical, word-emergent associations [see Figure 10: Word-Emergent Association] the emergence is restricted to respective vocal or abstract-graphical phenomena/concepts and of far less practical relevance as conceptual-emergent associations [see next section]. However, conceptual-emergent associations are often accompanied by phonic word-emergent associations. Take the opposition of up and down (auf und ab), where the specific phonic-articulatory difference between the two words clearly creates a word-emergent opposition (somehow also reflecting the concept-emergent opposition of moving or looking up and down), which indicates a multi-modal emergent opposition of tension (up) and relaxation (down), of opening (up) and closing (down). I guess that in gestural sign languages there are far more word-emergent associations than in written/spoken languages, due to higher-dimensional gestural symbol patterns (including motion and three-dimensional temporal-spatial relations). The word-emergent association is productive in that it generates an association between the corresponding concepts. This conceptual association, however, will not be very strong, at least not unless the word-symbol opposition is matched by a corresponding concept opposition. Optionally, a word opposition can be denoted by a (more or less generic) word-symbol. Associating the word-symbol in-between the emergence-creating words, however, might destroy the specific word-opposition effect. There is a significant phenomenological difference between thinking *up (and) down* and *up is the opposite of down*, with the latter utterance not associating *up* and *down* to each other, but each to the verbal phrase *is the opposite of*.

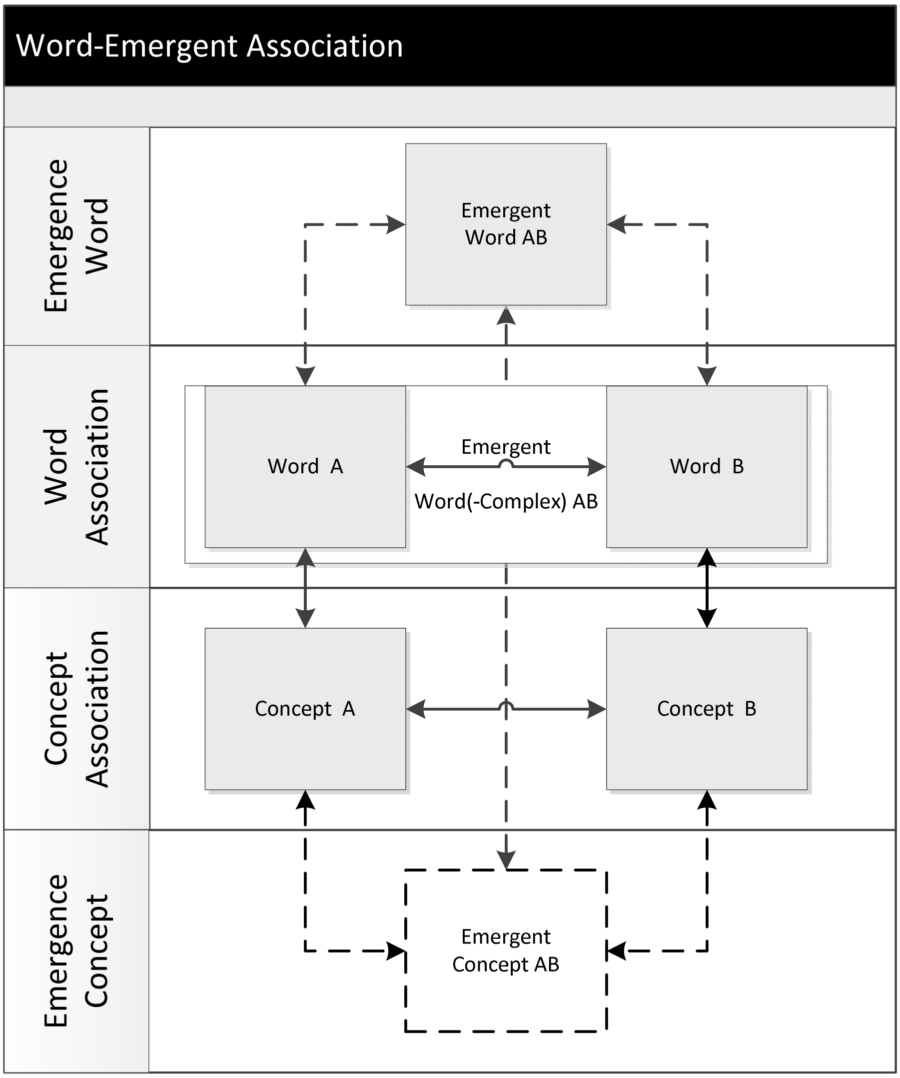

FIGURE 10: WORD-EMERGENT ASSOCIATION

CONCEPT-EMERGENT ASSOCIATION

A concept-emergent association [see Figure 11: Concept-Emergent Association] potentially creates an association between corresponding word-symbols. As the word-emergent association is a special type of concept-emergent associations (insofar as we abstract from the symbol-function of the word and allow a *higher*-order, e.g. graphemic, symbol to symbolize the words), the basic mechanisms at work are not different at all. There is an interesting observation to add, however. In concept-emergent associations, the directionality of the association is of great importance (more so than on word-emergent associations if they are not matched by a concept-emergent association). The transitional emergent effect of up-down is clearly different from the transitional emergent effect of down-up. The author experiences these particular concept-emergent associations as going from tension to relaxation and from relaxation to tension respectively. Immediate, non-relational [sic] associative bi-directionality is a surprising feature of a principally non-contiguous association type (in which it resembles similarity associations, while analytical associations will be bidirectional naturally due to contiguity-based chunking). Many conceptual oppositions can be expressed by a single word (word A) being affixed to form the *opposite* word (word B). A common example is the opposition of negation (or disappearing, dissolving, reversal etc., as in *doing* and *un-doing*).

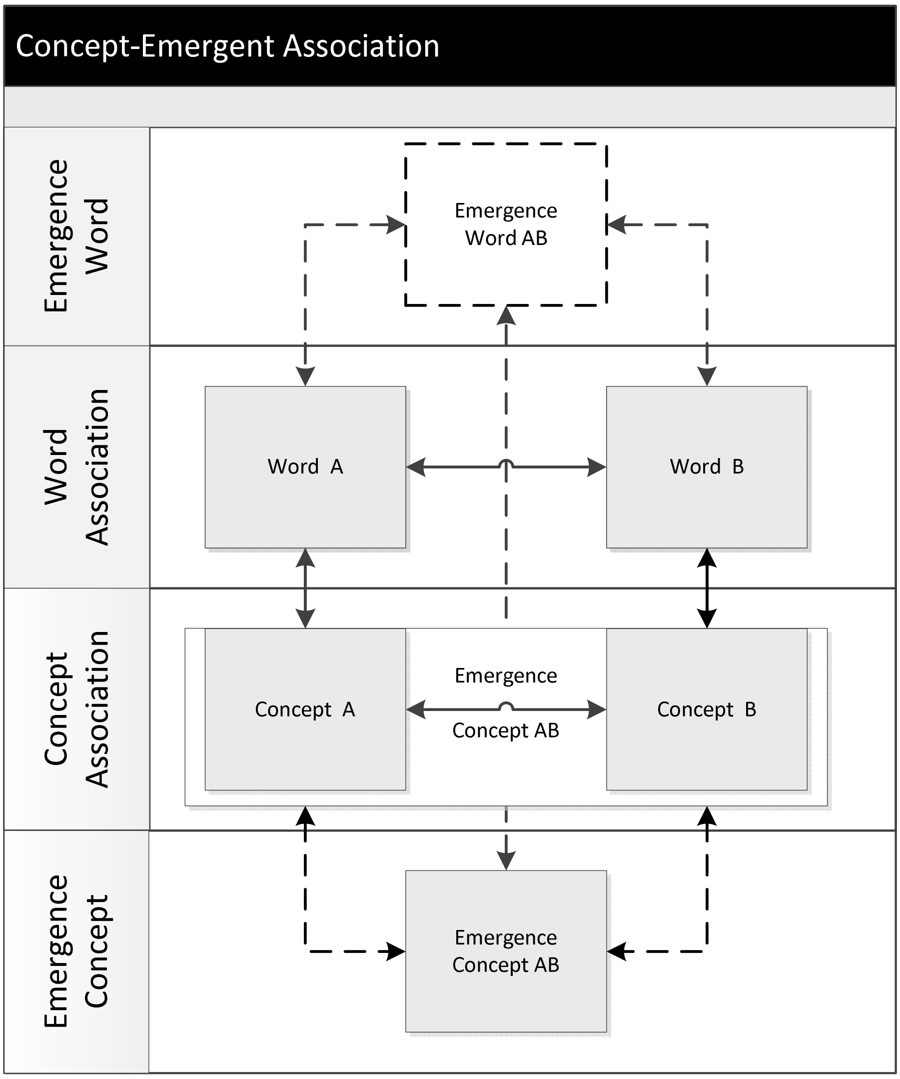

FIGURE 11: CONCEPT-EMERGENT ASSOCIATION

In agglutinative languages, certain affixes function as indicators of emergent oppositions. This is due to the possibility of manifold instantiations of basic oppositions such as negation or opposite movements). Many basic oppositions even (in)form syntactical markers of a language, as is the case with gender (male versus female) and number (single versus many) and they affect different word types (e.g., in Russian, less so in German, verbs are frequently prefixed to express oppositions). Languages differ in their cultural-syntactical means to instantiate oppositions easily by applying ready-to-use syntactical schemata. In a radical interpretation, even spatio-temporal oppositions such as *before-now* and *now-then* (in future) are of the concept-emergent association type, for example in the sense of morphologically evolving from (*before-now*) and evolving into (*now-then*).

2.6.1.2.6 Syntacto-Semantic Word/Concept Association

Syntacto-Semantic Word Association

The last of our basic associative building blocks is called syntacto-semantic. It establishes a symbol and/or concept relation by a distinct third. This could be, for example, a syntactical marker, a prepositional phrase or verb phrase (in linguistic terminology), all interconnecting two symbols word A and word B. In Figure 12, the interconnecting unit is called relation word. In some special cases, it does not even need a relation word, as when in Russian the verb *being* is often omitted altogether. Still, there is a relation present even in these shortened Russian sentences, which are built according to a specific syntactical schema (expressing that A is a B, and not that B is an A). A syntactical schema corresponds with a conceptual schema. Even if the relation word is left out, the relation concept is not. The relation symbol(s), if present, do not have to be between word A and word B. In principal, any order is possible, restricted only by the schematic/syntactical (language) conventions in place, which normally help to avoid syntacto-semantic ambiguity. There does not even have to be a single relation word only. A syntactical schema may comprise several relation words, syntactical markers etc. in a single syntactical schema. In one langue a suffixal number-marker relating an adjective to a noun will be concatenated to both, adjective and noun, while in another language only one of them will be changed, and in a third language no explicit relation-indication is needed or there are no means to express number at all. Cultural schematic conventions can take many forms. The picture is considerably complicated by the possibility of multiple superimpositions of syntactical schemata, adding several conceptual dimensions at once to the associative constellation of word A and word B. This can be accomplished, for example, by affix serializations or special, semantically high-dimensional syntactical markers. It is, however, crucial to understand that any syntactical schema has to correspond to a conceptual schema, and that any number of relation words have to be arranged according to their specific syntactical schema(ta). Syntactical markers or syntactical words or any relational words (e.g. verb phrases) all seem to have one thing in common: they enact a semantic schema by filling word variables into a syntactic word(-symbol) schema/template. They are symbol-triggered modifications (usually specializations) of basic conceptual associations (between concept A and concept B, in our example).

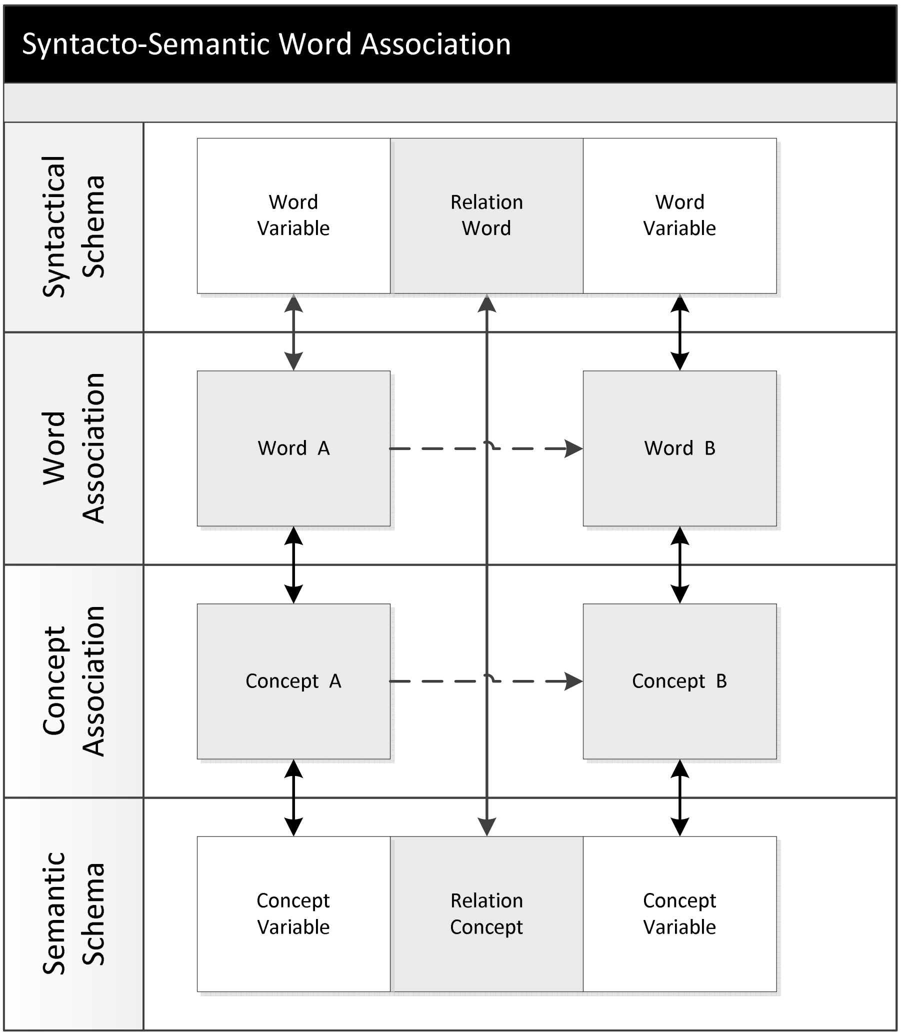

FIGURE 12: SYNTACTO-SEMANTIC WORD ASSOCIATION

SYNTACTO-SEMANTIC CONCEPT ASSOCIATION/BLENDING

In the same way, in which the syntactical schema is simplified in Figure 12, the semantic schema is (over-)simplified, too. The great variability of relation word templates even for but two words to be relationally associated is reflected in the great variability of conceptual blending that is brought about by the instantiations of word templates. There could be much said about the conceptual effects of relation word phrases like *is a(n)* in sentences like *This doctor is a God* (in short form: *God doctor*) or *This doctor is a butcher* (in short form: *butcher doctor*). *Conceptual blending* was analyzed and described as a number of very basic cognitive operations by Gilles Fauconnier and Mark Turner (Fauconnier & Turner, The Way We Think - Conceptual Blending and the Mind's Hidden Complexities, 2002). They see conceptual integration/blending as *pervasively at work behind the many innovative and imaginative capacities of cognitively modern human beings*[106].

[106] (Fauconnier & Turner, The Way We Think - Conceptual Blending and the Mind's Hidden Complexities, 2002, S. 111)

> *We hope to show that the study of blending, like chemistry, has the potential to change our view of the world, subsuming many disparate phenomena for which we had partial descriptions, connecting them, and branching out to discover new phenomena we had not seen. Many phenomena for which we had partial descriptions - categorization, mathematical invention, metaphor, analogy, grammar, counterfactual thinking, event integration, various kinds of learning and artistic creation, global insight integrating vital relations like cause and effect - are products of the same, well-defined imaginative operation.*
>
> (Fauconnier & Turner, 2002, S. 90)

The conceptual templates mirror cognitive operations of conceptual integration. Basic conceptual integrations do not have to have corresponding syntactical schemata. However, most conceptual integrations are complex cultural relational concepts, such as *marriage*, *employment*, *trading* etc. These depend on highly abstract language concepts. Applying (e.g., reading/hearing) a syntactical schema (say, *A is married to B*) filled in with two words (the names of two persons, A and B) may trigger a complex conceptual integration (or thought) process, resulting in the belief that A is the father of B's children, that A and B live together, that A and B know each other etc. This type of integration is relation-word-associative in the sense that it cannot be triggered by the mere conceptual contiguity of the words *person A* and *person B* and/or their respective concepts. It cannot be directly associative. Other conceptual integrations, however, are non-relational. A conceptual blending based on similarity, that is, in Fauconnier's and Turner's terminology, a conceptual blending based on *analogical mapping*, does not depend on a relational association. A similarity association [see Figure 9, p. 104] produces a fragment concept and, possibly, a fragment word, namely if a word preexisted denoting the fragment concept (forming a word(-symbol)-concept complex). There is, however, a remarkable special case. In word-similarity associations, the fragment concept is a word-fragment. If it is a syntactical marker / morpheme with an attached or attachable semantic conceptual fragment, the word similarity association will generate or strengthen a syntactical schema. Reusing the shared word fragment across a number of word-associations will weaken the relative co-occurrence frequency of any non-fragmentary word or word part in the word association. This helps increasing the schematicity of fragment words and hierarchically built fragment word complexes (i.e., complex syntactical structures). The individual acquisition and social evolution of syntax are thus based on similarity associations, or, in other words, analogical mappings and, subsequently, abstractions potentially generating syntacto-semantic relational associations. Fauconnier and Turner regret that …

> *Analogical mapping per se is not part the theoretical apparatus; nor is it viewed as part of the child's learning apparatus. So, paradoxically, although the child may be equipped with vast analogical capacities in all kinds of domains, the view of formal linguistics has been that the learning of grammar does not involve analogical mapping. Rather, to learn the grammar is to induce a productive system (the formal grammar) on the basis of innate a priori constraints (the universal grammar). Perceived analogy will be a by-product of that system, not one of its theoretical concepts nor, surprisingly, a means for the child to apprehend that system.*
>
> (Fauconnier & Turner, 2002, S. 13)

Extending Fauconnier’s and Turner’s idea a bit and re-focusing on our typology of basic semantic associations, one could say that the analogical capacity, that is the capacity to form similarity associations and resulting syntactical schemata, is to be understood as a precondition for word-based relational-associative conceptual blending/integration. A primitive developmental pattern can be theorized: First, contiguity associations establish the basic reference between word and concept where, in a concept association, word A *is* concept A, and concept B has no word B. At that stage, the word A – concept B association is established, even though concept B is the same as word B, because it represents word A as well as it is represented by word A. The (usually) vocal word or language-modality, however, is easily producible by humans in a less disturbing and more quality-rich manner than gestures are, whereas the visual modality is dominant (always present) in experience. Vocal utterances begin to carry visual meaning. Frequent, *naturally* relevant *visual* concepts such as number and gender begin to form conceptually productive/integrative syntactic templates by word-similarity associations. Concept fragments from concept similarity associations are being named by fragment concept words, potentially gradually creating layers of higher-level abstractions. Conceptual- and word-co-occurrences form highly integrative conceptual- and word-compounds (complexes) or less integrative (interpretable) conceptual and word chunks, which become complex units of syntacto-semantic word-association and complex conceptual integrations. Analytical associations allow for (re-)interpretations of communicated or learnt complex words/concepts. Concept-emergent associations work similar to similarity associations in that they produce syntactic templates based on words denoting basic emergent qualities (e.g., in affixes/markers for negation). Ambiguity associations invoke critical reflections needed to disambiguate cases of homonymy and synonymy intentionally.

2.6.1.3 New Substructures of Semantic Networks

The complexity gained by relational associations as instantiations of syntactical templates consists in a gradually formed **relational-associative semantic network** around relationally associated concepts and words, with reifications of these relational associations to express conceptual blendings on (ever-)higher levels of expression. Contiguity associations, on the other hand, form a complex **hierarchy network of compounds and chunks, which expresses, not least, staggered meaning specifications in the sense of conceptual filtering / slicing and dicing**. Similarity associations, besides generating syntax, form different levels of abstraction. In case of a concept-similarity association, the fragment concept word's independence from the related concept words will often lead to a totally dissimilar word being used for the abstraction/similarity fragment concept. The similarity-association-induced **abstraction hierarchy** is not to be confounded with the contiguity-association-induced **compound/chunk hierarchy**, even though both are similar in defining more general/specific senses, in the first case by conceptual abstraction, in the latter case by conceptual cross-sections.[107] These considerations are illustrated in Figure 13 (p. 113), which shows how different basic association types constitute four major semantic word-structures and tentatively depicts their interworkings. Here we see how our analysis of the standard semantic network component *set of relations to other terms*, which let us to define a set of different association types as alternative building blocks of semantic networks, has brought about a rather different conception of semantic networks. This semantic network conception represents a significant extension to the standard semantic network model in that it identifies largely independent substructures, their forming and gradual increase in syntacto-semantic complexity.

[107] We'll later have to discuss this peculiarity that in ontological practice has very puzzling effects and to the best of my knowledge is not understood by ontology engineers (as it is only indirectly addressed in ontological modeling). In ontology engineering, the chunk hierarchy is normally addressed in class hierarchies, while, in some cases at least, the abstraction hierarchy is addressed by allowing instances of classes to be classes of instances. But there is no coherent practice (or understanding), so that abstraction levels and compound/chunk levels get mixed up regularly.

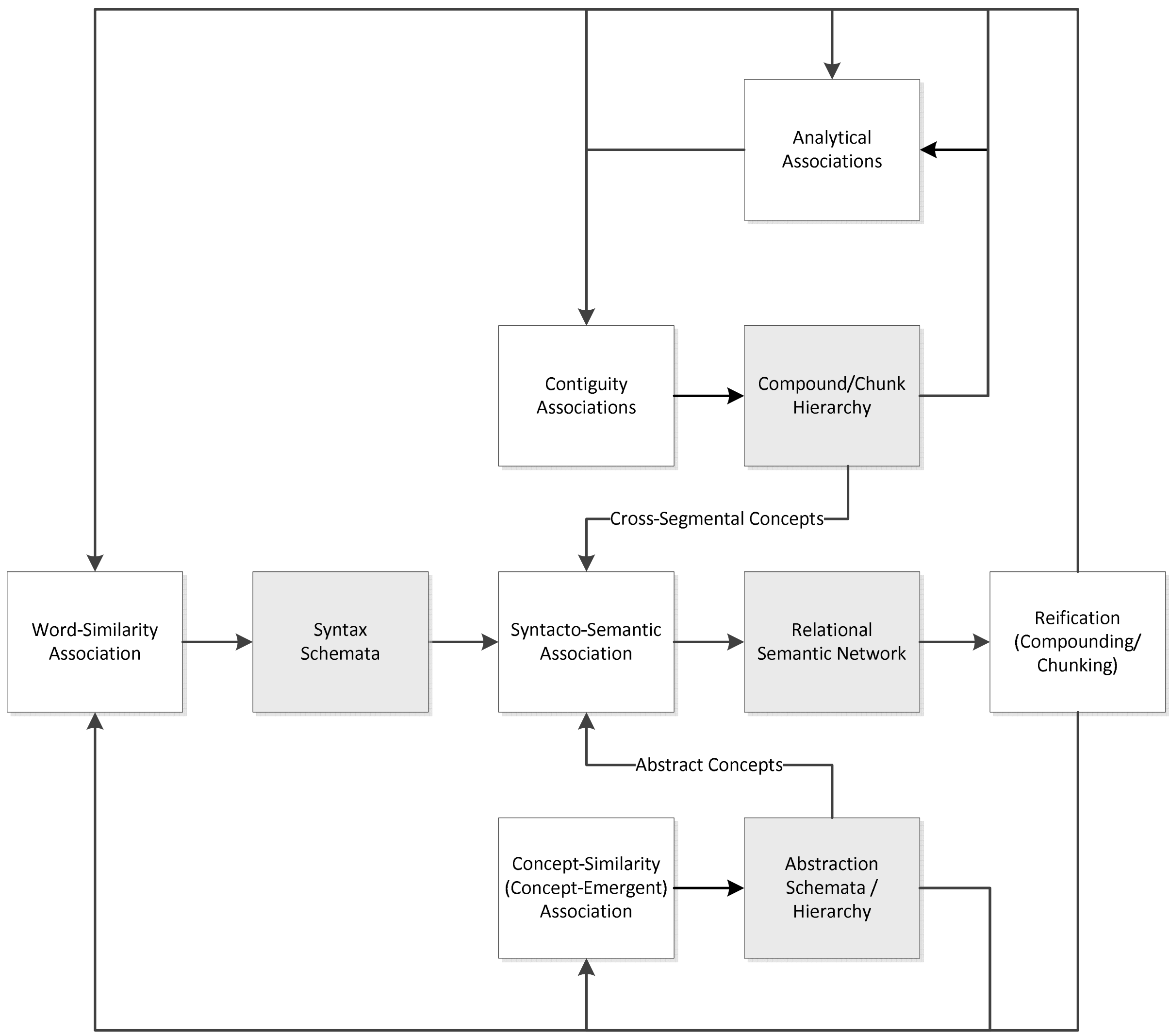

Figure 13: Basic Association Types and Related Major Semantic Structures

2.6.1.4 Insufficiency of the Common Semantic Network Model

Helbig's components of terms (words (1), relations (2), perceptual patterns/concepts (3)) reflect the components of semantic networks.

> *A semantic network is a directed labeled graph composed of a set of nodes and a set of unidirectional edges, and each has a name. Nodes represent concepts, instances of concepts and property values. Edges represent properties of concepts or relationships between concepts.*
>
> (Gómez-Pérez, Fernandez-Lopez, & Corcho, 2004, S. 52)

Words form the labels of semantic graphs. Concepts are symbolized by nodes. Unidirectional edges represent relations. By now, we can start working out some fundamental weak points of semantic networks as alleged reflections of knowledge structures:

1. *Word associations* are not modeled, for *labels* and their outer word structure are not separate structural components of the semantic network.
2. *Word complexes* are not modeled, for *labels* and their inner word structure are not separate structural components of the semantic network.
3. Word similarity relations, consequently, are also not modeled by semantic networks.
4. *Concept associations* (conceptual contiguity) are not modeled, because the model is strictly relational. Sequentiality is thus not an inherent structure of the semantic network model.
5. *Concept complexes* are not modeled, for this would demand for a modeling of *reification* (abstraction/instantiation of node-edge-node triples or node-edge fragments, in order to use them in higher-order triples or double-fragments).
6. *Concept similarity* modeling is hampered by the non-conceptual status of edges, which are said to represent properties (as if properties were not concepts, too). As edges are not relatable as concepts representations, they cannot be modeled as full *terms*. *Concept similarity* modeling is further hampered by the idea of unidirectional edges.
7. *Analytical associations* are made difficult, as word compounds/complexes are not defined with respect to their inner word-structure and inner concept-structure.
8. Emergent associations are disturbed by a relational representation with labeled edges. Even though it is possible to represent emergent associations in a common semantic network model, the experienced semantics of this model would be inappropriate. Emergent associations generate a semantic paradox: were semantic network *model* and semantic network *representation* identical (using labeled edges), they would differ [sic] in meaning, because the modeled meaning can only be generated in a representation that differs from the relational-descriptive model. This is but a special case (and complication) of the more general *problem of meaning* that Fauconnier and Turner point us to:

   > […] *we take the construction of meaning for granted. Or rather, we tend to take the meaning as emanating from its formal representation, the picture, when in fact it is being actively constructed by staggeringly complex mental operations in the brain* […]
   >
   > (Fauconnier & Turner, 2002, S. 5)

I think these are already enough points of criticism to demonstrate the insufficiency of common semantic networks. They render semantic networks rather unusable for language-knowledge representation and language-knowledge management. All simple (graph-like) triple-based language-knowledge notations suffer from these problems. To be fair, some of these issues[108] have been addressed in one way or another in ontology engineering based on *advanced* (first-order logic) logic notations like those of *common logic*[109]. That these problems are based on phenomenologically (and, very likely, also cognitively) distinct association types, is, in my experience and to the best of my knowledge, not acknowledged/understood in IT. They use to surface as specific or domain usability problems, and appear to the ontology engineer as totally unrelated problems. **Accordingly, they are not tackled as a fundamental language-knowledge representation problem area demanding for an integral modeling- and representation-solution for language-knowledge.** Further cognitive-psychological research is needed to verify and elaborate this new basic semantic network model. In chapter 3, I will try to illuminate the basic memory mechanisms at work and the memory systems involved. In chapter 5, the provisional experimental realization in the Artificial-Memory-system will be discussed.

[108] Cyc, for example, allows to separate labels from concept nodes (see footnote 79, p. 73), which, in principal, makes inter-label relations possible. Reification is a concept supported by RDF (Resource description framework). For RDF see en.wikipedia.org/wiki/Resource_Description_Framework (accessed on 07.09.2012). Common logic uses special markers for relating labeled concepts as *literals*. In notations used in Computer Lexicography, word compound/complex structures will be represented. These structures, however, are (to the best of my knowledge) not being used for knowledge representation. They are restricted to *language* analysis.

[109] See en.wikipedia.org/wiki/Common_logic (accessed on 07.08.2012).

2.6.2 Mental Spaces

It is not uncommon to talk about complex conceptual units. Fauconnier (Fauconnier, 2006), within his framework of cognitive linguistics, for example, discusses *mental spaces*, which are described as *small conceptual packets constructed as we think and talk, for purposes of local understanding and action*. A mental space is said to *consist of elements and relations activated simultaneously as a single integrated unit*.[110] The idea of mental spaces reminds us of common *semantic* network structures, for they are constructed as we think and *talk*, and they are structures of *elements and relations*. Their definition goes **beyond simple word semantics, however**. Mental spaces are *conceptual packets* (sub-networks), demarcated (instantiated) dynamically by simultaneous activation (blending). Fauconnier mentions that *it has been hypothesized that at the neural level, mental spaces are sets of activated neuronal assemblies and that the connections between elements correspond to coactivation-bindings*.[111] This is a commonly held belief, usually accompanied with a reference to Hebbian learning / Hebb's law and, sometimes, extended by the idea of cortical columns as basic functional (abstractive-integrative, consolidating, computing, hierarchy-forming etc.) brain modules.[112] Language plays a very important role in mental spaces and respective conceptual blending, despite the fact that *conceptual* packets are **not limited** to *semantic* packets. Fauconnier and Turner introduce the concept of a stable, *organizing frame*, as the structural component of a mental space:

> *An organizing frame provides a topology for the space it organizes; that is, it provides a set of organizing relations among the elements in the space.*
>
> (Fauconnier & Turner, 2002, S. 123)

The organizing frame appears as an abstracted knowledge structure. Mental spaces are blended or compressed into different types of conceptual integration networks. A typology of different networks is derived from different constellations of organizing frames of mental spaces involved. Four main types of integration networks are being distinguished: Simplex, Mirror, Single-Scope, and Double-Scope. These network types are generated by association between two mental spaces a time.

A **simplex networks**, *connects the two input spaces through Frame-to-values organization [as in father-John, daughter-Su]*.[113] It is worthwhile considering the example given to illustrate the Simplex. There is, in our terms, a threefold association within and between the word compounds *father-John* and *daughter-Su*. *Father* and daughter each denote abstract

[110] (Fauconnier & Turner, 2002, S. 104)
[111] (Fauconnier, Mental Spaces, 2007, S. 351)
[112] See, e.g., (Hawkins & Blakeslee, 2005).
[113] (Fauconnier & Turner, 2002, S. 122)

roles. The word compound father-John is a short form of a syntacto-semantic word association: *John is a father*. In it, both concepts are compounded (blended). The word compound *daughter-Su* is as well a syntacto-semantic word association, even though it is only indicated by hyphen-ation, i.e. only given in a contiguity-association-like pattern. The third association, between both word *compounds*, is one of explicit contiguity, strengthened by a comma separating the two phrases. It could be interpreted as a mere list, with no affordance for conceptual integration at all. However, interestingly, it establishes a strong word-emergent and concept-emergent quality, evoked by the semantic opposition father-daughter. The emergent concept and word it provokes is the syntactic schema *a of b*, or, in our case, *father of daughter*. The conceptual blends of, first, father and John, and, second, daughter and Su, can be further integrated in the inter-blend conceptual blend evocable by the sentence *John is the father of daughter Su*. Thus, we have analyzed and explained the simplex network as a possible composition and associative sequence of more basic association types we have introduced earlier. There is, however, an important conceptual extension in the idea of the Simplex. It stresses the very productive function of abstractions (which we identified as being derived from concept-similarity associations). Abstractions, if blended with or instantiated in lower-level (more concrete) conceptual entities, allow for a quick and efficient extension of limited (concrete) mental spaces. In our example, we would not really know more about John and Su than their names, if we had not learnt a lot through a combination of semanto-syntactic and concept-emergent blendings. Now, we can start hypothesizing about many properties of John and Su: their individual ages, a third person (the mother) connecting both, possible inherited similarities, feelings for each other, legal duties and responsibilities, etc. Fauconnier and Turner call the role-value blending of the Simplex a *vital relation*. When Fauconnier and Turner give us their short example of a Simplex, they trust our capability of interpreting it as intended by them. The syntacto-semantic structures they use and the semantic opposition they create they must have thought generally intelligible. Thus, one could argue that language as communication technology rests on *vital relations* as (provoking) conceptual blendings (conceptually integrative associations) and abstract mental spaces (abstract concepts) being *shared* and being reconstructable by language symbols. In other words, vital relations are basic associative (semantic) correspondence structures. Other vital relations identified by Fauconnier and Turner (besides Role) are Change, Identity, Time, Space, Cause-Effect, Part-Whole, Representation, Analogy, Disanalogy, Property, Similarity, Category, Intentionality, and Uniqueness.[114] A simple test (that I would suggest) for identifying a vital relation (type) is to denote the *mental spaces* (concepts) to be integrated by a minimal (not formerly learnt) syntacto-semantic word compound (that is one that comes without any

[114] (Fauconnier & Turner, 2002, S. 101)

indicative relation word or only with a general syntactic marker indicating that two mental spaces are to be related). If it is possible to get to the intended conceptual integration, one could speak of a vital relation, even if there are several interpretations possible (as is usually the case in direct conceptual integrations, which are not specified by an explicit relation-word-concept). That any non-relation-word-containing word-compound is at all understandable and usable in language-symbol communication is very astonishing (and thus worthwhile illuminating).

It should not remain unmentioned, even though we have no time to further discuss it here, that reconstructing vital relations from minimal syntactic structures would be a litmus test for artificial (general) intelligence systems, far more so than the Turing Test, which is prone to deception, as became clear from my discussion of the *Eliza effect* [see p. 86]. Artificial intelligence has to imitate vital *analogical* information processing and learning, which goes beyond, but does not exclude symbol manipulation. Basic, vital (often literally bodily, temporal, spatial, etc.) relations or vital cognitive-integrative operations, as we might call them, guarantee that language-technology maintains a semantic (technological) correspondence structure. The usability of productive language is a shared *meaning-constructive* and not a shared *referential* phenomenon.

In the case of role-value, the conceptual-integrative tendency can be somewhat clarified by considering the associative history of the concepts involved. One could ask, for example, why the mental space of father is not (normally) enriched by the mental space of John? So that we could say Tom is a John, when we mean that Tom is a father. The directionality of role-value integration can be understood by seeing that *father* is an abstraction space (similarity extract/pattern) of particular instances of sexually mature male (human) animals. As John is indicated by his forename to be a male (human) animal, John is identified as a potential father. The potentiality being that *father* was abstracted from the likes of John and is still in force, forming an abstraction-level(-hierarchy). There is, therefore, an analogy (or similarity) association between the *father* space and the John space, with the abstraction hierarchy defining the direction of conceptual integration. This (non-obvious) integrative-associative move within a *simplex network* creation process is actually an instance of a *single-scope network*, another type of conceptual network introduced by Fauconnier and Turner:

> *A single-scope network has two input spaces with different organizing frames, one of which is projected to organize the blend. Its defining property is that the organizing frame of the blend is an extension of the organizing frame of one of the inputs but not the other.*
>
> (Fauconnier & Turner, 2002, S. 126)

The simplex network is not an independent network type, and the single-scope network can best be understood as the result of a specific semantic association history. The asymmetry of the blending, the fact that the blend inherits only one of the frames is the earmark of source-target metaphors. The single-scope network is contrasted with the *double-scope network*, in which frame and identity properties are brought in from both inputs, generating a creative conceptual blending. In word compounds (and likewise relational phrases), the syntactical frame of word order often clearly indicates the to-be direction of integration. Only if the double-scope conceptual blending were not susceptible to changing directionality, a double-scope network would appear to be a sufficient category. If there were cases of direction-dependent differentiation of double-scope network results (which seem very likely to the author), further terminological differentiation of double-scope networks would become necessary.

The last major conceptual integration network category, mirror networks, is defined as follows:

> *In a mirror network, there are no clashes between the inputs at the level of organizing frame, because the frames are the same.*
>
> (Fauconnier & Turner, 2002, S. 125)

Mirror networks perform compressions over the vital relations of Time, Space, Identity, Role, Cause-Effect, Change, Intentionality, and Representation. The four network types, Simplex, Single-Scope, Double-Scope, and Mirror, can be described by their effective frame pattern. In the Simplex, a (dominant) frame and no frame is given. I have shown that this is not true, but, for the sake of comparison, we will leave it as it was defined. The Single-Scope has a dominant frame and a subordinate frame. The Double-Scope has two dominant frames (i.e., none at all). The Mirror has a single (shared) frame. It seems that in conceptual blending, organization frames play a decisive role.

Vital relations let us create manifold conceptual integrations in the form of a compact compound/chunk hierarchy, without introducing lengthy (nominalized) verbal relation-word complexity, which, by the way, is also based on vital relations at the borderlines between subject and predicate, predicate and object, etc. The abstraction-hierarchy plays an important role by providing conceptual schemata determining the possibility of direction (dominant space) in conceptual integration networks. Simple syntactic schemata are needed to define which possible direction integration takes. In summary, the cognitive-linguistic conceptual blending theory of Fauconnier and Turner blends well with (and is, to some degree, even corrected and extended by) the basic thoughts about semantic network components and processes and language-technology described so far in this thesis. Blending is, of course, not totally new or unique, as are most concepts and ideas in linguistics and cognitive science. Wolfgang Wildgen reminds us that …

> *Die Operationen, die von Langacker construal, von Lakoff mapping, von Goldberg fusion, von Fauconnier blending genannt wurden, enthalten im Kern das Problem einer Verbindung zweier Inhalte, wobei das Ganze mehr (durch Emergenz neuer Strukturen) und weniger (durch Selektion) als die Summe der Teile ist.*
>
> (Wildgen, 2008, S. 200)

However, even before cognitive linguists started theorizing about conceptual blending and conceptual compression, the emergent properties of arrangements of mental spaces and the important role of some special (vital) word-relations were described in the (discontinued, to my knowledge) linguistic theory of *word-fields* [Wortfeldtheorie].

2.6.3 Word Fields

Word field theory originated with Jost Trier, as a mere sidetrack of his **diachronic** studies of language (Trier, 1931). Trier studied the development of the meanings of sets of words occurring during longer periods of time. This seems important, because Trier must have observed historic changes of individual word meanings and how these changes formed new sense fields (topic fields) [Sinnbezirke (Sachfelder)], and how a given sense field underwent changes when the words *covering* it (word blanket, word mosaic [Wortdecke, Wortmosaik]) changed their meanings. Trier's comparative diachronic-interindividual perspective is somewhat analogous to the comparative synchronic-interindividual perspective taken in this thesis for conceptualizing individual, word-field *artificial memory* systems. Trier's conception was probably influenced by Wilhelm von Humboldt's comparative international language theory. It is applied intra-nationally by diachronic splitting, though. There is, in simple terms, an analytic-segmental progress from differing language-national (word-field) views [*Welt*sichten] to differing national-historic (word-field) views [Zeitsichten] to differing individual-contemporary (word-field) views [Ansichten]. A basic language-thought [Sprachgedanke], that is a word-induced or word-related conceptual integration or association, represents the smallest possible word (/-sense) field. Starting with an example of this smallest unit, Trier remarks that …

> *Kein ausgesprochenes Wort steht im Bewußtsein des Sprechers und Hörers so vereinzelt da, wie man aus seiner lautlichen Vereinsamung schließen könnte. Jedes ausgesprochene Wort läßt seinen Gegensinn anklingen.*
>
> (Trier, 1931, S. 1)

The examples Fauconnier and Turner (2002) give are typically based on two *preexisting* mental spaces joint together by sequenced representation of written concept-labels. There is a subtle but very significant difference between the language-thought Trier describes and those used by Fauconnier and Turner. Trier refers to a single word only, one evoking the memory of an opposite concept (without this concept being named before). Fauconnier's exemplary language-thoughts are concept-*integrative*, whereas Trier's exemplary language-thought is concept-*disintegrative*. According to Trier, a singular word lets its word-sense activation spread into its antonymous sense(-word) [anklingender Gegensinn]. The idea of conceptual integration conceals a bit that there are, besides *centripetal*, associative-integrative forces, also *centrifugal*, associative-disintegrative forces at work in language-thought. Any particular word-sense is limited (at least in a temporary experiential manner, i.e. in the universal antonymy of existence versus nonspecific nonexistence). This limitation means that there always has to be a more or less specific *limiting* experience/sense. The individually experienced word's centrifugal associative power is not counterweighted by a succeeding word's centripetal associative power. Trier's focus on a single word allows him to demonstrate inter-conceptual associations that are not actually *presented*:

> *Dies Begriffsfeld gewinnt keine körperlich wahrnehmbare Erscheinungsform in äußerer Lautung, deswegen ist es aber nicht weniger wirksam, nicht weniger einwirkend auf den Sinn des Wortes, nicht weniger dem Bewußtsein zugänglich.*
>
> (Trier, 1931, S. 4)

Trier here uses the word *Begriffsfeld* as opposed to Wortfeld [word field]. *Begriffsfeld* denotes the sense-field created by a word field. A word-sense field [Begriffsfeld] is not the same as a perceptual sense field [Sachfeld]. People normally use language to describe perceptual sense fields. Therefore, this important differentiation tends to escape their attention, as we will see. Trier's word-sense field gains *presence* even without all corresponding words being presented or becoming conscious. It is a sense-field structured by words. A perceptual sense field is different. The colors of the rainbow, for example, form a specific perceptual sense field of distinctive color perceptions, provided normal eyesight. Franz von Kutschera describes the effect of different changing word fields covering the colors of the rainbow:

> *Die Farbwörter (z.B. „rot", „orange", „gelb", „grün", „blau") bilden ein Feld. Es sind einstellige Prädikate erster Stufe, und der zugeordnete Sinnbezirk ist der der Farbigkeit. Fügt man z.B. das Wort „violett" hinzu, so werden die Bedeutungen von „rot" und „blau" eingeengt, und streicht man das Wort „orange", so werden die Bedeutungen von „rot" und „gelb" erweitert.*
>
> (Kutschera, 1973, S. 72)

This statement is interesting because it uses a number of color words to remember a certain perceptual sense field, namely the colors of the rainbow. It moves on to describe the effects of changes in the color word field and corresponding color word-sense field. This serves as an example of Kutschera's definition of word fields:

> […] *daß es sich bei den Wörtern eines Feldes in der Regel um Prädikate (im logischen Sinn dieses Wortes) derselben Kategorie handelt. Und man kann hinzufügen, daß die Bedeutungsabhängigkeit zwischen den Wörtern des Feldes u. a. darin besteht, daß die Bedeutungen anderer Wörter erweitert bzw. eingeengt werden, wenn man ein Wort eliminiert, bzw. hinzufügt, und daß sich die Bedeutungen anderer Wörter verschieben, wenn man die Bedeutung eines Wortes verändert.*

> *Diachronisch gesehen wandelt sich also die Bedeutungsstruktur des Feldes als eines Ganzen. Das ausgesprochene Wort steht vor der zum Feld sich ordnenden Fülle seiner Nachbarn. Es hebt sich von Ihnen ab und ordnet sich ihnen doch an bestimmter Stelle ein.*
>
> (Kutschera, 1973, S. 72)

In these citations, there is no clear differentiation between perceptual fields [Wahrnehmungsfelder] and word-sense fields [Begriffsfelder]. A color word, however, can be part of many different word-sense fields. The national colors, the colors of the rainbow, revolutionary colors, Web colors etc. Kutschera gives the *ontological* interpretation of a single [sic] color-word-sense field identical with a natural perceptual color field, which is probably due to his education as a logician. This impression is strengthened by his claim that words forming a word field belong to the same *category*. Trier's word fields are rather *pragmatic*, as becomes obvious from his critique of dictionaries:

> *Die Wörterbücher* […] *lassen aber den wahren Wortgebrauch gar nicht erkennen, da sie sich um die sogenannten Synonyma, d.h. um die begrifflich nächstbenachbarten Worte und erst recht um die übrigen zum gleichen Feld gehörenden Worte nicht oder nicht ausreichend bekümmern können und so oft an den bezeichnenden Eigenschaften eines Werkes oder einer Zeit vorbeigehen.*
>
> (Trier, 1931, S. 24)

Trier's entities of research are writings of individual authors [*Werke*]. Their specific word usage [*Wortgebrauch*] is said to become understandable only if the sense-limiting words and field-associative words [*begrifflich nächstbenachbarte Worte*; *zum gleichen Feld gehörende Worte*] are uncovered. This is something that lexeme-oriented dictionaries would not normally accomplish. However, the picture is not all clear:

> *Die Begriffsbildung mit Hilfe der Worte ist ein gliedernder Klärungsvorgang aus dem Ganzen heraus. Dabei spiegelt die Sprache nicht reales Sein, sondern schafft intellektuelle Symbole, und das Sein selbst, das heißt das für uns gegebene Sein, ist nicht unabhängig von Art und Gliederung der sprachlichen Symbolgefüge.*
>
> (Trier, 1931, S. 2)

Trier's clearly sees intellectual differentiation [*ein gliedernder Klärungsvorgang*] by word fields [*sprachliches Symbolgefüge*], but he does not perceive of word fields as complex *mental spaces* or, in other words, language-knowledge structures. In the above citation, Trier directly links being [*Sein*] and language. This thinking is also manifested in his misdirecting and frequently criticized[115] metaphoric idea of a word blanket [Wortdecke] or word mosaic [Wortmosaik] covering the perceptual realm (or the realm of being / reality).

In a modern interpretation of word fields, however, Horst Geckeler moves word-fields closer to *conceptual* fields by extending the *word*-sense field definition to a (more constructive) word-phrase- and word-compound-sense field, differing from single-word word-collocation fields:

> *Die Wortfelder sind nicht identisch mit Begriffsfeldern. Jedes Wortfeld ist ein Begriffsfeld, aber nicht jedes Begriffsfeld muß ein Wortfeld sein, denn ein Begriffsfeld kann auch ein terminologisches Feld sein. Jedes Lexem entspricht wohl einem Begriff, aber nicht jeder Begriff wird notwendigerweise nur durch ein [sic] Lexem wiedergegeben. Es kann auch durch eine Fügung, die mehrere Wörter umfasst, zum Ausdruck gebracht werden.*
>
> (Geckeler, 1971, S. 200)

Geckeler also *individualizes* word fields as knowledge structures [*Wissensbesitz*]:

> *Zutreffend scheint uns die neueste Formulierung von H. Schwarz den Sachverhalt darzustellen: "Die sprachlichen Gliederungen, innere wie äußere, also auch die Felder, sind dem Sprachbraucher vertraut, sind sein Wissensbesitz, mit dem er sicher umgeht, dessen er sich aber nicht bewußt ist. Daher vermag er auch nicht aus dem Stegreif über sie Rechenschaft abzulegen."*
>
> (Geckeler, 1971, S. 123)

Geckeler furthermore cites Weisgerber, who continued the work on word field theories for some decades, stressing the presence of an intermediate language layer between language and real thing:

> *"Es gibt keinen unmittelbaren Bezug vom Lautzeichen zur Sache; immer geht diese Verbindung durch eine geistige*

---

[115] Horst Geckeler notes (Geckeler, 1971, S. 142):

> *Die kritische Literatur zur Feldtheorie kommt geradezu einmütig zu dem Schluß, daß der Mosaikvergleich der sprachlichen Wirklichkeit nicht - oder höchstens in besonderen Einzelfällen - entspricht. So schreibt S. Ullmann: 'The neatness with which words delimit each other and build up a kind of mosaic, without any gaps or overlaps, has been greatly exaggerated.'*

> *'Schicht' hindurch, die inhaltsbezogen als 'sprachliche Zwischenschicht' zu fassen ist.“*
>
> (Geckeler, 1971, S. 108)

According to Geckeler, this word(-phrase/-compound)-sense layer is further differentiated by Weisgerber:

> […] *Weisgerber* [hat] *die Frage der Beziehung zwischen Wortfeldern und Einheit des Wortes in konsequenter Anwendung inhaltsbezogener Prinzipien gelöst: durch Auflösen der 'Bedeutungsklumpen', d.h. durch Aufteilung der Homonyme (besser: der Homophone) in getrennte Einheiten, die in verschiedenen Wortfeldern funktionieren.*
>
> (Geckeler, 1971, S. 112)

Contrary to my initial characterization of word-sense-field (conceptual) associations as centripetal, as compared to centrifugal word-induced conceptual integrations, Geckeler stresses the coherence of word field associations:

> *Die Wortfelder sind keine Assoziationsfelder. Assoziative Felder sind zentrifugal, sie breiten sich unkontrollierbar aus, wogegen Wortfelder zentripetalen Charakter haben. Ein Wortfeld stellt ein lexematisches System dar, dessen Strukturierung aufgrund der Bedeutungsunterschiede seiner Glieder gegeben ist.*
>
> (Geckeler, 1971, S. 199)

This special coherence may explain why it is at all possible to use homonymous words without mixing up the different word-sense fields they relate to. The word-sense field [Begriffsfeld] is a distinctive, *closed* word(-phrase)-semantic context. Presenting a single word of the field with a word of another field will **redintegratively** activate the respective word fields and lead to a semantic re-segmenting not only of the two word senses directly involved, but potentially also of the bordering word senses of the respective fields. Trier/Weisgerber’s linguistic field theory of *word fields* thus stresses the functional importance of word(-phrases) for the shaping of *mental spaces*. Trier (1931, S. 2) noted that the structure of the whole (field) would determine the single word’s sense [*vom Gefüge des Ganzen her empfängt das Einzelwort seine inhaltliche begriffliche Bestimmtheit*]. All signifying is signifying in the (word) field and by virtue of a word field [*daß alles Bedeuten ein Bedeuten im Feld und kraft eines Feldes ist*][116]. These are actually very radical thoughts for their time, with far-reaching theoretical consequences. The conception of

[116] (Trier, 1931, S. 19)

holistic (or compositional) word meaning contrasts sharply with the traditional conception of *atomistic,* semantically isomorphic word meaning, which fields like symbolic logic and lexicography use to build upon. Polysemous words and polysemous synonyms indicate the multiplicity of word-sense fields sharing the same words and [sic] the same referents. Of course, this, in principal, had bothered logicians before, as is obvious in the problem that Ludwig Gottlob Frege posed. Frege famously differentiated between word *intension* [Begriffsinhalt or Sinn] (referent properties and connotations given in a specific reference) and word *extension* [Begriffsumfang or Bedeutung] (the real-world referents). Intension clearly refers to the conceptual layer or intermediate language-layer described in cognitive linguistics and Trier-Weisgerberian word field theory respectively. A specific referent can be conceptualized (perceived or, more generally, experienced) into different *word fields*. Morning star and evening star, both referring to planet Venus, are the examples of referent-sharing (referentially synonymous) words with differing intensions. A statement about word A (of word-sense A) may be true, while the same statement using the co-referring word B (of word-sense B) may be false. All referencing (or interpreting), however, is experientially bound (cognitively). The *semantic* Frege problem is not a lexical or ontological, but a cognitive-psychological problem. Intension, mental spaces, word fields, meaning schemata, you name it, *are* not just *by* or *in definition*. They are individual, experientially formed knowledge structures, partly replicated culturally, often vitally (inter-)related or *embodied*. George Lakoff broadly characterizes this as the *new view*:

> *The new view is that reason is embodied in a nontrivial way. The brain gives rise to thought in the form of conceptual frames, image-schemas, prototypes, conceptual metaphors, and conceptual blends. The process of thinking is not algorithmic symbol manipulation, but rather neural computation, using brain mechanisms.*
>
> (Lakoff, 2006)

If the merely symbolic(-propositional) structure of logic does not represent embodied reasoning, what could? If the endless subtleties of interpretation, the numerous pitfalls of polysemy, synonymy, and homonymy are directly relatable to individualized, complex mental spaces, how are information technology for knowledge management, for automatic reasoning and for communication to react? **The (somewhat bold) answer given in this thesis is: by (extended) *artificial memory*, namely by expression of individual mental spaces in their word-field organization**, enhancing universal language-*technology* by a universal individual mnemonic tool, based on a progressive and progressing understanding of semantic networks.

2.6.4 Sentence Fields

Remarkably, Trier related the word-sense field with the, if I may say so, *sentence*-sense field:

> *Schlichte Beobachtung eigenen Sprechens und Hörens klärt deutlich genug darüber auf, daß ein in einem Satz ausgesprochenes Wort seinen Sinn nicht allein aus dem Zusammenhang des Satzes empfängt, daß der Satz nicht das allein Wirkliche ist, von dem aus das tote Einzelwort Leben erhält, daß vielmehr hier ein zweites Wirkliches mitspricht, nämlich das System des objektiven in der Sprache überlieferten und dem Sprecher und Hörer gegenwärtigen Ganzen des Begriffsfeldes.*
>
> (Trier, 1931, S. 4)

We already noted that the word field is not structured only by single lexemes, but could comprise word compounds and word phrases/word collocations. Distinct word-senses blended into new sense-*units* thus correspond to the respective word(-phrases) sequenced into larger string units or *word chunks*. Word fields extend into phrase fields by means of concept- and symbol-blending conducted in parallel. The de facto chunking of words (Linear Units, as we got to know them) often clearly refer to distinct individual conceptual memory-units. However, this is not true in all or even most cases. Chunking practice (we'll get to this in more detail later) demonstrates another important case: conceptual blending in word-fields (as is also implicitly indicated by the *two-word/concept* examples frequently chosen by Fauconnier and Turner) tends to happen between two distinct word-senses corresponding to two consecutive word(-phrases). In consecutive-type word chunks there is thus an inner structure demarcating two word-phrases of (usually) distinct word senses and their word-sense fields. **The bipartite [sic] consecutive-type word chunk is the precursor to the semantically unitary word chunk.** There is a simple test for this. The reader may isolate a few word(-phrase) chunks of his own (by reading or active language production). In analyzing these chunks, one will find that one is normally able and prone to split them into two [sic] coherent consecutive (unitary or, again, analytically bipartite) sub-chunks. Word-field based language-thought is Linear-Unit-consecutive (which the reader should not consider a natural given, especially not in complex visual thinking, which is very difficult to stimulate and direct by means of language utterances, which is the reason why we need visual models and is the reason why the author sometimes engages in diagrammatic thinking and diagram production for this thesis). The analysis of individual dynamic patterns of bipartite (Linear-Unit-based) word-sense-integration in language perception and language production contrasts with a *syntacto-symbolic*-linguistic, hierarchical-analytical approach to language analysis based on word-type and phrase-type structures of language symbols. There is no language analysis possible or reasonable disregarding the sub-symbolic cognitive processes of, in particular, bipartite chunk-sense structuring and, in general, word-sense integration, at least not if we restrain from interpreting language as *la langue*. Horst Geckeler, in his critique of transformational generative grammar, cites the structural semanticist Eugenio Coseriu, who conceives of word fields as content-differentiating words standing in opposition to each other[117]:

> *'Struktur' bedeutet für die TG ausschließlich 'syntagmatische Struktur', d.h. kombinatorische Struktur. Die TG ist sich darüber nicht im klaren, daß, wie es E. Coseriu formuliert: 'Una lengua no es sólo un conjunto de reglas de constitución sintagmática, inmediata o mediata, sino también, y ante todo, un sistema de paradigmas functionales.' Bevor man sich also entschließt, eine Semantik der syntagmatischen Strukturen auszuarbeiten, ist es notwendig, zuerst eine Semantik der paradigmatischen Strukturen aufzubauen. Die Wortsemantik muß der Satzsemantik logischerweise vorausgehen.*
>
> (Geckeler, 1971, S. 229f)

In other words, and reminding us of the basic association types and related major semantic structures we differentiated in chapter 2.6.1.3 in Figure 13, we have to construct the compound/chunk hierarchy (sequence structure) [Wortsemantik] before we can understand (or make understandable) the relational semantic network structure associated with predicative-relational sentence structures [Satzsemantik]. Language is a system of functional paradigms (conceptual arrangements/oppositions) [*un sistema de paradigmas functionales*]. In Figure 13, the syntagmatic structures (if indicated by syntactic markers) are derived late from word-similarity associations forming syntax schemata that enable, subsequently, the syntacto-semantic associations forming the relational semantic network [Satzsemantik]. While a syntagmatic analysis of language seems possible at first glance, it cannot truly reflect existing knowledge structures unless it has knowledge of the individual compound/chunk structure involved in language *pragmatics*. Syntagmatic analysis is also blind to the power of word-similarity associations to form new, *sub*-syntagmatic structures and thus to the true extent of syntax schemata effective. It is important to note that the predicative, sentence-wise integrative word-sense-field is

[117] (Geckeler, 1971, S. 192f):

> *Ein Wortfeld ist in struktureller Hinsicht ein lexikalisches Paradigma, das durch die Aufteilung eines lexikalischen Inhaltskontinuums unter verschiedene in der Sprache als Wörter gegebene Einheiten entsteht, die durch einfache inhaltsunterscheidende Züge in unmittelbarer Opposition zueinander stehen.*

not usually prone to word chunking and not strictly bound by bipartite concept integration. The sentence-predicate is a syntax schema of varying and individually growing complexity. The schematic complexity is indicated in multi-place predicates (especially three-place and higher-place predicates). These cannot just be given or acquired at once, but have to be constructed from word-similarity patterns, which may comprise (large/multi-partite, contiguous) chunk-sequences. The predicate (schema) represents a vital relation, for it expresses actions and events attracting a multitude of different actors and undergoers, stressing its general schematic character and its broad syntacto-semantic effects. It is thus naturally prone to form larger contiguous, rather infrequent conceptual associations, with limited temporally integrative or conceptually compressive tendencies. The predicative sentence-sense-field is less likely to be matched by a corresponding word sequence field (vector) to form a lasting word chunk field unit than, say, more static, static-object-oriented noun-phrase-sense fields. **Therefore, the very *episodic* nature of sentence-sense-fields implies a severe *construction error* or language-technological insufficiency in semantic networks: they do not become addressable by a word-phrase-vector. That is, sentence-sense fields tend to remain isolated and not to form a *functional* word field.** The sentence-sense-field is more or less limited to the sense-opposition generated by antonymous predicates and the active-passive meta-schema where appropriate. Sentence-structure-maintaining reifications do not solve the problem (they are too complicated to be remembered, therefore mostly limited to temporary pronominal recursions, and too inefficient to be conceptually decrypted). Chunking by shortened nominalized-predicate phrases demands for a string transformation, which can be helpful. Reification leaving out predicates altogether is possible when the predicate expresses a *vital relation*, in which case it should be possible to omit it in a sentence-sense-reflecting word-compound/word-chunk transformation.

The sentence is conceptually productive in that it manages to break the stricter, bipartite sequentiality of word chunk sequences. Sentence predicates instantiate higher-ary conceptual relationships by multi-place syntax schemata. This comes at a cost, however. Word-wise, the predicative sentence does not affect the comparably *closed* word field to the same extent as word chunks do. Semantically, sentences form small islands, whereas words and word chunks form huge continents. The set of sentential instances/particulars of a predicate schema (i.e., sentences sharing the same predicate) does not form a conceptually direct-associative sense field. Same-type sentence-fields are linked *syntactically*. **Their indirect-associative, schematic inter-relations seem to drive (a certain type of) analogical thinking.** One does not have a problem varying a particular predicative schema by filling in different variables, not just arbitrarily, but also in the sense of real remembrances. There is an automatically formed, non-experiential, that is *artificial* memory of sentence fields.

Word fields, on the other hand, are formed direct-experientially. Their artificiality consists in their cross-experientially constructed word-sense fields, grouped around words and word chunks. Word fields and single sentence fields are concept-artificial memories. Inter-sentence fields, by contrast, are syntacto-semantic artificial memories. The centripetal tendency of intra-word-field associations, that is word-field-productive artificial-memory thought, must appear as a centrifugal tendency if compared to the centripetal tendency of inter-sentence associations, that is syntacto-semantically, analogically productive artificial-memory thought. Geckeler's characterization of word field associations as centripetal is correct, insofar as they are viewed in the wider context of cross-sentential, syntacto-semantic artificial-memory thought. These realms of association are not strictly separated, though. The collocational range of (originally) non-predicative phrases may well include predicate-phrases, and the collocational range of (original) predicate-phrases may well include non-predicative phrases, always provided a high degree of relative co-occurence. Predicate-inclusion becomes immediately obvious in sequences of template- plus variable-sharing sentences. *Peter visits the church* + *Mary visits the church* stresses *visits the church*. *Peter drives to work* + *Peter drives to town*, on the other hand, will rather stress *Peter drives*. The exact conceptual structure of a sentence field thus also depends on chunking (and context). However, one would be mistaken not to think of a sentence as a mediated, relational, *syntactic* structure. The intricacies of complex sentences can only be understood if we admit their syntactic placeholder structure, which fundamentally breaks the strictly sequential word-associative structure of word chunks, by allowing de-sequencing insertions and complex relational arrangements. What we really encounter in word-chunk-dependent interpretations of sentences are different [sic] predicate patterns, namely differing in degree and structure of their variability. A syntacto-semantic sentence-instance can be *frozen* (conceptually compressed), partly or even fully (temporarily or permanently). The latter (i.e., the fully frozen sentence-instance) would be dubbed a *reification*. The former might be dubbed a partial syntax de-schematization. The potentially (even likely) *de*-sequential, higher-dimensional conceptual arrangement and resulting more complex conceptual blending within sentence fields does not have to give rise to word-chunking, though, as the particularity of sentential blending will often best (or only) be reflected in a (partial) re-formulation and thus also new [sic] interpretation of the resulting conceptual field. Re-wording and re-schematizing the dynamically changed sentence-induced conceptual field is a highly creative cyclic concept-driven mental activity.

In discussing Plato's criticism of written language, we noted that writing is a creative activity [see 2.4.5, p. 55]. By studying word and sentence fields, supported by an extended semantic network model, and in conjunction with Fauconnier's conceptual blending theory, we were able to theorize more clearly the underlying mechanisms at work. However, for a deeper understanding of language-knowledge structures and the dynamics of language technology, it appears to me that we have to turn to a very basic cognitive mechanism, the discussion of which I have deliberately avoided so far in order not to complicate the picture: MEMORY.

3. Technology Memory

3.1 What is Memory?

Memory is a word with many word senses. It does not matter whether we consider the colloquial or the scientific word usage. One is forced to commit to a specific word sense if one wants to avoid creating ambiguity or avoid having to (constantly) disambiguate. *Memory*, as I consider it in this thesis, denotes a human, brain-based, sensation-information replication- and variation-system. It follows, along general lines, the definition given by Rainer Sinz as cited by Hans Joachim Markowitsch:

> *Unter Gedächtnis verstehen wir die lernabhängige Speicherung ontogenetisch erworbener Information, die sich phylogenetischen neuronalen Strukturen selektiv artgemäß einfügt und zu beliebigen Zeitpunkten abgerufen, d.h. für ein situationsangepaßtes Verhalten verfügbar gemacht werden kann. Allgemein formuliert, handelt es sich um konditionierte Veränderungen der Übertragungseigenschaften im neuronalen 'Netzwerk', wobei unter bestimmten Bedingungen den Systemmodifikationen (Engrammen) entsprechende neuromotorische Signale und Verhaltensweisen vollständig oder teilweise reproduziert werden können.*
>
> (Markowitsch, 2002, S. 74)

This definition is special in several respects. It defines memory as a process [sic] of learning-dependent storing that leads to system modifications (engrams) [sic] leading to full or partial reproduction [sic] of behavior. In short, it is a process of information encoding into *engrams* and information decoding from engrams. A view, I totally agree with. In a behavioristic fashion, however, the definition restricts memory to nervous motor signals and behavior. This limits the information encoded to original motor signals (because of the claimed reproductive nature of the memory process). This contrasts sharply with the mentioning of *general* ontogenetic information in the first sentence, thus creating a contradiction. Another issue with this definition is that it envisions engrams as changes to transmission characteristics in the neural network, while a more modern interpretation would probably stress the *engrammatic* structural changes enabled by cortico-synaptic plasticity of the human brain. I guess the reason why the distinguished memory researcher Hans Markowitsch cites this definition despite its shortcomings is because of its core idea: memory is a process of *information reproduction*. Markowitsch further cites W.H. Burnham to stress the functional role and psychological nature of reproduction:

> *Burnham (1903)* […] *formulierte* […] *seine Gedanken zur Bildung von Gedächtnis folgendermaßen: Normales Gedächtnis ist durch einen kontinuierlich fortschreitenden Organisationsprozess gekennzeichnet - einen physikalischen Organisationsprozess und einen psychologischen Prozess der Wiederholung und Assoziation. Damit sich Ideen als bleibende Gedächtnisspur manifestieren können, muss Zeit vergehen, bis diese physikalischen und psychologischen Prozesse zum Abschluss gekommen sind.*
>
> (Markowitsch, 2002, S. 55)

Burnham refers to memory as a replication process, too. His memory-replication is a dynamic (associative) replication of ideas, marked by two-sided organization: physical organization and psychological organization. The idea of memory as a replication and organization process is associated with a memory theorist who is not widely known: Richard Semon (1859-1918), a German biologist, zoologist, and explorer.[118] Markowitsch writes about Semon:

> *Von ihm* [Richard Semon] *stammen zahlreiche Einsichten in die Arbeitsweise unseres Gedächtnisses, die bis heute Bestand haben und teilweise erst jetzt - im Zusammenhang mit der modernen Hirnforschung - verstanden und nachvollzogen werden können.*
>
> (Markowitsch, 2002, S. 84)

This statement is surprising from a leading, down-to-earth memory-physiologist for a theorist who published his ideas more than 100 years ago. Much of what we know about Semon's life goes back to Daniel L. Schacter's book *Forgotten Ideas, Neglected Pioneers: Richard Semon and the*

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[118] Schacter (2001, S. 248f) gives a short summary of Semon's background:

> *Richard Semon was born in Berlin on August 22, 1859. His father Simon was a stockbroker; his older brother Felix became a prominent laryngologist in England, received a knighthood in 1897, and was appointed physician to King Edward VII in 1901. Semon was awarded his Dr. Phil. for zoological work at Jena in 1883, and earned his Dr. Med. in 1886. During this period, Semon studied with some of the most prominent scientists of the day, including the noted biologist Ernst Haeckel; Haeckel's emphasis on the theoretical unification of divers biological phenomena had a particulary strong influence on Semon. After receiving an associate professorship at Jena in 1891, Semon led a successful biological expedition to Australia from 1891 - 1893 (Semon, 1899). He left Jena in 1897 for personal reasons, and established himself as a private scholar in Munich. It was during this period that Semon published his two books on memory: Die Mneme (1904) (translated into English as The Mneme in 1921) and Die mnemischen Empfindungen (1909) (translated as Mnemic Psychology in 1923). Mnemic Psychology is devoted completely to the analysis of human memory.*

story of Memory (Schacter, 2001), in which Schacter describes the scientific failure and tragic death of Semon. Scientific psychology did not take up Semon's ideas, even though Semon's term engram [Engramm] somehow managed to become a generally accepted technical term in memory research. It is also part of the definition given by Sinz cited by Markowitsch and introduced earlier. Some of Semon's ideas were *reintroduced* into psychology. Markowitsch, for example, mentions that …

> *Tulving (1983)* […] *reintroduced the term 'ecphory' to describe the process by which retrieval cues interact with stored information to effect the creation of an image or a conscious representation of the information in question.*
>
> (Markowitsch, 2000, S. 475)

Engraphy and ecphory are two core terms of Semon's memory theory. They represent stages of the mnemic[119] process, which is **a process of partial *sensation* replication and variation**. Tulving's pupil Schacter comes to the following conviction:

> *Semon's theory of memory had virtually no influence on the subsequent direction of memory research, and for this reason should be characterized as an anticipation, and not a foundation, of modern theory.*
>
> (Schacter, 2001, S. 165)

In his book, Schacter discusses at length why institutional memory psychology (engaged in Ebbinghaus-style experimentation and theorization) did not adopt Semon's ideas:

> *Semon's belief in the inheritance of acquired characteristics, his analogy between the mechanisms of memory and of heredity, and his proclivity for inventing new - and frequently bizarre - scientific terminology can be traced back to Haeckel.*
>
> (Schacter, 2001, S. 30)

Ernst Haeckel, a popular biologist and strict Darwinist, was teacher and friend to Richard Semon. Semon strongly supported the Lamarckian doctrine of the inheritance of acquired characteristics, which, in the end, proved wrong. In his theory of memory, Semon decided not to re-use common terms as technical terms, because of their misleading connotations. Thus, he invented some new terms, which was not such a bad idea after all, given the

[119] A *mneme* is defined as a replication or variation of a sensation by ecphorization, that is, it is defined as re-activation of an (engraphically-generated) engram into a *simultaneous (sub-)conscious complex*. Mnemic means *by a mneme* or *starting with a mneme*.

problems that are caused by polysemy (as admitted by Tulving). Schacter further remarks that Semon …

> […] *was blind to the theoretical importance of a number of important phenomena, such as interference effects, the role played by attentional processes in selecting input for storage, and coding operations that actively direct the flow of information through the memory system."*
>
> (Schacter, 2001, S. 179)

I would like to add that Semon was also not and could not be aware of the important role of priming in recognizing, remembering, and acting. According to Schacter, things on the positive side are:

> *Semon conceptualized engrams as unified complexes, comprised of 'emergent components' that fuse to form a qualitatively unique whole.*
>
> (Schacter, 2001, S. 167)

With his idea of engrammatic blending, Richard Semon, to some degree, anticipates the *psychological* field-theoretical approaches, such as conceptual blending, word fields, or Kurt Lewins field theory of life space (to name just a few), which all can and have to be theorized as (or rather based on) *engrammatic* fields. Clearly differentiating between a storage level and a reproduction level allowed Semon to define certain *memory aspects* in terms of memory dynamics:

> *He went on to propose that the term association and ecphory must be clearly distinguished: 'the fact of the binding-together of engram-components, which alone deserves the name of association should, logically, be sharply distinguished from this ecphoric process through which the fact itself is revealed. Briefly, association is the result of an engraphy disclosed on the occasion of an ecphory. This state of affairs does not seem to have been clearly apprehended up to now, and usually 'association' has been employed in two senses, first, quite correctly, as the complete union of engrams of mnemic sensations* […]*; secondly, also, as the process whereby this union becomes apparent. This inconsequent phraseology is the source of numerous misunderstandings and fruitless discussions (1923, p. 325)'*
>
> (Schacter, 2001, S. 168)

Semon redefined association as engrammatic association only, that is, as association on the level of engrams. Thus, Semon successfully overcame the Aristotelian taxonomy of associations, which does not include this differentiation and thus prevents us from recognizing the dynamic interplay between engrammatic associations versus engraphic *associations* (or, in Semon's terms: simultaneous complexes). This was only possible because …

> *Richard Semon offered a comprehensive theoretical analysis of retrieval phenomena at a time when the prevailing approach was largely atheoretical.*
>
> (Schacter, 2001, S. 139)

> *Semon's own conception of the retrieval process, freed from the intellectual shackles of associationism, was a synthesis of several different ideas: redintegration, component-overlap, and homophony.* […] *But Semon went beyond redintegration to articulate a view of the retrieval process that sounds much like modern theories in which feature overlap between retrieval cue and memory trace is granted a major role in the retrieval process (cf. Flexser & Tulving, 1978; Kintsch, 1974): 'Resemblance, that is to say, partial coincidence between the components of an actual group of excitations and those of any previous engram-complex, causes ecphory[120] of the latter through the former (1923, p 326)'*
>
> (Schacter, 2001, S. 168)

Semon's view of the memory process let him assume that (under normal conditions) each memory reproduction would result in the creation and modification of engrammatic complexes.

> […] *numerous studies that have been reported in the past decade or so substantiate Semon's claim that the act of ecphory modifies the state of the memory system.*
>
> (Schacter, 2001, S. 173)

> *Some modern research supportive of this view has been reported by Gardiner and Klee (Klee & Gardiner, 1976) in their studies of memory for remembered events. These authors, much like Semon, posited that 'Each act of remembering itself* […] *constitutes a new event in episodic memory (Klee & Gardiner, p. 471).'*
>
> (Schacter, 2001, S. 174)

Schacter lists …

> […] *three of the most striking propositions advanced by Semon: his multiple-trace theory of repetition, his*

[120] Ecphory here can be roughly translated with memory retrieval.

> *contention that each act of ecphory establishes a new engram, and his insistence that memory performance is critically dependent upon the internal and external conditions of ecphory.*
>
> (Schacter, 2001, S. 190)

… concluding that …

> […] *there can be little doubt that Semon's analysis of memory was full of possibilities; it contained myriad innovative features that pointed the way toward some exciting and then unexplored theoretical vistas.*
>
> (Schacter, 2001, S. 179f)

Now, it seems to me that there is a very important aspect to the work of Semon that goes unmentioned and unnoticed by Schacter. **Semon's greatest weakness, his Lamarckism, appears to have actually been his greatest theoretical strength, because it let him see and conceptualize memory (in its advanced human form) as a psychophysiological process of replication and variation of sensory information, somewhat similar to the Darwinian process of evolution of life by replication and variation.** Why does this matter? Well, it is quite important to find the right level of abstraction in theorizing about memory in order to understand its *technological* effects. Memory is only the second replication-variation system to be found in nature. It is also a *secondary* replication system, as the memory process is embedded in the process of life. Semon believed that there is a *direct* connection between engrams and the *genome*, as it is called today. This was clearly false.

Genes mutate/recombine and their allelomorphic information is further instantiated by germ cell fusion and subsequent cell division, at least in sexual reproduction. Survival and sexual reproduction are the basic conditions of the natural preservation and evolution of a species. Selection of the fittest individuals (i.e., surviving individuals) is thus combined with individual sexual selection and individual fertility. Different species have evolved to rely on these three basic prerequisites to different degrees, accounting for the great variety of biological sexual reproduction strategies found. Phenotypic expressions of genes, resulting in a cascade of phenotypic traits of living beings, however, do not influence the information content of the genome. In a recent scientific debate, the evolutionary psychologist Steven Pinker (The false Allure of Group Selection, 2012), argues against *group selection*. Pinker sees individual selection as the basis of evolution. In short, he stresses the individuality of mutations/recombinations and their crucial importance for Darwinian fitness and, thus, evolution. Pinker faces some opposition in comments by scientist who correlate natural selection with different phenotypic traits favoring group survival, even at the cost of individual reproduction rates. I think this debate misses a crucial point and can learn from a reinterpretation and application of Richard Semon’s core ideas. Let us reframe this debate a bit. Of course, as is mentioned in the debate, mathematically, any phenotypic trait (and even any other environmental or contextual feature) can be correlated with (individual) evolutionary success and may affect survival, sexual selection and fertility. And, for sure, this will delude the crucial mechanism of individual reproduction at the bottom of the causal chain. We started this thesis with introducing human *eusocial* technology as memory-based co-processual effectuation. This helped us to see the difference between a natural pseudo-technology such as a spider net (production) and an acquired, memory-based predictive technology process. The sexual preferences of a peahen, her compelling appreciation of a peacock’s impressive shimmery-colorful feathering, are phenotypic traits that can probably be traced back along a biological developmental chain, to specific gene expressions. It is thus genetically encoded. The ethologist Konrad Lorenz famously demonstrated (filial) imprinting (of birds) during a critical period, which I would characterize (for our purpose) as the introduction of a perceptual, (to be) *learnt* variable into a genetically anchored, rather static (nervous) behavioral program that is otherwise only influenced by predefined behavioral stimuli and the simple learning mechanisms of sensitization and habituation. There are only few animal species that we imagine having free imaginative (replicating) and extensive creative (varying) memory to their avail. Human(-like) memory, however, may strongly influence *genetic* sexual selection by a *technological* selective process. One could try to imagine the sexual preference of a human female for a *natural* group leader as being part of a genetic program, but this becomes impossible with well-liked millionaires, public servants, fellow believers, programmers, architects etc., which may all gain or lose attractiveness depending on specific historic-societal conditions. These are certainly not naturally motivated prototypes of female sexual interest. In other words, memory is able to vary preferences or decisions normally based on these preferences, namely by semantically associating and *motivating* learnt categories with basic impulses, emotions and drives. Nowadays, human fertility is influenced by reproductive medicine. Infertile men and women are no longer sentenced to evolutionary extinction. Soon, even total lack of natural fertility will no longer be an obstacle for reproduction at all, as germ cells can, in principal, be created from stem cells or *re-coded* by denucleation and subsequent renucleation. The creative potential of human memory, understood as an information reproduction and variation system, is directly accountable for such things as *reproductive medical practice*. Using less advanced technologies, humans have influenced natural evolution by plant and animal breeding for millennia. I think I do not even have to talk about the myriads of survival technologies culturally accumulated and taught by humankind. **The crucial step in evolutionary**

development is the essentially nonhereditary, cognitive-technological self-advancement of life through memory. The dawn of synthetic biology demonstrates how the memory replication system finally turns its information variation capacity toward the primary, genetic information replication system of life itself, which is disquieting given the huge technological risks involved in this step and the present lack of meta-technological processes and tools supervising and orchestrating human technological processes properly. Synthetic biology is more dangerous than an atom-bomb – says no less than Craik Venter[121]; and I would add: it is an *evolutionary* atom-bomb based on memory. The secondary information replication system starts to vary directly the primary information system, thus further suspending Darwinian evolution, possibly to a degree not even imaginable today. From this perspective, a scientific discussion of individual versus group selection appears a bit surreal, rather irrelevant, and narrowly focused. **The *one* crucial human trait of evolution is *replicative/variational memory*.** A classification of evolutionary effective traits would therefore first have to differentiate between memory-mediated, technological and memory-independent, immediate genetic-evolutionary traits and different complexes of both, as can be found in learnt motivational structures. Defining both natural evolution and memory evolution as interdependent information replication and variation processes can help us to see clearer the outstanding evolutionary importance of memory. Functional technology depends on the replicative-predictive capacity of memory to detect and record changes of informational states effectuated by actions. Semantic memory allowed for the co-structural artificial memory system of natural language to trigger and parameterize content-technological and functional-technological processes in symbolic manner, non-imitatively. Semantic memory further enabled the persistence and manipulation of replicative informational structures.

Semon's original conception of memory as a replication system of *mnemes* (Semon, Die Mneme, 1904) is a *precursor* to Richard Dawkins' meme-replicator, introduced in chapter 11 of his book *The Selfish Gene* (Dawkins, 1976), where all the following citations were taken from. Dawkin apparently did not and probably still doesn't know of Semon's astonishing work. Dawkin's meme-concept falls far behind the precision and elaboration of Semon's mneme-concept. Dawkin (1976) writes that

> […] *memes should be regarded as living structures, not just metaphorically but technically. When you plant a fertile meme in my mind you literally parasitize my brain, turning it into a vehicle for the meme's propagation in just the way that a virus may parasitize the genetic mechanism of a host cell. And this isn't just a way of talking – the meme for,*

[121] (Venter, 2012)

> *say, "belief in life after death" is actually realized physically, millions of times over, as a structure in the nervous systems of individual men the world over.'*

Dawkin sees his *meme* in his *mind,* but (also?) as a *structure* in the nervous system [sic]. In the same chapter, Dawkin abstracts the informational content of his meme:

> *The survival value of the god meme in the meme pool results from its great psychological appeal.*

Thus, the mental (conscious?) meme or nervous structure now somehow has psychological appeal (how and to whom?) and is an abstract (?) information item (*meme in the meme pool*) shared across individuals, too. Dawkin may be a great biologist, but he gets himself into further trouble when talking about *self-copying memes.* Does he mean self-copying nervous structures? Or self-copying abstract information structures, or self-copying mental (conscious) states? Dawkin also speaks of *unconscious memes,* which presupposes that there are also conscious ones, besides the neural structures. Does he think the latter are conscious, or unconscious? Dawkin, furthermore, talks about evolving memes (*memes will then evolve*); he speaks of copies of memes (*the longevity of any one copy of a meme*) etc. In short, it becomes very clear that Dawkin gets it all mixed up, and I therefore restrain from analyzing it any further. It is only a pity that the term *meme* was popularized despite its superficiality later on by other authors. The best, I think, we can do with it is to use it as a term denoting an abstract information structure that is instantiated in different sub-structures affected by the memory process and by memory-technological effectuation processes. Now, as a meme-philosopher, Dawkin may have failed, but as a biologist, he clearly stated the gist of the matter:

> *Whenever conditions arise in which a new kind of replicator can make copies of itself, the new replicators will tend to take over, and start a new kind of evolution of their own.*

Dawkin understands that there is, besides the genetic life-system, another replicator system and that this exhibits an evolutionary process of its own. The reader will soon be introduced to the mnemic replication process as defined by Richard Semon. However, before going into details, more has to be said about memory as a replication system. One may ask oneself: Why does the author of this thesis stress replication so much? Are there not more than enough and better-established and, thus, probably more important memory-theories? Theories talking about episodic and semantic memory, different sensory memories, working memories, perceptual and elaborated memory, behavioral memory, implicit memory, fact memory, face and object memory, priming memory, recognition memory, number memory, declarative and non-declarative memory, short-term and long-term memory, and so on and so forth, to name but a few. *Memories* have been differentiated across many features: especially temporal features, content features, and functional features, and often organized in dichotomies. This seemed and seems justifiable because of the numerous selective memory disorders (and memory dissociation paradigms) that memory researchers have managed to identify. Memory disorders and dissociation experiments can affect (and, mostly dually, dissociate) whether and how long some aspect can be stored and retrieved in a certain way. There can be no doubt that the brain-correlate of the memory process is the working of a distributed, complex nervous system, featuring specialization and localization of engrams and engraphic and ecphoric functions in different cortical areas and interconnecting brain structures. Now, following the tracks of Semon, it appears to me that, first, all of these so-called *memories* are indeed of importance to the central replication/variation-memory process, but do not represent *memory*-processes of their own, at least not in the replication/variation process sense. The memories I have listed above are actually on different abstraction levels resulting in wildly overlapping semantic structures. The crucial question that today's memory research does not answer to my satisfaction reads: What is the defining *function* of memory? Or, in short: What is memory? It cannot be sufficient and totally misses the point, as I have tried to show, if we just define memory as any (informational) system in the brain that takes an input and is somehow affected in its output function / connection strength by it. This would mean that each and every neuron would represent a memory or even several memories (matching the number of its input-output functions) of its own. This does not mean that individual neurons and neuron groups would or could not form the physiological basis of the memory process; it just means that the fundamental information replication/variation function of the neuron does not simply represent or translate into the replication/variation function of the memory process under discussion. The excellent bottom-up memory research of Eric Kandel may be titled *memory* research, but it researches a very different memory than the human replication memory process. The memory performance of aplysia is fundamentally different from the memory performance of creatively thinking humans. Any theory of a system of multiple interrelated memories would functionally only be justified if the memory-sub-processes or memory-sub-systems would represent independent replication/variation systems of their own. Otherwise, one will have to characterize them as sub-processes, structural components or abstract dimensions/aspects of the replication/variation memory process, in order to avoid confusion and functional defocussing. Technology-enabling replication/variation memory may actually be a chance for today's heterogeneous memory research to integrate its diverse research findings and its diverse multi-memory theories on a single, relevant process and abstraction layer. This cannot be a realistic goal of this thesis, though, but I will at least try to exemplify the research-integrative potential of this memory process whenever possible. The said integrative power results from the multidimensionality of perceptual-mnemic variation in the memory process, which binds and varies the dimensions of sensory modality and abstractness, experiential/attentional temporality and epistemicity, and syntacticity/semanticity, which will be detailed in chapter 4.3.1.

3.2 Memory Replication/Variation

Genetic evolution works by *creative* defects, going through life cycle's probation period. ***Mnemic* evolution works by engraphically effective, multidimensional integration. Its acid tests are technological correspondence and communicability.**

3.2.1 Importance of Memory Process

Schacter notes that …

> *Most important, we have now come to believe that memory is not a single or unitary faculty of the mind, as was long assumed. Instead, it is composed of a variety of distinct and dissociable processes and systems.*
>
> (Schacter, 1996, S. 5)

This is of course true in perhaps the same sense that one could come to believe that a car is not a single unit of driving, but composed of distinct and dissociable processes and systems. However, neither the car system as a whole, nor its components and the sub-processes involved in a driving car can be understood if perceived as functionally independent, dissociable processes and systems. **Most important, therefore, is that we come to understand the *natural* and possible *artificial* technological composition of the overall system to serve its perceived functional goals.**

3.2.2 Memory Process

The following memory process description is based on Richard Semon's books, but it does not try to be an exact replication of Semon's thoughts. I will try to provide an interpretation, integrating own lines of thought and different results from contemporary memory research. If not marked differently, the technical terms are those used by Richard Semon.

3.2.2.1 (Original) Engraphic Process

Semon starts his memory process by describing the stimulation of the sensory organs [Reiz], which ends a *primary state of indifference* [primärer Indifferenzzustand], leading to a (nervous [energetischer Vorgang in der reizbaren Substanz]) stimulus excitation [Reizerregung], building up a stimulus sensation [Reizempfindung]. While the stimulation of the sensory organs endures, the corresponding sensation is related to its stimulus by the stimulus excitation in a *synchronous* phase [Synchronphase]. The synchronous stimulus excitation [synchrone Reiznachwirkung] may endure after the stimulation of the sensory organs ends [akoluthe Reiznachwirkung: unmittelbare, an die snychrone anschließende Reiznachwirkung], which relates the stimulation of the sensory organ to the stimulus sensation in an *asynchronous* phase [akoluthe Phase].

> *Die Erregung (bzw. Empfindung) während ihrer synchronen und ihrer akoluthen Phase zusammen bezeichne ich als Originalerregung (bzw. Originalempfindung).*
>
> (Semon, Die Mnemischen Empfindungen, 1909, S. 26)

The, as we might say, *purely perceptual or sensory* stimulus excitation is named original stimulus excitation [Originalerregung] and the *purely perceptual* sensation is named original stimulus sensation [Originalempfindung]. Semon defines the process of original stimulus excitation and original stimulus sensation independent of any specific sense organ and sensory quality.

It is a *general,* highly dynamic sensory process. According to Semon, due to the asynchronous endurance of stimulus excitation, a constant or oscillating single stimulus sensation may arise despite of a *repetitive* stimulation of the sensory organs. The asynchronous phase demonstrates a stimulus-excitation-integrative and stimulus-sensation-integrative sub-function of memory. A simultaneous (original) stimulation complex [simultaner Reizkomplex] will create a simultaneous (original) stimulus excitation complex [simultaner Erregungskomplex]. Due to asynchronous excitation continuation, a simultaneous stimulus excitation complex will integrate with still effective asynchronous stimulus excitation complexes or, more precisely, with their still asynchronously active portions. The overall stimulus activation complex [kulminierende simultane Erregungen] at any particular point of time will therefore comprise different synchronous sensory stimulations and their subsequent synchronous or asynchronous stimulation activities. This means that stimulus sensation concurrency does not reflect sensory stimulation concurrency, especially if we assume modality-specific latencies of synchronous and asynchronous excitation phases. Semon raises an important question:

> […] *die Grundfrage, wie bei den aus verschiedenen Pforten einströmenden und in topographisch verschiedenen Teilen des Organismus kulminierenden simultanen Erregungen der simultane Erregungskomplex als ein geordnetes zusammenhängendes Ganzes, also, soweit er sich in Empfindungen manifestiert, als ein geschlossenes Nebeneinander von Empfindungen zustande kommt.*
>
> (Semon, Die Mneme, 1904, S. 119)

Semon is aware of the Gestalt-quality [geschlossenes Nebeneinander] of concurrent stimulus sensations. He believes …

> […] *daß sich alle Tatsachen der simultanen Assoziation von selbst aus der an sich als gegeben hinzunehmenden Grundtatsache ergeben, daß die organische Substanz auf eine Anzahl gleichzeitig auf sie als Reize wirkender Einflüsse mit einem gesetzmäßig geordneten zusammenhängenden Nebeneinander von Erregungen antwortet, und daß dieser simultane Erregungskomplex als solcher engraphisch wirkt.*
>
> (Semon, Die Mneme, 1904, S. 123)

The *integrated* and *ordered* original stimulus excitation complex is thought to be engraphically effective. Semon's original stimulus excitation complex is similar to the sensory memory of present-day memory research. Visual persistence, for example, resembles asynchronous stimulus excitation. George Sperling (Sperling, 1960) enriched our knowledge about the iconic buffer by showing that even a complex of (up to) twelve spatially ordered visual stimuli (letters) is kept available as a whole for a short period of time to a process of attention, which directs and focusses the transformation of stimulus excitation into stimulus sensation, which, in turn, greatly improves the engraphic effect of the excitation complex attended. Semon did not detail the effects of attention, something that Schacter rightly criticized. Semon, however, was aware of them, as he, at one point, mentions the *focus effect of attention* [*Fokuswirkung der Aufmerksamkeit*, *isolierende Macht der Aufmerksamkeit*], which would create *associative bridges* [Assoziationsbrücken].[122] Semon's *original* excitation phase is pre-engraphic and pre-ecphoric. Stimulus excitation continuation is not *memory*, at least not as understood by Semon; it is rather a *lawfully* excitation-pattern-forming and Gestalt-forming *integrative* process, partially cumulating in a direct-perceptual stimulus sensation complex. There are conflicting research findings as to whether the sensory buffer may comprise *categorical* information.[123] However, for example, the integrative work of the *iconic* buffer (that is, low-level visual processing) seems to be restricted to creating and binding basic perceptual features such as brightness, position, color, contour, size etc. Semon's epistemically *original* and, more generally, pre-ecphoric sensations are, per definition, limited to such aspects. Semon would certainly not have accepted the *letters* in Sperling's letter block (stimulus *sensation* complex) as *original* sensations. Complex letter shapes are *learnt* units, engraphically built on occasion of former original sensory stimulations and sensations. In their pre-ecphoric (direct-perceptual) excitation form (as in Sperling's experiments), the letter's stimulus excitation complex is best not called letter or letter-shape, as this deludes an important

[122] (Semon, Die Mnemischen Empfindungen, 1909, S. 125)

[123] Merike (Merikle, 1980), for example, supports the idea of categorical aspects encompassed in sensory memory, which is contradicted by Kehrer (Kehrer, 1985) and is also not in accordance with later research results of Sperling.

epistemic distinction, distinguishing between an (episodic-)*engram*-activating stimulus-related excitatory state and an original, purely stimulus-based excitation state. Of course, any nervous excitation state is based on a nervous structure that can (and has to) be perceived of as a basic form of (relatively) *primitive* (direct-perceptual?) *memory*. This is phylogenetically programmed *and* prenatally and postnatally *self*-organizing, involving sensory stimuli, too. However, these perinatal and infantile sensory-stimuli's *engrams* are very likely not mediated by the structures that form the replication/variation memory process discussed here. One could hypothesize a gray area where the most complex primitive-memory structures are also (perhaps even first) being encoded as very simple, compositional sensation engrams, before being *incorporated into* or *separately acquired by* the primitive-memory stimulus-processing/-integration system. In any case, original-sensation-excitation integration/processing-depth is certainly a developmental (lifetime) and sensory-experiential variable.

The original sensation complex is largely defined by the temporal structure of the sensory stimulation and the specific intra-integrative and inter-integrative characteristics of the sensory modalities involved. Mechanisms of (uncontrolled) outer attention, neglected by Semon, are important in temporally structuring and content-wise defining the original excitation complex. This complex can be behaviorally effective, especially in form of reflex actions. It certainly represents a phylogenetically older, *pre-memory* [sic] nervous adaptive system for reflex-like ways of acting and *instinctive* behavior, which are direct-perceptually, non-mnemically parameterized. The Semonian original excitation complex and, as I would add, its immediately related *original sensation behavior*, are, in a way, the cognitive-system realizers of *hot media*. McLuhan's ingenious basic categories of hot and cool media, which to many may appear dated and unfounded, might mark (to some extent), indeed, the borderline between two *stages* of cognitive evolution: pre-mnemic and post-mnemic. They also mark, to some degree, the borderline between two forms of cognitive existence: perceptual-*reactive* and technological-*active*, or, in other words, stimulus-impulsive and thoughtful-predictive. A hypothesis we gain from this separation is that the gradually developed human and *higher*-animal capacity of conscious-predictive thought is directly intertwined with the development of the variation/replication memory-system. The relatively primitive (or fundamental) cognitive operations of uncontrolled or impulsively controlled outer attention appear as functions of pre-ecphoric, *primitive(/fundamental)*-memory (/early processing) integrative memory capacities.

According to Semon, original simultaneous (synchronous-asynchronous) excitation complexes are engraphically fixated into corresponding original engram complexes. In his first mnemic law (law of engraphy), Semon states:

> *Kurz gefaßt ergibt sich uns daraus die folgende These, die ich als den ersten mnemischen Hauptsatz oder den Satz der Engraphie bezeichnen will: Alle gleichzeitigen Erregungen (in unserem Falle manifestiert durch Empfindungen) innerhalb eines Organismus bilden einen zusammenhängenden simultanen Erregungskomplex, der als solcher engraphisch wirkt, d. h. einen zusammenhängenden und insofern ein Ganzes bildenden Engrammkomplex zurückläßt.*
>
> (Semon, 1909, S. 146)

A *succession* of varying, simultaneous complex excitation states [Sukzession von simultanen Erregungskomplexen] is transformed into a succession of *associated* (interconnected) engram complexes [Sukzession von simultanen Engrammkomplexen]. The engraphic succession is reflected in the succession of singular, momentary stimulus sensation complexes [Sukzession von simultanen Empfindungskomplexen]. The successive engrammatic associations [Sukzession von Engrammkomplexen] are accompanied by *simultaneous* engrammatic associations *between* specific engrams (or specific engram sub-complexes) forming specific successive engram complexes. Semon gives the example of differentiating individual voices in a polyphonic piece of music.[124] S*imultaneous* (and successive) engrammatic associations [simultane Engrammassoziationen] are created between modality-specific engram complexes [Assoziation zwischen Engrammen gleicher Reizmodalität] and, within a single modality, between engrams integrating specific stimulus qualities [Reizqualitäten] (such as the before-mentioned single voices, or, more generally, any Gestalt- or Ganz-structure). Thus, Semon, in principal, describes the engraphic act as creating a multi-dimensional engrammatic associative structure of stratifications of successions and complexes, progressing from individual, unimodal to increasingly complex, multimodal engrams.

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[124] Semon (1909, S. 126) notes:

> *Ein wirklich musikalischer Mensch, dem ein polyphones Musikstück wiederholt vorgespielt oder vorgesungen worden ist, vermag nach einiger Zeit den Ablauf jeder einzelnen Stimme für sich innerlich zu reproduzieren oder auch singend oder spielend wiederzugeben. Diese Fähigkeit, zu der gar keine anderweitige musikalische Schulung erforderlich ist – wenn es sich um zweistimmigen Gesang handelt, so ist ein Kind dazu imstande – , ist nur unter der Voraussetzung erklärlich, daß die Tonfolgen innerhalb jeder Stimme enger assoziiert sind als von einer Stimme zur anderen.*

3.2.2.2 Ecphoric Process

The end of engraphy starts the *secondary state of indifference* or, in other words, *latency state of the engram* [sekundärer Indifferenzzustand; Latenzzustand des Engramms]. Schacter summarizes it as follows:

> *The secondary state of indifference signifies a period of latency in which the behavior of the organism is indistinguishable from its behavior in the 'primary' state of indifference. There is, however, a critical difference. The organism now has the potential to respond to certain stimuli - those that gave rise to the new engram - in a manner that it could not prior to the engraphic act.*
>
> (Schacter, 2001, S. 122f)

Semon describes the next crucial step in the memory process, ecphory, as the activation of the engrammatic nervous-excitatory disposition:

> *Unter Ekphorie eines Engramms verstehen wir die Versetzung eines Engramms aus seinem latenten in seinen manifesten Zustand oder, anders ausgedrückt, die Aktivierung einer Erregungsdisposition, die als bleibende, aber für gewöhnlich latente Veränderung im Organismus zurückgeblieben ist.*
>
> (Semon, 1904, S. 187)

During the mnemic process [mnemischer Ablauf, mnemische Reproduktion], the repetition of a specific *original* stimulus excitation [Wiederkehr der Originalerregung] will *ecphorize* [ekphorieren] its corresponding *original* engram. The sensation that manifests itself is, at its core, a mnemic-perceptual one. It has the potential to ecphorize originally associated engrams or engram complexes, thus fully or, more likely, partially reinstating the original sensations as *mnemic sensations* [mnemische Empfindungen]. Ecphory can be based on simultaneous engram associations [Ekphorie auf Grundlage der simultanen Assoziation] or be based on successive engram associations [Ekphorie auf Grundlage der sukzessiven Assoziation]. According to Semon, a mnemic simultaneous sensation complex does not have to reproduce the original sensation complex fully. Certain modalities can and often will be left out, even though, as Semon assumes, *all* simultaneous sensory qualities are engrammatically interlinked. Another important type of ecphory is *chronogenous* ecphory [chronogene Ekphorie] that explains regularly occurring sensations. Semon believes chronogenous ecphory to be based on regularly repeating endogenous stimuli, which have an engrammatic effect, too, and, therefore, are engrammatically associated [chronogene Engramme]. Chronogenous ecphory can explain time-based prospective thought (and action). Common ecphoric stimuli will explain event-based prospective thought (and action). There is no need to declare a *prospective memory* to explain prospective thought and action. All simultaneous complexes of excitation and sensation are either original-sensory, sensory-mnemic, or mnemic-mnemic. In the latter case, a mnemic sensation will trigger another mnemic sensation, in the absence of any corresponding sensory stimuli. Sensory-mnemic and mnemic-mnemic simultaneous and successive complexes are engraphically effective, that is, any ecphory is engraphically effective. Semon's engraphic ecphory [engraphisch wirksame Ekphorie] goes beyond the common *strengthening effect of retrieval*:

> *Semon contended that each act of ecphory establishes a new engram-complex comprised of the retrieved information and information in the present context: 'each ecphory of an engram-complex produces not only a mnemic sensation* […] *but through this creates a new engram which adheres to the new engram-stratum (1923, p. 178).'*
>
> (Schacter, 2001, S. 173)

Schacter cites modern memory research supporting this view:

> *Some modern research supportive of this view has been reported by Gardiner and Klee (Klee & Gardiner, 1976) in their studies of memory for remembered events. These authors, much like Semon, posited that 'Each act of remembering itself* […] *constitutes a new event in episodic memory (Klee & Gardiner, p. 471).'*
>
> (Schacter, 2001, S. 174)

Semon's engram stratum [Engrammschicht] reveals a specific mnemic or sensory-mnemic sensational episode. Semon stresses the *variation* potential of the ecphoric-engraphic mechanism:

> […] *daß der hochentwickelte Mensch imstande ist, durch simultane Ekphorie von Engrammen verschiedener Engrammschichten jedes Element seines individuellen Engrammschatzes mit jedem anderen neu zu assoziieren, somit unzählige neue Engrammkombinationen zu bilden.*
>
> (Semon, 1909, S. 167)

The ecphoric-engraphic mechanism for engram combinations [Engrammkombinationen] (mnemic engram complexes combining engrams from different engram strata) seems to be fundamental to *conceptual integration*. Semon furthermore characterized simultaneous engrammatic associations similar to *conceptual blendings*:

> *Von all diesen verschiedenen Bestandteilen* [des Emfindungskomplexes] *erscheinen bei der mnemischen Reproduktion unter gewöhnlichen Verhältnissen bestenfalls*

> *Bruchstücke der eindrucksvollsten Komponenten wieder, und diese Bruchstücke nennen wir dann assoziiert. Eine viel sinngemäßere Auffassung aber ist es, nicht diese Bruchstücke für assoziiert, sondern sie als gemeinsame Bestandteile, als Höhenpunkte eines zusammenhängenden simultanen Empfindungskomplexes anzusehen.*
>
> (Semon, 1909, S. 152)

Hence, Semon's memory theory of mnemes offers numerous theoretical integration points (and even bears some resemblance) to Fauconnier's cognitive linguistics. One could say that engram combinations form *second order* engrams (meta-engrams) of a mnemic-integrative nature. Engram combinations are, however, not (and perhaps even never) strictly mnemic, as mnemic simultaneous excitation and sensation complexes will normally also comprise original sensory or sensory-mnemic percepts as key ingredients or, at least, *contextual* elements. Accordingly, it should not be difficult to integrate findings of modern *source memory* research and of research on (*implicit) context memory* into Semon's theoretical framework. Contextual stimuli have an ecphorizing effect [Ekphorie durch partielle Wiederkehr des Originalreizes]. The *context* is part of a largely sub-sensational (sub-/near- or pre-conscious) engraphic and ecphoric simultaneous excitation complex.

One of the intellectual achievements of Semon's theory is that it reduces engram associations to a single general (quasi-physiological) association type. Semon's forming of engrams is thus very much in accordance with Hebbian learning. Semon, however, manages to embed the dynamics of the creation, activation, and evolution of engram associations into the dynamics of the central memory function of information replication and variation. This allowed him to explain different phenomena by general memory-mechanisms and processual developments. The following citation gives an example for this by showing how Semon views associations of contrast (Aristotelian associations of dissimilarity) [Kontrastassoziationen], which also play an important role in word field theory:

> *Nun ist der individuelle Engrammschatz eines jeden von uns förmlich gespickt mit solchen simultan assoziierten kontrastierenden Engrammpaaren. Kontraste wirken schon in Form von Originalempfindungen besonders lebhaft und werden leicht mit Lust- und Unlustbetonungen versehen. Sie gehören infolgedessen zu unseren eindrucksvollsten Erlebnissen und werden schon von früher Jugend an als besonders kräftige und eng assoziierte Engramme im individuellen Engrammschatz eines jeden erzeugt und durch unablässige Wiederholung verstärkt und weiter entwickelt. Begünstigt wird dieser Vorgang noch durch die Art und Weise, wie besonders der Kulturmensch die Sprache, diesen großen Sammel- und*

> *Verdichtungsapparat der Assoziationen, zu handhaben und seinem Nachwuchs zu übermitteln pflegt. Ein wenig systematisieren da schon die meisten Mütter und Wärterinnen, wenn sie das Kind in der Bereicherung seines Wortschatzes bewußt unterstützen und ihm, wenn er ein Eigenschaftswort aufgeschnappt hat, das 'Paar' dazu lehren; zu klein – groß, zu heiß – kalt, zu schnell – langsam usw. usw.*
>
> (Semon, 1909, S. 188)

Semon here takes an explicit developmental perspective that considers contrast associations as common simultaneous associations, stressing that …

> *So schafft uns Erfahrung und Sprachgebrauch ungezählte Engramme von gepaarten Kontrasten, Engramme, bei denen natürlich das Manifestwerden des einen Paarlings den anderen prompt zu ekphorieren vermag.*
>
> (Semon, 1909, S. 189)

This allows him to conclude:

> *Die* […] *simultane Assoziation der einzelnen Engramm-komponenten hat sich* […] *als die einzige ergeben, die überhaupt vorkommt.*
>
> (Semon, 1909, S. 189)

Semon goes even one step further by maintaining that …

> […] *ebenso gibt es nur eine einzige Grundform der Ekphorie, diejenige durch mehr oder weniger partielle Wiederkehr der energetischen Situation, die engraphisch gewirkt hat, bzw. des Erregungskomplexes der engraphisch gewirkt hat, mag nun diese Wiederkehr in Gestalt von originalen oder von mnemischen Erregungen erfolgen.*
>
> (Semon, 1909, S. 189-190)

We know that *perceptual* salience (reflecting vital relevance) directs uncontrolled outer attention. There is very likely a similar *mnemic-salience* mechanism directing uncontrolled *inner* attention, as expressed in willful/intentional mnemic associations. Markowitsch emphasizes the strong link between memory and affective information:

> […] *brain research that showed that those regions involved in the processing of affective information are also involved in the processing of memory information. The visceral brain (MacLean, 1952) or the 'rhinencephalon' (Macchi, 1989; Nieuwenhuys, Voogt, & van Hizen, 1988) were early labels for*

> *what today is termed the 'limbic system' and most frequently associated with memory encoding* […]
>
> (Markowitsch, Neuroanatomy of Memory, 2000, S. 465)

For Semon, affective information is but another engram of an engram complex, an engram, though, that stems from a non-sensory (or, more precisely, *inner-sensory*), endogenous source, the stimuli of which are not directly perceptible to an outsider. Therefore, Semon would not consider the frequently found *affective* directionality of thought (motivational thought structure) as anything else than an instance of the general mechanism of ecphory. An affective state functions as an ecphoric influence (besides many other sensory- and mnemic-ecphoric influences), notwithstanding the enormous ecphoric effectiveness of strong affects, as, for example, conveyed in vivid visions of very hungry and very thirsty people. Engrams under constant ecphoric influence will associate with other engram complexes infectiously, potentially contextualizing (motivating) streams of thought. It is, however, important to note that Semon’s ecphory breaks with the idea of *association strength,* (the main associative principle of associationism). Constellations of ecphoric influences relative to engrammatic-associative structures determine ecphory. Kurt Lewins field theory (or topological psychology), which is said to be the *background paradigm* of modern motivation research (Herber & Vásárhelyi, 2002), can be easily translated into mnemic processes.

> *Die Lokomotion wird durch eine Kraft bewirkt, die aus der Beziehung von mindestens zwei Regionen im Lebensraum entspringt (z.B. dem Bedürfniszustand einer Person und der Attraktivität oder Valenz einer bestimmten Zielregion im „Umweltsektor” des Lebensraumes). Es können auch mehrere Kräfte gleichzeitig – gleich- oder gegensinnig – wirken und eine bestimmte Veränderungsresultante ergeben. Diese (resultierende) Kraft ist definiert als Stärke und Richtung der Tendenz zur Veränderung, die an einem bestimmten Punkt des Lebensraumes ansetzt.*
>
> (Herber & Vásárhelyi, 2002, S. 32)

In Semon’s terms, an affective state [*Bedürfniszustand*] ecphorizes and maintains a related engram, a target region of the life space [*Zielregion im Umweltsektor des Lebensraums*]. Lewin’s *momentary* life space, his *psychological situation* [der in strukturierter Weise gegenwärtige Bereich des Lebensraums[125]] can be interpreted as the *fluid* simultaneous complex that is dynamically created by the ecphoric effects of its mnemic, its endogenous and exogenous ecphoric influences. Psychological locomotion [psychologische Lokomotion] combines physical and psychological locomotion.

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[125] (Lewin, 1969 (1936), S. 45)

Lewin distinguished between quasi-physical, quasi-social, and quasi-terminological locomotion.[126] These types of locomotion do not establish independent processes of life-space locomotion, though, but rather describe different situations in which various epistemically distinguishable ecphoric influences and their corresponding engrammatic structures become effective due to the outer realities of individual physical and social environments, and the inner reality of engrammatic environments. One might add that individual personality factors would represent a fourth, likewise mnemically effective reality, providing the affective stimuli that drive ecphory in form of sensations of thinking and acting. The easy combinability of Kurt Lewins' and Richard Semon's theories may well be based on a shared principle of conceptual economizing:

> *Die Begriffe, die wir in diesem Buche entwickelt haben, beziehen sich auf den gesamten psychologischen Lebensraum, d.h. auf Person und Umwelt. Sie gestatten die Behandlung aller Lage- und Zusammenhangsprobleme des Lebensraumes und seiner Teile. Sie sind ebenso auf quasi-physikalische wie quasi-soziale und quasi-begriffliche Tatsachen anwendbar.*
>
> (Lewin, 1969 (1936), S. 210)

Topological psychology, reinterpreted in terms of the memory replication/variation process, would represent an important extension to Semon's memory theory, as Lewin focused on consecutive simultaneous complexes [psychologische Situationen], linked by locomotions according to diverse influences of psychological and non-psychological origin, thus spanning across different *engrammatic* structures. The goal of dynamic psychology to construct a dynamic representation of the individual and her environment [*dynamische Darstellung von Person und Umwelt*[127]] reminds us of the technological double-process, which combines affective and mnemic influences, instantiating the actuator process, with frequently (but not exclusively) exogenous influences on the substitution process, stemming from physical and social reality etc. **In a way, one could characterize the technological actuator process as a set of ecphoric influences (and a related engrammatic structure) that precede over or somehow subdue other ecphoric influences provided by the substitution process. Lewin would probably have characterized the actuation process as a contiguous psychological space** [zusammenhängendes psychologisches Gebiet]**, glued by a shared (ecphorically effective affective-engrammatic, as we might add)**

[126] (Lewin, 1969 (1936), S. 223):

> *Man kann quasi-physikalische, quasi-soziale und quasi-begriffliche Lokomotionen unterscheiden.*

[127] (Lewin, 1969 (1936), S. 43)

***valence*, engaging the individual in a process of psychological and (often also of) physical locomotion.**

3.2.2.3 Multiple Traces & Homophony

Semon invented a new term, *homophony* [Homophonie, Empfindungsdeckung] to denote the homologous sensory-mnemic sensation that makes an appearance when a stimulus excitation becomes ecphorically effective to form a single, integrated sensory-mnemic simultaneous sensation complex. **Homophony, as a phenomenon, becomes obvious during two-stage recognition, when familiarity turns into recollection, or when there is the sensation of difference between sensory percept and the mnemic sensation it ecphorizes:**

> *Den gleichzeitigen selbständigen Ablauf der mnemischen und der neuen Originalerregung haben wir demnach auf dem Wege der Introspektion durch zwei sehr charakteristische Reaktionen erkannt: die Reaktion des Wiedererkennens und die Reaktion des Unterschiedempfindens.*
>
> (Semon, Die Mneme, 1904, S. 209)

Homophony, according to Semon, is in force *between* mnemic sensations, too. Engrams in different engrammatic strata referring to the same (original) stimulus effectuation (that is, its perceptive-primitive memory engram, as I would add) are activated on the return of the original stimulus (excitation).[128] Semon assumes that the engrammatic episodes are not inextricably fused [*keine unentwirrbar verschmolzene mnemische Erregung*[129]], but are distinguishably *homophonic* [*entwirrbares Miteinanderklingen*[129]]. The important point here is that Semon introduces a multiple trace theory of repetition: associations are not just *strengthened*, but new engrams are created.[130] Ebbinghaus' *saving method*[131] [Ersparnismethode], however, demonstrated that recall performance somehow benefits from relearning or re-experiencing. *Benefit* only being understandable if we consider Ebbinghaus' forgetting curve in the first place. *Recall failure* has two

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[128] (Semon, Die Mneme, 1904, S. 226):

> *Wir haben nun schon früher (S. 116–119) als ein allgemeines mnemisches Gesetz erkannt, daß, wenn zwei Erregungen koordiniert in einem Organismus auftreten, sie auch koordiniert engraphisch aufgenommen und fixiert werden. Es ist selbstverständlich, daß die Erregungen p1(mn [mnemisch]) und p2(or [original]) hiervon keine Ausnahme machen, wenn sie nach ihrem Ablauf als Engramme in das Latenzstadium ein- bzw. zurücktreten. Werden sie durch eine erneute Wiederholung des Originalreizes wiederum ekphoriert, so müssen sie natürlich auch wiederum koordiniert und nicht homogen verschmolzen als eine homophone mnemische Erregung p1(mn) + p2(mn) manifest werden und sich in dieser Form zu der neu aufgetretenen Originalerregung p3(or) gesellen. Es findet also jetzt die dreifache Homophonie p1{mn) + p2{mn) + p3(or) statt. Dasselbe findet bei der dritten, vierten bis n-ten Wiederholung statt.*

[129] (Semon, Die Mneme, 1904, S. 227)

[130] See (Semon, Die Mneme, 1904, S. 231).

[131] See (Ebbinghaus, 1885). - The savings method uses relearning to express the time saved as a percentage of the original learning time.

faces: non-ecphory and erroneous ecphory. Within Semon's memory framework, non-ecphory can be explained by lack of suitable ecphoric influences (inner and outer memory cues, if you will) or, possibly, by engraphic failure or engram decay, the latter not at all being excluded by a multiple-trace theory of repetition. Erroneous ecphory can be explained, first, by all the reasons for non-ecphory, provided an additional inappropriate engram stratum responding to ecphoric influences present, or, second, by engram association *bifurcation* or, in fact, multifurcation [Engrammassoziations-vergabelung]. According to Semon, successively associated engrams (belonging to one engram stratum or episode) sharing the successively associated engrams of another or several more strata offer either alternative mnemic association pathways or integrative [sic] association pathways.[132] Non-original mnemic successions involving different engrammatic strata (episodes or simultaneous complexes) could thus easily appear as erroneous reproductions. **The multifurcation principle offers a sound memory-theoretical explanation for word-similarity associations and concept-similarity associations, which played a decisive role in the development of syntax schemata and abstraction hierarchies in our new semantic network model.** Ebbinghaus' experimentation paradigm of exact reproduction as a measure of memory performance is misleading us (and has been misleading generations of memory researchers) in that it diagnoses *erroneousness* of reproduction, where we actually encounter and ought to pay attention to the core mechanisms of mnemic variation. **I have already stressed the outstanding importance of word similarity for the development of syntax schemata and, therefore, language production. Conceptual similarities, on the other hand, create abstractions (by engrammatically fixating mnemic-associative multiple-trace engram complexes anew). Abstractions take centre stage in different types of inference: as *analogy* between different instances, as information creatively infused (blended) into an instance in *abduction* or logically infused into an instance in *deduction*, and as generalizations in *inductions*.** In other words,

[132] (Semon, Die Mneme, 1904, S. 145):

> *Höre oder lese ich z. B. das berühmte Goethesche Gedicht: »Über allen Gipfeln ist Ruh« zuweilen in der ersten, zuweilen in der zweiten Fassung, so prägt es sich mir in folgender alternativ dichotomischer Form ein:*
>
> »Über allen Gipfeln ist Ruh, in allen { Wäldern hörest du / Keinen Hauch —« } { Wipfeln spürest du / Kaum einen Hauch —« }
>
> *Diese alternative Dichotomie läßt sich nicht durch gleichzeitiges Hören oder andere engraphische Einflüsse, wie diejenigen des obenerwähnten zweistimmig werdenden Musikstücks, in eine simultan assoziierte verwandeln i. Wo aus irgendeinem Grund eine Simultanassoziation der Aste einer Dichotomie (oder Trichotomie) unmöglich ist, da bleibt dieselbe dauernd eine alternative.*

syntactically and inferentially effective and creative multifurcation is not a weakness, episodic *decay*, as which it must appear in any sort of exact-replication-type memory experimentation, but, on the contrary, a recipe for successful memory variation and, thus, human creativity and human intelligence. Exact mnemic replication and mnemic variation are mutually exclusive and, at the same time, closely interdependent [sic]. How is this seemingly contradictory claim possible? Well, exact replication seems only possibly if there is an exact replication of original stimulation (exact re-experiencing) or if there is a chain of mnemic ecphoric influences reactivating the original engrammatic stratum (exact remembering). Replication of experiential variation (partially or similarly re-experiencing) would require a new original encoding if the repeated/similar experiential parts did not become ecphorically effective. This, of course, would allow no variation besides simple re-sequencing of partial exact mnemic replications. Memory would appear as an endless recording and always *single-voice* mix tape. Introducing separate (episodic) engram strata and homophony, however, gives a different picture. Partial or similar (enough) re-experiencing leads to simultaneous activation of all suitable engram strata. Furcation (putting aside special cases of ecphoric engram integration) indicates that, as a rule, only a single engram stratum is ecphorized to the level of mnemic sensation and subsequently effective mnemic (engrammatically associative) engraphy, at a time. A single mnemic sensation gaining the upper hand resembles a more or less *planned* action *crossing the Rubicon* toward action performance, which lets us assume that acting is also based on perceptive and mnemic ecphoric influences, and thus likewise represents an ecphoric memory process. Richard Semon's memory theory is, thus, compatible with the common coding (of perception and action) theory introduced by Wolfgang Prinz[133]. In perception, a perceptive ecphoric influence ecphorizes an engram (from a specific engram stratum, besides activating other engrams from other strata, too) to homophonous perceptive-mnemic sensation, which creates a mnemically derived co-perceptual ecphoric influence. I would name this *predictive* effectuation of (as the case may be, sequentially) neighboring engrams of the ecphorized and probably also, though to a lesser degree (because often not or not yet further supported by ecphoric influences), of co-activated engram-complexes. The phenomenon of mnemic-perceptive differentiation (which was one of the phenomena used by Semon to infer homophony in the first place) marks a situation that likely promotes an act of mnemic-perceptive engraphy of an abstraction (similar mnemic-perceptive structure) engram. **What we learn from this is that seemingly mere *episodic* perception is, indeed, rather an intertwined process of mnemic-perceptive ecphory and engraphy, a highly creative process of co-structural (stimuli-engraphic and mnemic-ecphoric-engraphic) *automatic* abstraction.** It is, in contrast, also a process of ongoing chunking, because abstractions function like pieces of a

[133] See, e.g., en.wikipedia.org/wiki/Common_coding_theory (accessed on 29.11.2012).

puzzle: they permit a process of homophony poor in conflicting sensations (breakdowns of homophony, so to speak). Perception is being mnemically organized. Abstraction gradually provides the right (i.e., perceptively/ecologically valid) granularity of further episodic engraphy. Abstractions (or, in less *complex*, more *episodic* terms: *segments* or *substrings*) effectively reduce the number of (perceptive-integrative) engrammatic associations needed to encode perceptive-mnemic experiences, as they (likely) form higher-level complex/episodic engram chunks (associated or associatively integrated abstractions/segments). Basic *stimulus* integration mechanisms therefore contrast with *mnemic* integration mechanisms. In individuals with an increasingly structured (rich in abstractions and chunks) engram repertoire, the former are more and more replaced (or covered) by the latter. Original-stimulus engraphy makes room for mnemic-perceptive engraphy. Analytical abstracting or segmenting, on one hand, and synthetic complexing or chunking, on the other hand, are likely kept in balance by the tradeoff between a better reflective, perceptive-mnemic (homophonous) fit of smaller engrammatic units and a better predictive, mnemic-perceptive fit of larger engrammatic units. Reflective fit increases Darwinian fitness by correct space-time *focused* evaluation, whereas predictive fit increases fitness by correct space-time *extended* evaluation. Even though complex/chunk engrams (referentially) integrate smaller abstractive or original-perceptive engrammatic units (which becomes obvious in their intentional analysis), they nonetheless represent fully autonomous engrammatic units with experientially distinct engrammatic associations across all perceptive-mnemic episodic engram strata in which they became mnemic-engraphically (homophonously or purely mnemically) effective.

Schacter links *recognition* to Semon's process of ecphory:

> *Semon simply characterized recognition as a sub-type of ecphory;* […] *Semon hypothesized that each act of recognition, just like any other ecphory, functions to establish a new engram-complex.*
>
> (2001, S. 178)

In Semon's memory theory, there is no need to declare a separate *recognition* memory, as recollection as well as any form of episodic remembrance or, even, thinking and acting, can be well explained within the memory process framework. Familiarity before recollection, a possible first stage of recognition, could be linked to the presence of mnemic excitation (as compared to more or purely perceptive-original stimulation) before it *crosses the Rubicon*, turning into a mnemic-ecphoric influence (*recollecting*/ecphorizing associated *information*/engrams from different related episodic *information*/engram strata).

Semon, of course, did not know of *priming* and its huge importance for memory performance. In priming experimentation, the prime stimulus presented first influences a later memory-related cognitive process. The target stimulus follows the prime. Positive priming decreases the target’s processing time. Negative priming increases the target’s processing time. The prime can be subsensational (i.e., subconscious), from a different sensory modality and more or less directly (engrammatically) associated. Priming therefore takes many different forms, such as (target) word priming, (target) action priming, attention (action) priming, emotional priming, perception priming, repetition priming etc. As the priming effect goes back to a (prime) stimulus, within Semon’s memory framework, stimulus excitation is the first candidate possibly accounting for priming. Primitive/perceptive (pre-episodic integrative) memory engram sensitization may account for simple *perceptual* (sensorial) priming, in which (in the *visual* modality) items with a similar form are primed. There is evidence that rejects the idea of a direct correspondence between familiarity and perceptual priming, which is in agreement with our explanation of familiarity in recognition based on a perceptive-*ecphoric* mechanism:

> *There is other evidence that undermines any presumed correspondence between familiarity in recognition and perceptual priming (e.g., Snodgrass, Hirshman, & Fan, 1996; Wagner, Gabrieli, & Verfaellie, 1997). Jacoby's process dissociation procedure retains the idea of two independent processes, and the idea that similar processes may operate in recognition and in perceptual priming. But the contrast now is between controlled and automatic processes, and it is assumed that recollection is a controlled process and familiarity is an automatic process.*
>
> (Gardiner & Richardson-Klavehn, 2000, S. 236)

By now understanding the ecphoric influence of the inner affective state *directing* mnemically progressing ecphory, it would be right to characterize mnemic ecphory (i.e., ecphory in turn influenced by an ecphorized stimulus) as a perceived *controlled* process (recollecting), whereas the early phase of ecphoric excitation of multiple (abstracted, chunked, or direct episodic) engrams must appear as *automatic*. We may therefore differentiate between an automatic and controlled phase of ecphory, reflecting automatic familiarity and controlled recollection. The presumed sensitization effect of perceptual priming must have a counter-part in *ecphoric* priming, which subsumes all non-perceptual priming effects. The distinguishing feature (or, rather, prediction) between perceptual and ecphoric priming is that the former is non-associatively similarity-based, while the latter will affect multiple traces of abstracted, chunked or direct episodic engram strata. Ecphoric priming is therefore here conceived as ecphoric-influence-based *multiple*-trace sensitization. This could be experimentally tested (controlling effects of inner attention directed by ecphoric priming). There is supportive evidence showing […] *that perceptual and semantic kinds of priming occur in different cortical regions* […] (Mayes, 2000, S. 435). Markowitsch points us into a similar direction.[134] Interestingly, there is evidence for context-dependency of a prime's effectiveness. Jeffrey Toth points out that …

> *Another example of context specificity is provided by Oliphant (1983), who showed that words presented as part of the instructions for an implicit test may produce no priming on that test (see also Levy & Kirsner, 1989; MacLeod, 1989).*
>
> (Toth, 2000)

Within the (by now somewhat extended) Semonian memory process framework, there could be a simple explanation for this: not *each* word is effective as a prime, because if the word stimulation *happens* within an ecphorically effective mnemic homophony, predominantly only the momentarily corresponding engram unit (word chunk) ought to be effective as a prime, activating (multiple) chunk-unit-related traces only. This, too, could be tested experimentally. I would further predict that words heading a word-chunk (especially at the beginning of a sentence and if not yet pre-contextualized) are more prone to producing a rather general, single-word-specific priming effect than postpositionally embedded members. Furthermore, as discussed earlier, perceptive-contextual ecphoric influences may hamper ecphory of similar episodes and episodic ingredients if they belong into (i.e., engrammatically associate) another context, because ecphoric influences are supposed to be *holistically* effective, which, in our case, would have less explanatory power, though, because it merely *prefers* contextual engram strata, but does not necessarily *exclude* engram strata out of the current context. *Disturbing* contextual ecphoric influences, however, may well neutralize the sensitization effect established out of context.

This brings us to another major type of priming: negative priming. Negative priming appeared first in the Stroop color naming task, in which the color of a color word (denoting a different color) is to be named quickly. Color naming here takes longer and is error prone (falsely naming the word's

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[134] (2000, S. 469):

> […] *cortical regions surrounding the primary sensory regions, above all the unimodal nonprimary cortices, have been suggested as controlling priming (Nielsen-Bohlman, Ciranni, Shimamura, & Knight, 1997; Ochsner, Chiu, & Schacter, 1994; Seeck et al., 1997). Results from an electrophysiological study suggest the regions involved in priming are even more widespread and may include polymodal areas as well (Zhang, Begleiter, & Projesz, 1997).*

color). The color word interferes with color naming. The color word itself is not a classic prime, though, as it is presented at the same time as the target color to be named. The negative effect, however, is increased when the color to be named is the color word's color in the trial before. It is, of course, not reasonable to assume a habituation effect here. On the contrary, we can assume a normal sensitization effect and normal automatic engram activation. A possible explanation for experimental negative priming is inhibition:

> *Whether a response slowing or speed-up results when the prime distractor becomes the probe target depends on the net effect of excitatory and inhibitory components. When the inhibitory effect exceeds the excitatory effect, response slowing will be found and vice versa. When both effects are equal in size, no priming effect will result.*
>
> (Mayr, 2005, S. 13)

One of the surprising capabilities of humans is quick, deliberate prospective acting. In reaction time experiments, one is asked to react in a certain way to a certain stimulus. If one *intends* to follow the instruction, the stimulus gains a kind of *action valence*. Intention to act during an experiment, however, is not exactly an inborn endogenous stimulus. *Charging* a stimulus-response is an effort, linking the will to participate in the experiment with the prospective stimulus and the prospective action. The test person learns to associate stimulus and action and then sets itself into a state of stimulus expectation and preparedness for action. As a rule, in an experiment, learning to react does not take the form of *unintentional*, (learnt) reflexive reaction. It is, so to speak, not a stimulus-action engram complex automatically/inherently (i.e., not in *controlled* mnemic-ecphoric fashion) crossing the Rubicon from perception to action.

We have already linked chronogenous ecphory in form of prospective thought to endogenous ecphoric stimuli. During an experiment, it seems, intention functions as a sustained ecphoric influence, referencing (engrammatically co-associated with and thus keeping activated) the stimulus-action engram association established during instruction. In reaction time experiments, as experimenters and experienced test subjects know well, the first trials exhibit rather slow reaction times. The jointly ecphorically effective intention and stimulus influences seem to but mnemically ecphorize the associated action engram, resulting in a rather slow reaction. The test subjects will experience this as *conscious* reactions, with stimulus and action perception temporally separated. Within a few trials, however, given *stable* instructions, the reaction time will improve considerably and stimulus and action may be perceived as quasi-simultaneous. The threshold to action-engram activation seems to drop below the mnemic-ecphoric level. Odmar Neumann has characterized this as direct (action) parameter specification.[135] It can be demonstrated by masking the action-associated stimulus by another stimulus associated to a *dissociating*, different- or no-action instruction. Depending on the instructions given, to a test subject, reacting to a masked stimulus without becoming aware of it seems to be a mistaken reaction. The longer the stimulus onset interval between masked and masking stimulus becomes, the higher the *error* rate will be, which seems plausible, as automatic, stimulus-influenced ecphory will have more time to progress. If the test person is instructed to react quickly as well as correctly to the perceived stimulus, it has to suppress its tendency to react automatically to the masked stimulus. Instead of relying on automatic motor-action ecphory, controlled, mnemic motor-action ecphory has to be chosen. In a similar experimental paradigm, Ludwig (Ludwig, 1996), incidentally observed that *misguided* reactions slow down reaction times in the following trials, before, after a few trials, they recover again. It is as if the will to react quickly is at a disadvantage after a mistaken reaction. In the reaction error case, the automatically ecphorized motor action and the perceived stimulus do not match the stimulus-action engram motivated on occasion of the instruction. They form a simultaneous complex, resulting in a novel, non-instructional (contrary) engram association between the stimulus percept engram and the motor action engram. This, however, is not motivated (encouraging automatic motor ecphory/action), but demotivated (inhibiting automatic motor ecphory/action). Subsequent masked (same) stimulus presentations will automatically activate both, the instructional stimulus-motor engram association and the non-instructional engram association, creating an intentionally conflicting automatic engram ecphory increasing the threshold to action. After a number of correct reactions, the *presence* of the intentional ecphoric influence, entertained during the experiment as the want to react quickly, will be strengthened mnemic-ecphorically (i.e., under the impression of correct reactions), while the inhibiting (disliking) ecphoric influence will gradually lose its potency (not be mnemically strengthened, disadvantaging the activation of the corresponding engram association). This creates an opportunity for new mistaken reactions, which, if occurring, would again strengthen the (slower) controlled mnemic-ecphoric reaction type, by reestablishing the dislike of false reactions as an ecphoric influence. The net result of this may well be the effect known as *response priming*, in which the masked stimulus seems to function as an ambiguous prime, having a positive effect on reaction time in case of congruency between masked and masking stimuli, and a negative effect in case of incongruence. This view, however, seems to conceal the dynamics of the memory-process involved. *Negative* ecphoric priming is probably a more complex and dynamic phenomenon then positive ecphoric priming. This also seems to be reflected in the somewhat ambiguous

[135] See, e.g., (Neumann, 1990).

experimental results regarding negative priming in general, as reported by Mayr.[136]

The theoretical explanation presented here could be tested, for example, by tracking the cyclic effect of erroneous reactions in negative priming together with their (to be) assumed specificity introduced by *specific* non-instructional associations in combination with their automatic activation (priming). One would expect a dissociation of the strength of the response prime effect for different instructional responses as a function of the rate of actual corresponding mistaken reactions. Mayr’s own experimental research on *negative* priming supports or, at least, seems to be compatible with our (extended Semonian) interpretation of the somewhat puzzling and thus theoretically challenging set of phenomena related to it:

> *The retrieved prime response might interfere with response selection in that the prime response hampers the selection among response alternatives. This may take time, which would explain a negative priming reaction time effect, but it may also lead to the wrong response selection every so often, which would account for the error effect of negative priming.*
>
> (Mayr, 2005, S. 118)

In this thesis, I do not consider priming to denote a mere *strengthening effect* of *memory retrieval*. Automatic *homophonous* activation of engram complexes and other, *sequential* engram associations from multiple traces by mnemic, perceptive or complex mnemic-perceptive ecphoric influences is an integral sub-process of the main replication/variation memory process. I, therefore, see no reason to expect priming to involve a separate *priming memory*. The popular theoretical practice of inventing memory instances for dissociable memory effects is questionable. It leads to rather problematic statements like the following:

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[136] (Mayr, 2005, S. 13):

> *Excitation was supposed to be a slowly and passively decaying process, whereas inhibition was assumed to be a more labile and strategic component influenced by task demands. Tipper and Cranston (1985) assumed that participants are able to deliberately maintain a selection state when response selection is difficult (such as when the probe display requires selecting between two objects). Inhibition would stay active and prevent fast responding to the suppressed object. On the other hand, when the probe target is easy to select or does not require a selection at all, the selection state is abandoned, and inhibition vanishes quickly. Consequently, only the excitatory component remains and is revealed by facilitated responding as was found in probes without selection requirement.*

> *The next system is the priming system in which the unconscious encoding of information results in a higher and successful recognition rate, even when only some details are presented (cf. word-stem completion tasks).*
>
> (Brand & Markowitsch, 2010, S. 149)

Unconscious encoding of information into a priming (memory) system would either dissociate the priming effects from consciously encoded information (which seems impossible) or it would imply that consciously encoded information is *additionally* encoded *unconsciously* (i.e., in a separate store system). The question then would be why we have to store anything *consciously* at all. This is, by itself, a good question, but it would be difficult to relate it to priming. Sensitization of an existing *neuronal* engram (complex/sequence) due to its signal activation, on the other hand, offers a rather simple, well-researched memory mechanism for the preferential treatment that comes with priming. It would imply, however, that engram activation is a necessary, but not yet a sufficient criterion of mnemic consciousness, as the associatively spreading effect of (ecphoric) priming is not (fully) reflected by conscious associations. Priming would nevertheless represent a form of learning or *encoding* (sensitization), but based on given [sic] engram complexes. This is consistent with long-lasting priming effects:

> *Schacter, and Stark (1982) found very little 'forgetting' in a word-fragment completion task between 1 hour and 7 days after initial presentation of the studied words. These long-lasting priming effects may be regarded as examples of perceptual learning rather than as episodic memory in the usual sense (Jacoby & Dallas, 1981).*
>
> (Brown & Craik, 2000, S. 102)

However, I do not think that *perceptual* learning is, in general, the right term for *priming* learning, for, in principal, any ecphory, be it mnemic, perceptive or (homophonously or non-homophonously) combined, will produce this effect. In a certain sense, though, it is accurate to characterize priming learning as perceptual learning, because unimodal perceptual priming (activation) must be the only or primary learning form of the perceptive-*primitive* (early sensory processing) memory. It is interesting and important also to consider the temporal aspect of priming learning. Schacter summarizes Eric Kandel’s differentiation between short-term and long-term memory as follows:

> *Kandel and colleagues have provided persuasive evidence that Aplysia’s short-term memory is based on an enhanced release of neurotransmitter at the junction of synapse between a neuron that receives the noxious stimulation (a sensory*

> *neuron) and a neuron that is involved in withdrawing the gill (a motor neuron). As a result of stimulation, a chemical messenger travels more easily across the gap that separates one neuron from another. The long-term memory involves a process known as protein-synthesis and appears to be accompanied by the growth of new synapses. They conclude that "on the cellular level the switch from short-term to long-term facilitation is a switch from a process-based memory to a structural-based memory."*
>
> (Schacter, 1996, S. 83)

Adopting these basic forms of neuronal learning for priming learning, one may assume that there is a process-based short-term and a structural-based long-term form of both perceptual priming learning and ecphoric priming learning. One has to ask whether the activation of multiple traces in ecphoric priming would not establish a qualitatively different form of learning than non-ecphoric perceptual priming. I have already mentioned **co-structural (stimuli-engraphic and mnemic-ecphoric-engraphic) *automatic* abstraction.** As abstraction encompasses multiple traces, ecphoric priming is very much a candidate mechanism for *unconscious, automatic* abstraction learning, whereas conscious, *differentiating* abstractions must be mnemic-ecphorically mediated, by engraphy of new simultaneous complexes [Simultankomplexe] into corresponding engram complex/sequence associations. Priming-based abstraction using engraphically [sic] associated (sequenced/complexed) engrams may provide the nuts and bolts needed for chunking. *Chunking* is, on one hand, a form of meta-level engraphy, mediated ecphorically, by homophonously, *chunk-wise* structuring the mnemic-sensory simultaneous complex. *Chunking*, on the other hand, may also denote the (original) forming of a chunk engram, which may well be characterized as a form of prime-based abstraction. As far as I see, in theoretical practice, these two (very) different meanings of chunking tend not to be distinguished, though. Chunking as meta-level ecphory/engraphy is falsely perceived as the chunk-creating act itself. This, however, is only true in the sense that higher-level chunk-*abstractions* are based on inter-chunk-associations engraphically established through homophonous (meta-level) chunking. Homophonous chunking does not only provide the new inter-chunk associations potentially forming novel higher-order chunks, it is also the mechanism turning the chunk-abstraction into an abstraction-enhancing prime. The multiple-traces-based chunk-abstraction uses not to have a direct stimulus-counterpart (because else it would not have needed a *creative abstraction* at all, but just a, so to speak, *summarizing complexing* of an engram stratum). It cannot simply be *directly matched* by an ecphoric influence / ecphoric prime. The ecphory of a chunk-abstraction, meta-level chunking, must be a process of effectively inhibiting lower-level competing priming activation. This is thinkable, for example, by an efficient type of inter-chunk-level inhibition between chunk-abstractions engrammatically overlapping on a lower level. Multi-level abstraction fields would thus effectively prevent an ecphoric-prime activation from otherwise spreading uncontrollably across multiple (rather, countless), historically highly inter-related (episodic) engram strata. Chunked homophonous ecphory appears to function as a mechanism for channeling ecphoric priming. A chunk-abstraction engram is to be seen as a unit of *conscious* structuring; it is an elementary *mnemic* unit. An original stimulus engram is a unit of pre-conscious stimulus excitation and sub- or *lower*-conscious mnemic-ecphoric structuring. Its prime-based activation can be *direct* (bottom-up), by an appropriate stimulus-ecphoric influence, or *indirect* (top-down), by the activation of a hierarchically more or less distant abstraction. A mnemic ecphoric influence will take effect on a mnemically structured associative engram level. A stimulus excitation, however, will always first have to take effect as an ecphoric prime (bottom-up). If it falls into the excitatory region of chunks within the (momentarily activated) simultaneous complex, it is incorporated homophonously, perhaps slightly varying or *deepening* the actual mnemic sensation, without, however, changing its mnemic-ecphoric or mnemic-engraphic structure. If it, on the other hand, falls into the currently inhibited engrammatic region of chunks within the momentary simultaneous complex, it could be fully suppressed, or it is strong enough to provoke a bottom-up ecphorization of a competing chunk, thus inhibiting other mnemically activated engrams, causing a sensory-based (bottom-up) change in the simultaneous complex. If it falls outside of any inhibitory or excitatory engrammatic region of currently active chunk-abstractions, it may well have a bottom-up effect, too, activating a superordinate chunk-abstraction engram that may or may not rise to the sensational level. According to our extended Semonian theory of memory, there ought to be a direct and constant nervous activation chain between the perceptual priming of the sensorial engrams of primitive (early perceptual) memory and the chunk-abstraction layers and multiple episodic traces associating them in varying complexes and sequences. Theoretically, more conventionally speaking, *sensory memory* and (episodically constructed) *long-term memory* are always *directly* interlinked through the mechanism of perceptual (endogenous and exogenous sensorial) priming. Sensorial activation of stacked abstraction-units will depend, first, on a suitable (sensory) stimuli pattern, and, second, on the local inhibitory and excitatory nervous situation exerted by prior ecphory, which we by now may well identify with the (still somewhat enigmatic) creation of a stable, stimulation-independent (chunk-)abstraction- and (chunk-)trace activation.

Changes of comparably stable (compared to mere priming-activation) mnemic sensational or sub-sensational states are normally associated to the mechanism of (outer) attention or the experience of thought, which, in turn, can be associated with concepts such as *psychological situation* (Kurt Lewin), *simultaneous complex* (Richard Semon), and *short-term* or *working* *memory* (Alan Baddeley)[137], or, more generally speaking, *consciousness*. These concepts can be characterized by a pattern span or digit span. Baddeley (Baddeley, 2000, S. 80), for example, describes *a short-term visual memory store that is limited to one pattern, with performance on that pattern being a function of its complexity*. The pattern (complex) or digit (sequence), or, simply, *memory* span is determined by the sensory modality involved, or, in the multimodal case, their particular combinations. George A. Miller famously related it to *the magical number of seven, plus or minus two* chunks[138]. The number, however, is of no concern to us here. A memory-span chunk is not a stimulus- or content-quality, but, as I have suggested, the activation of a chunk-abstraction within a simultaneous complex that is typically created by stimulus-ecphoric and mnemic-ecphoric influences being effective simultaneously. One could argue that the maximal *chunk span* (on any specific abstraction layer) equates memory span, because no chunking trace could exceed memory span. This also limits chunk-abstraction span to memory span minus one (measured in consecutive length in case of chunk-abstractions) or to the integer of memory span divided by two (measured by possible variable gaps in case of abstractions in form of variable schemata)[139]. Consciousness (or working memory or simultaneous complex etc.) indicates an abstract-integrative function, creating engrammatic traces of chunked complexity and sequentiality. Consciousness creates a perceptive-mnemic and a mnemic-associative momentary *meta*-reality for the biological system. While stimulus excitation could only just be said to *represent* stimuli[140], the perceptive-ecphoric and thus engrammatically effective unit

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[137] See, e.g., (Baddeley, 2000).
[138] See (Miller, 1956).
[139] In the latter case, a span of three would put an exception to the rule, as it offers the opportunity of two variables and not just one variable.
[140] Thomas Metzinger (Metzinger, 1999, S. 68) talks about mental presentations:

> *Mentale Präsentate sind spezifische innere Zustände, die die aktuelle Präsenz eines bestimmten Sachverhalts bezüglich der Welt oder des Systems anzeigen.*

Pain is an example that Metzinger uses for a mental presentation, expressing a system state. There are, indeed, very strong endogenous sensations that offer little room for abstraction. Metzinger contrasts these presentations with mental representations referring to mental representations [mentale Repräsentate] and mental simulations, which are mental representations of a contra-factual situation [mentales Repräsentat einer kontrafaktischen Situation]. Consciousness is characterized (Metzinger, 1999, S. 97) as …

> *Die Inhalte phänomenalen Bewußtseins sind Meta-Repräsentate, die für ein System eine Teilmenge der gegenwärtig in ihm aktivierten mentalen Simulate und Präsentate abbilden. Das, was alle bewußten inneren Zuständen miteinander gemein haben, ist die Tatsache, daß sie durch eine einheitliche Metarepräsentationsfunktion erfaßt werden.*

Metzinger (Metzinger, 1999, S. 156) further describes mental self-*simulation* as the mental representation of a contra-factual state of the system as a whole [das mentale Repräsentat eines kontrafaktischen Zustands des Systems als Ganzem]. Metzinger’s ideas about mental models of self could be easily translated into the extended Semonian memory framework, of consciousness and subsequent engrammatic fixation is the chunk-abstraction. Its associative features stem from its integration into multiple engrammatic traces, and its analytical features stem from its abstraction from multiple engrammatic traces.

Synthetically/analytically differing, separate chunk-abstractions can be (seemingly) activated by homomorphous stimulus excitation, as is *intra-individually* demonstrated in homophonous words and phrases. It is less easy to see, how, inter-individually, homomorphous stimuli activate synthetically differing chunk-abstractions, especially if we (again taking words as an example) cannot consider the stimuli to represent homonyms. The representational, communicative-technological effectiveness of the meta-representational system depends largely on the synthetic-analytic correspondence structure between the actuator’s and the substitutor-actuator’s engrammatic structures. *Shared* experiences, inter-individually analogous momentary simultaneous complexes will create comparable memory traces, creating comparable abstractions, creating comparable chunking (interpretation, if you like). Late Wittgensteinian *language games* represent *engrammatically* shared moments and thus create the foundation for shared language-based abstractions etc. Wittgenstein, however, other than Semon, did not develop a coherent theoretical framework demonstrating the cognitive processes involved.

In neuropsychological terms, *working memory* (i.e., the simultaneous complex) can be dissociated from long-term memory (i.e., abstractions and their episodic traces).

> *Neuropsychological Evidence: Amnesic patients such as the classic case HM (Milner, 1966) showed grossly impaired LTM, together with preserved span. Such patients also showed preserved recency, and if intellectually otherwise intact, normal performance on the Peterson Short-Term Forgetting Task (Badeley & Warrington, 1970).*
>
> (Baddeley, 2000, S. 81)

The *grossly impaired LTM* here refers to anterograde amnesia. LTM is actually not impaired, as this would necessarily create *retrograde* amnesia. Anterograde amnesia is characterized by impaired episodic encoding

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interpreting mental presentations as primitive-memory-level integrations and mental representations as chunk-abstractions, with the simultaneous complex as a meta-representational function contra-factually (i.e., mnemically) associating (predicting) inner and outer states into a model of self(-expectation). An integrated Semon-Lewin-Metzinger framework, which I can only hint at in this thesis, would provide a very attractive theoretical framework of the self, knowledge and motivation structures, describing possible ways of artificially extending all three of these aspects in a single replication/variation memory framework.

(engraphy), sometimes suddenly caused by damage to the medial temporal lobe, as indicated in …

> […] *Squire and Alvarez's (1995) hypothesis of medial temporal lobe (MTL) amnesia, which states that fact and episode memories are initially stored in the MTL, but through gradual reorganization storage is transferred for very long-term maintenance to neocortical structures such as the anterolateral temporal cortex.*
>
> (Mayes, 2000, S. 429)

Fact memory could be translated into chunk-abstraction (i.e., in terms of Thomas Metzinger, *representational*) memory structures. Episode memories equal memory traces (of simultaneous complexes). Episodic chunking, however, would rather suggest a reference structure than a separate and independent *initial MTL store*. One would therefore think that …

> *The hippocampal complex* […] *acts as a temporary 'indexer' linking together traces in other cortical areas. Over time, with repeated exposure to and retrieval of information, direct cortico-cortical connections are established that are independent of hippocampal function, a process known as consolidation.*
>
> (Hodges, 2000, S. 451)

This would explain why damage to the neurophysiological structure facilitating engraphy impairs engraphy without impairing ecphory. This is also to some extent supported by the reverse dissociation where …

> […] *patients with damage to temporal neocortical regions, as in semantic dementia, sparing the medial temporal cortex, have the reverse pattern, with better memory for both recent personal experiences and recently encountered or reinforced general knowledge (Graham & Hodges, 1997; Hodges & Graham, 1998; Snowden et al., 1996b).*
>
> (Hodges, 2000, S. 451)

Ecphoric priming learning, the idea of chunk-abstraction through simultaneous activation of multiple episodic traces, does not require new memory traces to be created episodically. It, thus, cannot surprise to learn that

> *There is also accruing evidence that it is possible to acquire some new semantic information in the absence of a functional hippocampal system (Vargha-Khadem et al., 1997; Kitchener, McCarthy, & Hodges, 1998); this slower, and more*

> *limited, form of direct cortical learning probably depends upon multiple stereotyped exposures.*
>
> (Hodges, 2000, S. 451)

Hippocampal learning of chunk-traces contrasts with neocortical learning of chunk-abstractions. In the extended Semonian memory theory, this neocortical memory encoding system is solely based on ecphoric priming learning. Frequent exposure (of adequate stimuli) will gradually build up a direct-associative field demarcating the new chunk-abstraction and thus increase the likelihood of its active mnemic ecphory verifying it as neocortically learnt (e.g. in a completion task). The link between episodic encoding (engraphy) and consciousness is less clear. If subjects have to work on a secondary task while encoding or retrieving lists …

> […] *the finding is that division of attention has a strongly negative effect on later recall and recognition when the secondary task is performed during encoding, but relatively little effect when performed during retrieval (Baddeley, Lewis, Eldridge, & Thomson, 1984; Craik, Govoni, Naveh-Benjamin, & Anderson, 1996; Kellogg, Cocklin, & Bourne, 1982).*
>
> (Brown & Craik, 2000, S. 103)

Undivided, focal attention and, associated therewith, *full* consciousness seem to be pivotal to subsequent episodic encoding, but they do not depend on the encoding system (both, thus, cannot be equated). As the cognitive state of *chunked* consciousness implies a reference to neocortical (engraphic) engrams, the episodic encoding system must hold such a reference, too, but independently, as the impairment of the MTL system does not hamper consciousness. There is a double dissociation between episodic encoding and consciousness in that …

> *In contrast* [to the famous case HM]*, a second class of patient appeared to show the opposite pattern with digit spans of 1 or 2 items, very poor Peterson performance, and little or no recency, coupled with apparently normal LTM (Shallice & Warrington, 1970). This double dissociation strongly supported a separation of LTM and STM.*
>
> (Baddeley, 2000, S. 81)

Well, again, this rather supports dissociation between episodic encoding and consciousness, not between alleged *LTM* and *STM*. What is astonishing is that, on one hand, focal consciousness is clearly needed for episodic encoding, and, on the other hand, it is maintained that a short digit span should not hamper episodic encoding. The limitation of LTM (episodic encoding) to 1 or 2 memory items (which would be *normal* LTM of abnormal

STM, as an abnormal STM cannot reproduce a normal LTM), however, would, in my opinion, rather indicate that the associative span of consciousness is directly reflected in the associative span of episodic memory traces, so that any particular memory trace would reflect a momentary simultaneous complex. This window or span of (chunked) consciousness becomes the window or span of replicative mnemic-associative (-predictive/-simulative) traces. The capacity of consciousness (i.e. of whatever biologically instantiated system behind it) seems to limit the capacity of (factual/perceptive-ecphoric) prediction and (contra-factual/mnemic-ecphoric) simulation[140], both of which are essential to intelligent behavior. However, consciousness has to have a special, focal, attentional quality in order to induce engraphy. Otherwise engraphy remains fragmentary, resulting in short, *low-span* traces, with little overlapping between memory traces and, hence, little opportunity to ordered mnemic ecphorization, decreasing *memory performance*. Outer attention may be paraphrased as fixation of a given stimulus excitation (and its changes). While perceptual priming is obviously very fast, ecphoric priming, on the other hand, has to progress through hierarchical layers of abstractions, top-down activating inactive missing components and inhibiting disturbing lower-level components that are activated bottom-up. This seems necessary so that perceptual priming can turn perception into a *predictive* mode, in which activation spreads along multiple chunk-related memory traces. Outwardly attending (often involving motor activity) creates the stimulus excitation stability needed for chunking a strongly stimulus-influenced simultaneous complex and for any predictive priming and perceptive ecphory. Inwardly attending creates the sensation excitation stability needed for mnemic-simulative and intentional ecphory. [141] Sudden attention shifts, *masking* a given stimulus/sensation (activation), will prevent activation from reaching higher levels of abstraction and multiple related engram traces. This conception of attention-based stimulus persistency and its effect on priming-activation and ecphory is, in general, in agreement with the *levels of processing approach* of Fergus Craik and Robert Lockhart:

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[141] Otto Selz (Selz, 1924, S. 11) rightly stated:

> *Eine der wichtigsten Lösungsmethoden der reproduktiven (gedächtnismäßigen) Aufgabelösung ist die intellektuelle Operation des B e s i n n e n s.*

Otto Selz believed that knowledge complexes (which are similar to Semon's simultaneous complexes and ecphorized memory traces are awakened by bethinking [durch Besinnen erweckter Wissenskomplex].

> *Craik & Lockhart (1972) proposed that incoming stimuli were processed to different levels, or depths, within the cognitive system, from 'shallow' or sensory levels to 'deep' or meaningful levels of analysis*.
>
> (Brown & Craik, 2000, S. 94)

Meaningful, here, however, may be misleading, as it seems to reduce the chunk-abstraction hierarchy to language-semantic relations. There are, however, also *conceptual* (often unimodal) abstraction hierarchies, and non-successive (non-chunk-type) abstractions, resembling syntax schemata, but not limited to them; abstractions, thus, that Roger Schank would label (higher-level) *scripts* or (lower-level) scriptlets[142].

> *The lower, shallow levels of processing may be driven predominantly by perceptual inputs (bottom-up or data-driven processing) and the higher (deeper) levels driven either by the same perceptual inputs, or activated 'top-down' by expectations and intentions (Norman, 1968)*.
>
> (Brown & Craik, 2000, S. 94)

One might want to comment here that limiting top-down processing to expectation and intention misses the point of *expectations* and *intentions* both being *incorporated* into memory traces engrammatically, and of *intentions* playing an endogenous-sensory and engrammatic-ecphoric double role, which I have already discussed in its memory-process dynamics when delving into motivation.

> *A further difference between sensory and conceptual codes is that sensory codes are likely to be reused in many different combinations, just as the 26 letters of the alphabet are recombined to form many different unique words; conceptual*

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[142] Roger Schank (Schank, 1999, S. 129) distinguishes these two terms as follows:

> *The problem with the old conception of scripts was that too much of what could be defined generally, and of what is likely to be stored in a general fashion in memory, was defined specifically as a part of a particular scriptlet. When one takes away from $AIRPLANE everything that could have been defined generally, only things specific to $AIRPLANE* […] *are left. These are what I now call scriptlets.*

Even though scripts or scriptlets, if reflected upon and labeled, appear as sequences of elements or consecutive memory traces, their origin is best be thought of as one of abstraction across multiple similar memory traces, whether implicitly (via joint priming) or consciously (perceptive- or mnemic-ecphorically). *Script(let)s* are variable abstraction schemata, organized more or less hierarchically. They form, so to speak, the syntax of thinking and acting.

> *codes, on the other hand, are more usually specific differentiable (Moscovitch & Craik, 1976).*
>
> (Brown & Craik, 2000, S. 94)

Sensory codes can be equated to original stimulus engrams, that is, to use the respective term of Thomas Metzinger, mental presentations [mentale Präsentate]. An important question is, in how far higher-level abstractions do indeed *reuse* (refer to) sensory codes/mental presentations. According to the extended Semonian model guiding us here, one would expect higher-level abstractions (abstract *re*presentations) not to refer directly to lower-level sensory presentations (original or non-ecphorically integrative stimulus engrams). They seem to exert a strong influence on ecphory (providing, for example, the syntax of thought and action) without, however, having the conscious imprint of sensory stimuli. The course of thinking (and acting), as it was first researched by the Würzburg School (of psychology of thinking) under Oswald Külpe and further elaborated by the ingenious Otto Selz, is clearly dominated by schematic anticipation [schematische Antizipation], and not by *direct* associations between rather elementary mental presentations, as was a long-held belief of psychological associationism.[143] The simultaneous complex, as we have noted before, is increasingly *chunked*. New memory traces are mostly constituted by chunk-abstractions. The depth of processing is not just a *vertical* depth of *meaningful analysis* (or synthesis, respectively), but also a horizontal depth of schematically productive and associatively reproductive priming and ecphory, which is not sufficiently characterized by cognitive processing *'top-down' by expectations and intentions*. The subsequent

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[143] Otto Selz (1924, S. 12), with respect to reproductive thinking / task solving, states:

> *Das Aufgabebewußtsein verhält sich also zu dem zu aktualisierenden Wissenskomplex wie das Schema eines Komplexes zu dem vollständigen Komplex, und der Vorgang des Besinnens, welcher den Wissenskomplex wieder ins Bewußtsein hebt, stellt sich als Unterfall einer i n t e l l e k t u e l l e n O p e r a t i o n d e r K o m p l e x e r g ä n z u n g dar.*

The intellectual operation of complex completion is similar to Semon's mnemic ecphory (using a variable abstracted schema). This similarity (amongst others) allows an easy entanglement of both theories, and it stresses the congenial theoretical achievements of Semon and Selz. Otto Selz relates the (top-down-effective) complex completion to a reflex-like reaction [reflexoide Zuordnung], offering a surprisingly stable scaffolding for memory reproduction, especially as compared to the alleged diffuse reproductive tendencies of associationistic theory. Selz (1924, S. 13) then, ingeniously, places the diffuse reproductive tendencies into another, namely bottom-up-effective (pre- and sub-ecphoric, so to speak) realm:

> *Im Rahmen der konkurrierenden aufgabengemäßen Prozesse gelten dann allerdings jene Gesetzmäßigkeiten, welche die klassische Assoziationspsychologie durch ihre Theorie der diffusen Reproduktionen zu erklären suchte.*

assumption that *the more deeply or meaningfully the information is processed, the more well retained the information will be*[144], therefore, seems to be an inappropriate generalization, as engraphy is linked to engrammatically effective simultaneous complexes, which do not have to reflect any of *the information* at all, even if some experimental settings aim to create favorable conditions. However, while we ought to reject its general prediction concerning retention, we, nonetheless, ought to approve that the *levels-of-processing (LOP) view* […] *emphasizes the role of mental operations in memory, particularly encoding processes*[144], as it is pivotal to understand that there is nothing like an automatic or direct translation of information into (episodic) memory traces. Chunking likely creates a situation of mnemic-ecphoric association (associative remembrance). Stimulus information and memory information are joined to form individual memory traces. The engraphically effective part is the mnemic-perceptive simultaneous complex.

Chunking and mnemic-associative ecphory do not always need bethinking [Besinnung] in order to come to being. Expert perception and expert behavior do differ markedly from novice perception and novice behavior. There is a kind of experience-based acceleration and automation of perception and action. Otto Selz (1924), for example, describes how through trying-out behavior (many trials) [Probierbewegungen], after some time, it is no longer necessary (and not even advisable) to bethink the means of achieving a specific action goal. The numerous episodes of actions leading to the goal state wanted are abstracted in a way that they directly link the given (problem) state to the desired goal state. The expert simply has to focus on the goal, while the intermediate action steps (the problem solving method) will be performed (ecphorized) automatically [*automatische Lösungsmethode*]. The automatic ecphorization of problem solving methods/actions remains subsensational and, therefore, will no longer be engraphically effective anymore. This permits more other perceptive and ecphoric influences to enter the simultaneous complex, potentially forming new (more) complex memory constellations and traces, coordinating actions on higher abstraction levels. Goal-directed schematic anticipation gradually transforms into an abstracting compression of chains of ordered thinking and/or actions. Ideally, this compression increases the scope of information that can be successfully chunked. Learnt specific automatic reactions resemble inherited automatic reflexes, but are fundamentally different with regard to their ontogenetic or memory development. Different types of conceptual compression (sub-types of conceptual blending mentioned by Fauconnier[145], such as cause-effect compression, metonymic compressions, and compression of disanalogy into change) play a crucial role in thinking.

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[144] (Brown & Craik, 2000, S. 94)
[145] See (Fauconnier & Turner, 2002).

During his emigration years in the Netherlands, Otto Selz influenced the chess psychologist Adrian D. de Groot, who, on one hand, influenced Allen Newell and Herbert Simon, two important pioneers of artificial intelligence, and, on the other hand, inspired research on expert knowledge and expert intuition. One of the latest theoretical approaches stems from Fernand Gobet: the two-stage process of expertise acquisition. In an extensive review of experimental research, Guida et al. propose …

> […] *that, in terms of brain activation, expertise acquisition in WM-related tasks is a two-stage process that starts with a decrease in activity and ends with functional brain reorganization.*
>
> (Guida, Gobet, Tardieu, & Nicolas, 2012, S. 42)

With practice, *the elements that have been bound gradually begin to stabilize in LTM, first as chunks and then as high hierarchical chunks: knowledge structures.* [146] This is described as *a profound cognitive modification that occurs only at a late phase of expertise acquisition.*[147] Cognitive *templates* and *retrieval structures* are said to be *highly hierarchical structures that can incorporate chunks. They constitute a phase of expertise that is superior to the use of simple chunks.*[148] Guida et al. remark that *no functional reorganization has been observed in less than 5 weeks.*[149] They claim that *chunking theory offers a good explanation of the decrease in activation in WM-related tasks*[149], because …

> […] *if one can represent the same amount of information in WM with larger chunks, then the number of chunks (or the percentage of chunks) in WM necessary to represent this amount of information decreases. This could easily explain why the brain activity in WM regions decreases.*
>
> (Guida, Gobet, Tardieu, & Nicolas, 2012, S. 46)

With expertise, however, …

> […] *the involvement of LTM occurs in two ways: (a) in terms of semantic memory knowledge used to encode the incoming information, and (b) in terms of transfer of the incoming information into episodic memory.* […] *the incoming information can be rapidly linked to knowledge structures, either retrieval structures or templates.* […] *experts only need to activate the knowledge structures that have been*

[146] (Guida, Gobet, Tardieu, & Nicolas, 2012, S. 57)
[147] (Guida, Gobet, Tardieu, & Nicolas, 2012, S. 43)
[148] (Guida, Gobet, Tardieu, & Nicolas, 2012, S. 45)
[149] (Guida, Gobet, Tardieu, & Nicolas, 2012, S. 46)

> *associated (via cues or slots depending on the theory) with the incoming information to form an episode.*
>
> (Guida, Gobet, Tardieu, & Nicolas, 2012, S. 54f)

Now, it is very clear that this up to date two-stage theory, which is broadly backed by experimental findings, is very similar to and well compatible with the extended Semonian theory of memory, as applied by us upon the Selzian theory of specific reactions [Theorie der spezifischen Reaktionen] before. The Selzian theory (of productive and reproductive thinking), however, has an interesting additional aspect (missing in the two-stage theory). It describes two opposing ways of abstracting (means/methods to solve a problem): reproductive (means) abstraction [reproduktive Mittelabstraktion] and accidental (means) abstraction [zufallsbedingte Mittelabstraktion]. So far, in our discussions, abstraction has been based on structural similarities or overlapping of memory traces, present in stimulus situations promoting abstractions. Otto Selz, though, considered abstraction in the context of experimental tasks. A question to be answered (often two words to be interlinked by a third word, e.g. a shared top-category) is an anticipation schema with a missing (variable) element. If the answer is known, the variable (means) is reproduced by actualization [*Mittelaktualisierung*], or, in our words, it is ecphorized. Abstraction, on the other hand, means abstracting the missing link from an existing *similar* memory trace. If this is possible in a reproductive manner (i.e., by ecphory), it is called reproductive abstraction; if it is not possible on the given engrammatic basis, but happens on occasion of an accidental new experience, it is called accidental abstraction.

> *Infolge der starken und langdauernden Nachwirkung ernsthafter Problemstellungen können bei der zufallsbedingten Mittelabstraktion, wahrscheinlich aber auch bei der reproduktiven Mittelabstraktion die Einfälle in einem Augenblick auftreten, in dem wir gar nicht mehr an das Problem dachten. Hierdurch wird der von genialen Persönlichkeiten oft berichtete gänzlich passive, eingebungsartige Charakter mancher Einfälle verständlich. Die Vorgänge der 'Inspiration' finden hier teilweise Erklärung.*
>
> (Selz, 1924, S. 27)

Selz wants to show that …

> […] *gerade die konstanten gesetzmäßigen Zuordnungen der geistigen Operationen und die Wiederkehr der gleichen Auslösungsbedingungen die Voraussetzung der Entwicklung, der Entstehung neuer Operationen und neuer geistiger Produkte*

> *bilden. So entstehen durch die konstanten, gesetzmäßigen Zuordnungen der allgemeinen Operationen der Mittelabstraktion und der Mittelaktualisierung zu bestimmten Auslösungsbedingungen die neuen speziellen Lösungsmethoden und neuen Geistesprodukte, welche die Träger der geistigen Entwicklung sind.*
>
> (Selz, 1924, S. 30)

Selz clearly saw the (memory) variation mechanisms given by different (means) abstractions (which, in a very general sense, could also be named *conceptual blendings*). **Selz, furthermore, clearly distinguishes two epistemic pathways to memory variation**, the solution-ecphoric, given a sensational (not yet engrammatic) *task* complex, and the task-ecphoric, given a sensational *solution* complex:

> […] *denn dieselbe doppelte Entstehungsmöglichkeit der Zuordnung von Ziel und Mittel ist überall gegeben, wo die Beobachtung von Naturvorgängen die Entdeckung von Lösungsmethoden auf dem Gebiete der Wissenschaft und Technik oder die Beobachtung ästhetischer Wirkungen die Entdeckung künstlerischer Ausdrucksmittel herbeiführt. Immer kann entweder eine gegenwärtige Problemstellung zur reproduktiven Verwertung f r ü h e r e r Beobachtungen als Lösungsmittel oder umgekehrt eine gegenwärtige Beobachtung zur Entdeckung der Lösung eines früher gestellten Problems führen.*
>
> (Selz, 1924, S. 23)

The schematic-incomplete task complex *determines* (motivates) thinking (*abstractive* mnemic ecphory). The later, non-schematic *solution* complex, however, is being *determined* (motivated) by the ecphorized, i.e. by then already engrammatic, task complex. This is different from the before-mentioned *chronogenous* ecphory by endogenous stimuli. Solution-based task-ecphory, it seems to me, is a considerable achievement of the memory process. It underpins its ability to reinstate a former, non-completed anticipation schema if the right conditions for means abstraction (from experience) are met. One could describe task-ecphory as the capacity of the memory system to first form an incomplete (question-like) schema, keep it by means of engraphy, and later instantiate it, on the occasion of an experience matching and completing the schema. Creative thinking, in part, becomes a matter of asynchronous outer stimulation, where the wealth of individual knowledge (engrams) does not suffice for a task solution. There is, hence, a growth of knowledge caused by perception, where the knowledge created is not *inherent* in the stimuli. It is constructed in a task-ecphoric manner as a mnemic-perceptual simultaneous complex [Simultankomplex aus mnemischen und sinnesreizgebundenen Empfindungen]. The characteristic of inspiration [sinnesreizgebundener Einfall] to *take over* can be interpreted as attention abruptly switching from outer stimuli to a mnemic schema being completed by perceptive-ecphoric sensations in the simultaneous complex. Whether a text (or any piece of language-artifact) is an *inspiration* (and not only generally informative) to the reader or listener, does not so much depend on the text's content (signs), but on its matching with the individual's incomplete, motivated task schemata. The more curiosity we have, the more questions we will ask. The more questions we ask, the more inspiration we will find. The more we know about the questions of others, the easier it will be to be inspiring. The more knowledge we have about the questions and the knowledge of people, the easier it will be to inspire people by matching their questions to the knowledge of others. Questions here are not restricted to questions as in *question sentences*. In a way, any form of motivated thought and engrammatic schema is an incomplete, solution-ecphoric or task-ecphoric *question*. Otto Selz imagined schematic anticipation without *means actualization* [Mittelaktualisierung] to be an incomplete schema in need of *means abstraction* [Mittelabstraktion], but he also saw the possibility of goal abstraction [150] and of means creation by trying-out behavior [Probierbewegungen]. Selz thus introduced the productive mechanisms (i.e., memory variation mechanisms) of, first, situation-variant direct ecphory (actualization), second, abstracting ecphory (abstraction), and, third, mnemic-associative or attention-based variation of (mnemic-ecphorically effective) thought and (rather perceptive-ecphorically effective) action (probing, trying-out). Ill-defined or over-constrained problem representations and solution representations may all impede problem solving. The basic memory variation mechanisms at work in overcoming insufficient problem representations and solution representations, however, are the same: ecphory, abstraction, and probing. A technological system supporting memory variation will have to address these mechanisms.

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[150] (Selz, 1924, S. 28):

> *Durch die Herbeiführung wertvoller Wirkungen kann der Zufall nicht nur der Entdeckung von Lösungsmethoden dienen, sondern er kann auch erst die Zielsetzung selbst herbeiführen, indem sich nachträglich eine Determination auf die willkürliche Herstellung des ursprünglich unbeabsichtigt eingetretenen wertvollen Erfolges richtet.*

3.2.2.4 Simultaneous Complex

So far, we have dealt with the dynamics of engraphy and ecphory, including effects of positive and negative priming, of chunk-abstraction (hierarchies or knowledge and retrieval structures) and of chunking (of stimulus excitation). And we have taken schematic anticipation into consideration, with means-actualization and synchronous (task-ecphoric) and asynchronous (solution-ecphoric) means-abstraction. We did not really focus on the dynamics within the mnemic-perceptual simultaneous complex, though. How is the conscious/sensational flow controlled? Sensory stimuli, if activating chunk-abstraction engrams, create a wider, dynamically extending perceptual-mnemic activation field, as do mnemic-ecphoric stimuli. There are, as basic types of sensational, episodically/engraphically-effective changes (in a first approximation) …

1. Endogenous and exogenous, bottom-up stimulus-ecphoric influences resulting in sudden conscious change **(change within stimulus focus)**
2. Endogenous and exogenous, salient bottom-up stimulus-ecphoric influences provoking stimulus shifting motor action **(change of stimulus focus)**
3. Complex, stimulus- AND mnemic-ecphoric influences, ecphorizing matching (homogenous) engram complexes / engram traces bottom-up AND top-down **(mnemic-perceptive chunking)**
4. Mnemic-associative, top-down or *lateral* influences, ecphorizing from engram strata (episodically) related to current mnemic sensations **(mnemic-associative interstitial)**
5. Reproductive, top-down mnemic-schematic (incl. reproductive language-syntactic) influences directly ecphorizing (the Selzian *actualizing*) for completion of schematically-bound sensations from an existing engram trace **(schematic-reproductive completion)**
6. Productive, top-down mnemic-schematic (incl. productive language-syntactic) influences ecphorizing (the Selzian *abstracting*, Fauconnier's blending) for completion of schematically-bound sensations from a similar engram trace **(schematic-productive completion)**
7. Co-reproductive complex ecphorization of, for example, a morpheme-concept (here meaning that a morpheme-chunk-activation *triggers* a morpheme-concept complex/chunk-abstraction ecphorization); other common co-reproductions are logogram-morpheme, logogram-morpheme-concept [151] , logogram-concept, concept-logogram, concept-morpheme-logogram, logogram-action, action-logogram, morpheme-action, concept-action etc. The trigger-chunk and co-reproductive complex will normally be activated within mnemic-perceptive chunking. This mnemic coproduction differs from mnemic-associative reproductions by the mechanism of *triggering* a (mostly multi-modal) complex chunk-

[151] *Concept* here means just any other chunk-abstraction component than the specified ones (i.e., others than graphemes, morphemes, actions).

abstraction. The abstraction of the complex chunk from associative chunk traces marks the transition from mnemic-associative ecphory to (sub-mnemic) *triggered*, co-reproductive ecphory. **(triggered co-reproduction)**

As we have already discussed (1)-(6)., we will focus for a moment on (7) (triggered co-reproduction). Co-reproductive complex chunks differ from stimulus integration or unimodal chunks in that a (usually) multimodal chunk-complex cannot be integrated into a single sensation of Gestalt-quality (and an alleged neurophysiological equivalent). Unimodal ecphoric influences of co-reproductive complexes therefore tend to affect the modality-specific complex-component only. This component, however, is normally ecphorized in its co-reproductive complex. A word has no meaning associated; it is rather a meaningful or semantic unit. A homophone of this word is just another meaningful unit sharing the same phonemic chunk-component. Ecphorizing the morpheme only (which is absolutely possible) and then *associating* its meaning would be a misleading characterization of the process occurring, because, as a rule, no *meaning* is (mnemically) *associated* in such a case. One rather shifts from the (mnemic) morpheme chunk to a complex unit *triggered* by it, as the morpheme turns into an integral complex-component, mnemically overshadowed by the holistic complex. - The original chunk-abstraction of the complex from episodic traces is also better not to be dubbed an *association* (of meaning), as the only associations given are episodic ones, resulting in original associative engram traces. These, however, are hardly what uses to be said to be *associated meaning*. The nature of the co-reproductive complex implies that the meaning of a meaningful unit is best characterized as the multiple episodic traces it forms with other chunks (outer engrammatic-associative meaning) and, additionally, the multiple episodic traces that its individual (multimodal) components form when they are (mnemically) not part and parcel of a meaningful unit or the changes are non-engraphic (i.e., for example, induced by stimulus integration). The latter would be the case, for example, when logogram variations of font types are learnt, or when we get to know the happy- and angry-face variations of a person. The sign-property of a meaningful-unit is mnemically non-associative. That, for example, a concept is said to be indicated by a morpheme, has its reason, likely, in the common role of the morpheme being the trigger of the *meaningful* chunk. The concept could as well trigger the morpheme and thus function as its symbol. *Homogenous* trigger-components (components that are also part of other meaningful units) are frequently found (same logograms, morphemes, gestures, etc.). Ecphoric influences have to affect multiple components to avoid more or less *randomly* triggering partially homogenous co-reproductive chunk-units. The sign-character is not a static property of any component. A *sign-effect* exists only during ecphory, through ecphoric influences activating a specific, triggering co-reproductive component. If a co-reproductive unit is ecphorized by multiple ecphoric influences, affecting several or all components of a co-reproductive complex chunk, there will be either a variable sign constellation or no specific sign at all (as the meaningful chunk is ecphorized as a whole). Mnemic ecphoric influences are as effective in co-reproductive chunk ecphorization as is stimulus excitation. This memory-process-oriented theoretical treatment of the sign (relation) has, of course, far-reaching theoretical consequences for semiotics. Consequences we have to leave aside in this thesis, though. We are, for now, interested in the effects of co-reproduction on the simultaneous complex. The co-structural artificial memory system of natural language seems to be somehow based on the co-episodic engraphy of co-reproductive chunk-components in the simultaneous complex. In our dealings with semantic networks, we differentiated between word association and concept association. The co-reproductive integration of word and concept combines word association and concept association into a single *semantic* association. The ecphoric influences effective in the simultaneous complex, however, do not only evoke co-reproductive chunks. If component-types are not (yet) co-reproductive (say different transitional face movements between laughing and being serious again, which we know well but have no words for), there will soon be new co-reproductive chunk-abstractions to be won from episodic engrams integrating varying co-reproductive chunks by blending in new/additional conceptual chunks from different *mixed* engram traces. The result is polysemy. The word field is, to some extent, automatically organized by experience in that it creates polysemous variations chunking and further integrating (via chunk-abstraction) the simultaneous complex. The frequent polysemous variations of word-constituents in word compound meanings as well as frequent peculiar, not purely combinational compound meanings, too, indicate how co-reproductive concept-perceptual episodes and their specifics are further chunk-abstracted integrating non-co-reproductive contextual information. The co-structural fabric [Gewirk] of language is thus highly polysemous on different levels of co-reproductive word and concept integration. The co-reproductive specificity of individual language-*signs* (words, short phrases, etc.) is rather low. There is thus a good chance of misunderstanding in communication based on (short) language triggers (only). Co-reproductive chunking by conceptual triggers will create new co-reproductive episodes potentially accessible by corresponding language triggers. Co-reproductive chunking by language triggers will create new co-reproductive episodes accessible by corresponding conceptual triggers. Episodes of co-reproductive units thus create (mostly modality-specific) *trigger fields*. Language-based trigger fields, however, tend to be ambiguous (due to polysemy and homonymy), as I have shown. Very specific mnemic conceptual triggering or conceptual mnemic ecphorization (if the memory trace was not formed co-reproductively), on the other hand, can be highly effective. Bower reports that …

> *Paivio [Allan Paivio] found that the imagery-arousing value of a word was the most potent determinant of its rate of learning* […] *Pavio found that pictures of common concrete objects (or presentation of the objects themselves) were even more effective items for learning that were their names.*
>
> (Bower, 2000, S. 25)

This, certainly, cannot astonish us anymore. It is also right that inner verbalization [Versprachlichung] can be contra-reproductive. Intentionally creating a co-reproductive field (by sententially describing) stimulates often more general (somewhat homophonous) co-reproductive chunks with productive and reproductive tendencies of their own. This will result in a description comprising successions of conceptual components, which are likely to differ from the original conceptual episode. This may be less obvious to the person describing, as her simultaneous complex may mnemically still include and re-encode (only co-reproductively enriched) the original conceptual episode. If, however, artifacts of the graphemic or morphemic components of the complex would function as triggers of co-reproductive ecphory, it is likely that (knowingly or unknowingly), the higher-order chunk-abstractive character will trigger (intra-individually and inter-individually) more general (prototypical) or even false co-reproductive chunks (in terms of their conceptual components). One could characterize this as construction, which is different from the Selzian production and reproduction. Sir Frederic Charles Bartlett famously demonstrated a similar type of generalization[152], by adding small illogical propositions into a story text that had to be retold. These absurdities were probably not even engramatized, as the respective co-reproductive chunks of the simultaneous complex will have mnemically ecphorized similar, but probably more sound conceptual engram traces, the later retelling (rather description) of which may appear as *changing* the story. *Re*construction (of a story, which normally consists of multiple episodes) works differently. Abrupt content changes are difficult to retell in the correct order because of the lack of engrammatic overlapping between the respective episodic engram traces. The episodic memory trace of a simultaneous complex is limited to the present moment [Jetztzeit or Gegenwartsfenster][153]. A story's event order may considerably differ from the event order of the retold story, especially if the memory traces do not

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[152] See his book: Remembering (Cambridge University Press, Cambridge, 1932).

[153] Thomas Metzinger (2009, S. 61) writes about Jetztzeit (the consciously present moment):

> *Übrigens gibt es auch eine Obergrenze für das, was wir bewusst als innerhalb eines einzigen Augenblicks stattfindend erleben können: Es ist fast unmöglich, ein musikalisches Motiv, den rhythmischen Teil einer längeren Gedichtspassage oder einen komplizierteren Gedanken, der mehr als drei Sekunden dauert, als eine einheitliche zeitliche Gestalt zu erleben.*

overlap or not overlap in a mnemic-distinctive way (and are thus not mnemically associable). This demonstrates (mnemically *random*) reconstruction rather than (original engraphic) construction. Now, the retelling is engraphically effective itself. A seemingly random mnemic reconstruction has to be based on (*randomly, non-reproductively*) suitable mnemic-ecphoric influences, binding the story episodes anew. Some mnemic-ecphorically accessible extraneous engram traces (*fictitious* engram traces, so to say) will probably be inserted into the reconstruction. Some original traces, on the other hand, will not be re-membered into the reconstruction. The engrammatic reconstructed version, in any case, will be more likely to be ecphorized in its *correct* order (that is, in its mnemically salient reconstructed, but originally *false* order) than the original story, which still has a less overlapping original order of memory traces than the reconstruction. Neisser notes:

> *Frederic Bartlett (1932) criticized standard research methods in memory as irrelevant to human life.*
>
> (Neisser & Libby, 2000, S. 315)

I hope that I managed to demonstrate that the extended Semonian memory theory is fit to incorporate findings from the ecological study of memory (as well as from classical experimental memory research). High-granularity memory *distortion* appears to be the result of constructive (chunking) processes, while low-granularity memory destruction appears to be the result of reconstructive (mnemic-associative) processes.

We have already explained word-associations and concept associations, and all other (more complex) semantic-association types can be easily described in terms of the memory mechanisms responsible for changes in the simultaneous complex. I finally want to turn the reader’s attention to the question of how we position ourselves with respect to the memory dichotomy of episodic and semantic memory as popularized by Endel Tulving. Both seem to be integral to the simultaneous mnemic-perceptive excitation and sensation complex (simultaneous complex) [simultan mnemisch-perzeptiver Erregungs- und Empfindungskomplex]. Mandler had his doubts about this dichotomy:

> […] *it is questionable whether these two kinds of memories represent different systems with different rules or laws governing their operation. At the simplest level, episodic memories draw on semantic knowledge (a point that is not disputed). But semantic memories also have personal, episodic characteristics.*
>
> (Mandler, 2007, S. 239)

Co-reproductive chunking will create more or less chunked episodes (memory traces), which will serve as raw material for further co-reproductive chunk-abstractions or polysemous variations and become part of the associative engram field activated during priming and perceptive or mnemic ecphory. Co-reproductive chunk-abstractions are often word-chunk abstractions (forming of word compounds), which potentially increases engraphic efficiency. Variations of polysemy are, as we have seen, variations through a kind of *one-sided* assimilation or blending of not yet (fully) co-reproductive components, potentially resulting in (overall) ambiguous conditions for triggering. It seems more appropriate to speak of chunks and episodes of co-reproductive chunks than to speak of semantic and episodic memory as distinct forms of knowledge. Both engram types are highly interrelated: co-reproductive, cross-modally integrated (engrammatically instantiated) engrams are episodically associated in memory traces. Semantic knowledge is as episodic as episodic knowledge is semantic. Co-reproductivity alone does not define semantic *knowledge*, which consists in mnemic-associatively or perceptive-ecphorically *chunking* of or into a simultaneous complex. Only the *creation* of episodes is a reasonably dissociable mechanism. An important weak-point of co-reproductive chunks is that they do not form sound hierarchies on any specific trigger-level (e.g. phonemes, graphemes, logograms, morphemes, word-chunks, but also all other concepts), especially because of different mechanisms leading to trigger-ambiguities of polysemy, homonymy, and synonymy. **The co-structural artificial memory provided by language-trigger components in co-reproductive chunks is, therefore, as difficult to express unambiguously in language symbols, as it is to reconstruct it by language symbols. There is, a fundamental *flaw* in the working of the (co-reproductive) *language* system**, if you will. It does not only concern memory research, it is not even merely a matter of written language (and only somewhat mitigated by conversation). It is a fundamental problem of the memory process and of memory structure. It is, as I have shown, **a constant epistemic challenge**, present in mnemic (reconstructive) as well as perceptive (constructive) information. Co-reproductive (multi-modal) units or *trigger* structures are the main episodic building blocks of human *knowledge*, whether in *simple* motivational structures (linking intention-sensation engrams to other-modality concepts) or in *advanced* complex symbolic language structures. The eusocial and, more generally, any technological process depends on our capacity to co-reproductively create *homophonous* simultaneous complexes and, based on this, effective technological anticipation schemata. The correspondence structure is thus a property of mnemically, schematic-anticipatorily associated co-reproductively chunked simultaneous complexes, (which ought to be and schematically even need to be often *tested* by stimulus-ecphoric influences). That it does not suffice to create only a highly abstracted type of (*constructive*) homophony, is explained, first, by the double-technological character of communication, where symbols (output/input parameters) have to function as *working* triggers to keep the (social) technological process alive and as intended. And, second, in non-cognitively mediated natural substitution processes (i.e., with substitutors not being substitutor-actuators), the output parameters (expressions/actions) still have to generate or influence the schematically anticipated effects and thus have to be well-adjusted, that is, they have to be in accordance with a supposed *stimulus world*. Co-reproductive unambiguity thus translates into technological correspondence. In the following chapter, based on the basic technology- and memory-theoretical ideas synthesized so far, I am going to introduce and sketch an innovative theoretical and (software-)experimental approach (that awaits further theoretical discussion and further experimental elaboration): extended artificial memory.

4. Extended Artificial Memory Theory

4.1 Extended Mind

In a number of articles and books {e.g. (Clark & Chalmers, 1998), (Clark, 2003), (Clark, 2008) }, the philosopher Andy Clark has entertained the idea of *extended cognition* and *extended mind*:

> *If, as we confront some task, a part of the world functions as a process which, were it to go on in the head, we would have no hesitation in accepting as part of the cognitive process, then that part of the world is (for that time) part of the cognitive process.*
>
> (Clark & Chalmers, The Extended Mind, 1998)

This argument has faced vehement opposition, for example by Robert D. Rupert, who argues against the *extended view*:

> *Argument from Demarcation: The systems-based principle of demarcation provides the only plausible criterion of demarcation in the field [cognitive sciences]. The systems-based principle places human cognition inside the organism, either entirely or in the main. Therefore, we should, provisionally, reject the extended view.*
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> (Rupert, 2010, S. 45)

Rupert instead proposes an *embedded view*:

> *An alternative to the extended view takes human cognition to rely heavily on the environment but, nevertheless, to be bounded by the human organism. According to this embedded view, typical cognitive processes depend, in surprising and complex ways, on the organism's use of external resources (McClamrock 1995, especially part two), but cognition does not literally extend into the environment.*
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> (Rupert, 2010, S. 5)

I fully support Rupert in that *a state is cognitive if and only if it is a state of whatever makes up the organismically bounded system.*[154] In the technological process, the substitution process is, to some extent, reflected and anticipated in the (cognitive) actuation process, but seems organismically separated. With regard to eusocial technology processes, however, the human substitutor establishes the substitution process in a cognitive process, too. In so far, from a social perspective, cognition

[154] (Rupert, 2010, S. 46)

could indeed be said to be *extendable* (namely into distributed cognition). The schematic-anticipatory control and activation structures of actuation are not any different in cases of non-cognitive substitution processes. The input parameters are signal-like or symbolic perceptive-ecphoric influences triggering co-reproductive chunk-abstractions, resulting in more or less homophonous or corresponding simultaneous complexes (information stages of actuation). From the actuator's perspective, in a technological process, there is no fundamental difference between *extending* cognition socially and not *extending* it. To the actuator, any close technological correspondence will *act* like an extension. To understand this, we have to consider the nature of co-reproductive chunk-complexes. They integrate whatever (endogenous or exogenous stimulus) sensations happen to exist in the simultaneous complex. The natural integrity of the cognitive system and the body creates a phenomenal/mental self-model that includes, by and by, the exogenous (esp. visual) sensations [155] of the body (and its artificial *extensions*). Basic body movements, for example, are normally not any longer understood as the technological processes they indeed represent. They do not show the variability of typical schematic-anticipatory actuation processes anymore, at least unless we suffer from shaking hands or tired legs that we do not manage to actuate automatically. In a way, one could argue that any motoric actuation *extends* or not extends (whatever one may think) the cognitive apparatus, in that something happens *outside of the head,* perceptive-ecphorically informing the cognitive apparatus along an anticipatory actuation schema. This is true at least for motoric actuations that are anchored episodic-engrammatically (i.e., non-reflexes), be they automatic or sensational-ecphoric. However, I want to lead the reader one step further, to an even more radical philosophical and psychological thought: **The cognitive apparatus extends (or not extends) *itself within itself*.** How is this possible? Well, the basis of technology, of extension (or not-extension) is the mnemic-ecphorically active actuation schema. Whether this ecphory results into a motoric (stimulus-world-changing) actuation or not, is not important at all, as long as the active anticipatory actuation schema is kept in homophony (i.e., as expected) in the upcoming simultaneous complexes. For this, however, purely *mnemic* ecphory does suffice. The memory process uses to instantiate *in itself* enormous numbers of distinct technological processes, mnemically ecphorizing engrams in a substitution process that informs simultaneous complexes as intended. The mnemic ecphoric effect depends on the memory

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[155] Thomas Metzinger (Metzinger, Subjekt und Selbstmodell, 1999, S. 171) points to the fact that not all self-models have to be conscious/mental:

> *Ein Selbstmodell verkörpert also das Wissen, das ein System intern über sich selbst gewonnen hat, in einer nicht propositionalen Form. Dieses Wissen über sich selbst muß nicht mit der Koinstantiierung von Selbstbewußtsein einhergehen, also in Form von mentalen Modellen gegeben sein, die noch einmal durch eine Metamodellierungsfunktion erfaßt werden.*

traces acquired by the organism so far (as in the Selzian *task-ecphoric* means abstraction) and can be as *variable* as any outward-directed actuation process (integrating perceptive-ecphoric influences). The *extension* is thus a part of the memory process itself and affects the simultaneous complex. Andy Clark's idea of extended cognition based on his parity principle (*a process which, were it to go on in the head, we would have no hesitation in accepting as part of the cognitive process*) is misleading. It does not picture the integration of the anticipatory schema and mnemic, perceptive or mnemic-perceptive ecphoric influences into a simultaneous-complex correspondence structure of more or less homophony or (in-)effectiveness.

The individual cognitive *extension* into any substitution process depends on a technological actuation process frame, which cannot be fully split off or substituted. Even in the *social cognitive extension* of eusocial double-technological processes, the primary actuation process is but (partially, substitutionally) *mirrored*, not *split off*. And also the Selzian asynchronous, solution-ecphoric *means abstraction* depends on an ecphoric re-instantiation of the (by then mnemic) incomplete (task) schema (with its anticipatory, determining tendencies [determinierende Tendenzen] again in power). Without these determining tendencies, one would soon be lost by multiple ecphoric influences mnemic-associatively constantly *de/re-structuring* the simultaneous complex in a more or less random fashion[156, 157], or the determination would be left to currently present stimulus-ecphoric influences, as appears to be the case in most (non-human) animal-behavior. *Extended mind* thus appears not to be a question of systemic extension (i.e., *extended view* versus *embedded view*), but rather a question of synchronous and asynchronous extension of determining tendencies in (schematic) chunk-abstraction instances and engram complexes (after episodic *task*-engraphy). The information of these extensions by mnemic- or stimulus-ecphoric influences is an important *epistemic* distinction, though. Other directions of extended determination are sketched out by the structure of schematic abstraction hierarchies. A lot more ought to be said about the theory of extended mind, but there is no space left in this thesis to do so.

[156] (Hark, 2004, p. 93) summarizes this aspect as follows:

> *By favouring those associative bonds which are in line with the goal of the subject, determining tendencies were thought to rule out irrelevancies and prevent chance stimuli from distracting the course of thought processes, thereby giving direction to the course of thinking.*

[157] An impression of how this could be like is given by Jill Price (Price, 2008), who suffers from a very rare hyperthymestic syndrome, which allows her to easily remember every detail of every day of her life since her early childhood, at least as long as it was of interest to her (basically talks with family members and friends, news, TV shows etc.). She often finds herself thrown into episodes of reminiscence that she cannot control and set her into different emotional states.

4.2 What is Extended Artificial Memory?

The original idea of artificial memory in ars memorativa denotes an engrammatic weave [engrammatisches Gewebe] of one mode (e.g. visual loci) that is engrammatically associated to another engrammatic structure or a specific memory trace (e.g. an engrammatic sequence of *named concrete objects*). The engrammatic association (through mnemic-perceptive manipulation of engraphically-effective simultaneous complexes) consists in episodes (memory traces) of new co-reproductive chunk units. The pre-existing engrammatic weave (e.g. the well-known network of loci) allows triggering the co-reproductive chunk units by means of (one of) the pre-existing engrammatic networks or episode traces. What is produced here is an *artificial* memory trace binding (at least partially) pre-existing structures into a correlational structure. Spoken language is probably the most frequent form of co-structural artificial memory. Interestingly, other than in the case of the loci, the supposedly *pre-existing* structure here is actually rather being *co-developed*, as it is given by the self-organizational structures of word-similarity abstractions (creating syntacto-semantic, mnemically productive schemata) and hierarchically organized (and conceptually blended) word-contiguity compounds/chunks. This co-developmental, co-structural artificial memory weave consists itself of co-reproductive units. Analogically, the visuo-spatial *loci* of spoken language are the hierarchical/staggered contiguity fields, the schematic-syntactical fields of words / phonemic fragments / word positions, and *simple* (i.e., simultaneous-complex) propositions[158]. Not all, especially not complicated (written) sentence propositions, induce a single simultaneous complex. They spread across different simultaneous complexes and, thus, different memory traces that can or cannot be mnemically integrated into a correct reproductive sequence. In addition, the co-reproductive language units of sentence-like-strings may be mnemic-ecphorically active, potentially creating a conceptually richer, integrated, and/or different picture than given by the co-reproductive language units considered *in isolation*. The simultaneous complex inspired by a sentence or a multi-sentences text, therefore, does not engraphically re-present the co-reproductive sentence (components) itself. The multi-momentous sentence/text string can thus often not be re-*membered*, which does not stop it from being mnemic-associatively and engraphically effective. In our dealings with the sentence field [see chapter 2.6.4, p. 127ff], we have already pointed out other reasons why sentences are difficult to recollect and appear isolated (less engrammatically associated than word chunk-abstractions) amongst each other.

The co-reproductive units of spoken language are difficult to express fully co-reproductively (e.g. by expressing visual concepts in *visual visual*

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language[159]). Besides, many are of *abstract* nature, standing on top of multiple levels of conceptual blendings in a hierarchy of conceptual abstractions. Therefore, the expression is usually restricted to spoken or written words. (Individual) polysemy, homonymy, synonymy, conceptual abstractions, chunking, and lack of knowledge of the knowledge of others all impair the technological effectiveness of spoken and written words in double-technological processes, as has been discussed by me in some detail in chapter 2. In chapter 3, we learnt that this is due to the insufficient qualities of language-symbol stimuli/engrams as ecphoric influences correctly triggering co-reproductive *meaningful* units in (communicative) technological processes. This culminates in the disadvantages of written language; as was first indicated in the Platonic-Socratic critique of script [see chapter 2.4.5, p. 55ff] and has been true ever since - up to the most current developments in semantic technology and AI [see chapter 2.5.3.2, p. 73ff]. If language symbol artifacts function as really no more than stimuli that perceptive-ecphorically activate engrammatic components that trigger co-reproductive engrams enriching simultaneous complexes, and all this embedded in a productive memory-technological process of syntactic-schematic anticipation, how - in the world - are we to deal with them? Is it ok that there are widely differing interpretations of texts and words? Or that people believe they understand each other when they, in fact, do not and, unknowingly, even often cannot understand each other? Is it alright that we engage in technological processes that start substitution processes that are destined to decouple and, thus, at best, become ineffective, because the language artifacts steering the mechanical logic soon cease to correspond to any (existing) anticipation schema or the (individual or social) original anticipation schema changed in intention and/or structure. In short, do we have to rethink (language) technology? To some this may seem farfetched. I will therefore give a simple example illustrating the possible design consequences:

4.2.1 An Example

Imagine a traffic lights system. It steers a complex social activity: traffic. The traffic light gives the illusion of a technological process to the car driver, because the driver has an anticipation schema of his own (driving at a green light or stopping at a red light). However, this is a secondary technological process, as the driver cannot actuate the traffic light. At an otherwise empty crossroad, the driver may want to start a technological process changing her light from red to green. A pedestrian sometimes will find a button to influence the traffic light system in an intended way. A driver cannot. In some countries, though, the traffic light system will sense the driver's car and set the traffic light to green (for the driver). This, however, does not always meet the intention of the

[159] See chapter 2.5.3.2.6 on Visual language (p. 83ff)

driver. When an old person crosses the road and takes more time than usual, both may want (technologically anticipate) the traffic light to stay red for the driver and green for the pedestrian as long as the crossing takes. If a young child runs onto the crossroads, the mother (and not only the mother) may want (technologically actuate) all traffic lights for all traffic lanes to turn red immediately. If, as a pedestrian, early in the morning, when commuters are on their way, somehow I cannot influence (actuate) the traffic light to turn green for me, it would be nice to know that a large number of commuters are on their way to work and they need to / ought to move on quickly to avoid a jam (epistemic mark of the traffic light state). The traffic light system, in a traditional *technology* design, may be a simple regulatory system steered by successions of time intervals set by traffic specialists. As a mere tool serving multiple technological processes by multiple people, it would (best) be steered by a very different kind of regulatory system, one that regulates synchronous and asynchronous actuation processes, directly *in touch* with the people it may affect and serve. Of course, it would be out of question to create such a system for traffic lights alone. In chapter 4.3.6, I will line out how cooperative extended artificial memory system agents may serve this and many other purposes.

4.2.2 Artificial Memory Expression

Imagine, however, this would be a universal basic regulatory system, not only steering traffic lights, but cars, light switches, communication devices, heaters etc. The effectiveness and availability of countless technological processes might improve. Out of the question? Well, the idea of semantic web services (see chapter 2.5.3.2.4, p. 86ff) may have fallen short of our expectations, but it points into the right direction. Remotely informing an Internet of *servicing* things and effectuation processes does not pose a fundamental problem. Not the means of effectuation of traffic lights (the switches, if you will), but their orchestrated (semantic) servicing defines their overall technological value. If we want to unleash the technological potential of (mechanical/digital) tools, we have to start thinking about actuation processes and their synchronous and asynchronous unambiguous representation and orchestration. We, indeed, have to radically *rethink* technology, namely, as I argue, as a dynamic process of a dynamic memory and as socially extended, negotiated and orchestrated cognition, making use of a huge number of empowering and substituting tools. The only (original) interface of all technology is the memory process itself. Its individually coherent representation ought to provide all semantics needed to steer all technological processes, irrespective of whether synchronously or asynchronously. I mentioned before that *artificial intelligence would require a formal, explicit memory of any eligible actuator at any time.*[160]

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[160] See chapter 2.5.3.2.4.

Now, intelligence can only become *artificial* by artificial memory being expressed and processed, as it contains the main engrammatic components of the actuation process: engrams instantiating anticipatory schemata and engrams of more or less co-reproductive units of (mostly) chunk-abstractions (stemming from various sensory modalities and abstraction/integration levels) associated or directly integrated by these schemata. I will only discuss this explication with regard to natural language symbols. Visual visual language or any sub-symbolic, non/other-co-reproductive conceptual chunks-abstractions cannot be dealt with in this thesis. The basic idea of artificial memory explication is to (more or less) exclusively and regularly express artificial memory component instances into an artificial memory (information) system. This ought to happen in a *thought-accompanying* manner and should not be thought-disruptive (i.e., the expressive actions ought to be automatic, co-reproductive, not mnemic-associative or *indirect*). The engraphically-effective, *sensational* portion of the simultaneous complex should not be changed by the motoric expressions themselves[161]. It is not necessary to always express complete simultaneous complexes (e.g. full propositional statements or other complete episodic chunk sequences), that is, it is, so to speak, not necessary to *textualize* each and every simultaneous complex, as not every simultaneous complex is of interest or represents a sufficiently distinct episodic variation. *Extended artificial memory* (i.e., in the first place, artificial memory expressions into artifacts) is not a complete replication of all engrammatic structures, but of its co-episodic top- or chunking-structure: artificial memory. The process most akin to artificial memory expression might be freeform and visual note taking. The former uses to be based on keywords or key-phrases, the latter on visual abstractions. That is, both refer to mostly co-reproductive chunks by expressing written/spoken language symbols or visual sketches). Freeform note taking is popular as *pen-and-paper buffer*[162], a working memory *extension,* as well as as long-term memory cue. The free form expression, however, poses a referential problem: it is not, to use a technical term, *normalized*.[163] A chunk in the context of note A is re-expressed in the context of note B, instead of being referred to by note A and note B from a central database. De-normalization and information fragmentation are

[161] Even though drawing cannot be dealt with in this thesis, I want to bring to the reader's attention that Leonardo da Vinci seems to have developed an ingenious way of sketching with his right hand and, at the same time, blindly, writing in mirror script with his left hand, as is indicated by his notebooks. Speech-to-text technology (probably in combination with eye-tracking tools for text placing) would make this an interesting and accessible way of expressing co-reproductive units in a multi-modal, symbol-rich way. Moreover, Eric Kandel has recently (Kandel, 2012) taught me that the painters of the Vienna Modern Era [Wiener Moderne] developed a technique of sketching without turning the eyes away from the real object. This innovative non-interruptive way of blind sketching could be imitated by augmenting the sketch onto the real object using augmentation technology.

[162] As mentioned by Clark in (Clark & Chalmers, The Extended Mind, 1998), who also introduces an interesting example of note-based extended memory.

[163] In relational database management, normalization describes a strategy of reducing duplicated data.

closely interlinked and would pose a problem to data unification (merging, e.g., note A and note B), which is a precondition of coherent artificial memory representation, as most artificial memory components are used cross-contextually. The extended artificial memory system has to overcome problems of information fragmentation across different syntax or information-organization types, across multiple User Interface components, across different file types of different applications (on different devices), across different physical locations, different storage media or databases, across any types of information scraps (incl. notes), across professional and private social situations etc. - all splitting up *personal information*. The artificial memory artifacts ought to be understood as belonging into an individual universal data store capable of unifying representation.

4.2.3 Artificial Memory *Extension*

Most software tools nowadays include databases and processes dealing with artificial memory artifacts. But they *decouple* the artifacts from their originators. For technological effectiveness, however, the actuation-information determining effectuation has to consist in *references* to the latest (expressed) actuation parameters, which are (per definition of the exclusiveness feature of extended artificial memory) to be found in extended artificial memory or a negotiated orchestrated aggregation of several extended artificial memories. Extended artificial memories (and their aggregations) provide a basic information layer interconnecting servicing (software or digitally controllable/accessible) tools, irrespective of whether they are used for functional or content technologies. This, of course, implies a radically different software system design than, say, organizational IT, app stores, digital clouds, the Internet, the WWW etc. currently have to offer. Their alleged human-centeredness revolves around centering human artificial memory artifacts on (organizational or central) software tools, whereas the human-centeredness of the extended artificial memory system-design would center servicing tools on the artificial memory artifacts constituted by technological actuation processes. So far, artificial memory artifacts are locked into and fragmented across an army of systems, though. It seems to me that we need a fundamental reframing of information and knowledge management, starting from extended artificial memory systems as the basic means of expression and informing; an intermediate information layer for (any) communication, tool use, and other technological processes, situated between engrammatic and ecphorized artificial memory and its extensions into artifacts used for actuation, on one hand, and engrammatic and ecphorized artificial memory and its extensions into artifacts used for effectuation during substitution. Yes, **the extended artificial memory system idea translates every substitution process (e.g. a tool-based process) back into its original (tool-function-creating, descriptive)**

actuation form and thus creates a (more or less synchronous) double-technological situation that could indeed be said to *extend* technological cognition socially. The correspondences of the two (double-technological) processes depend on the synchronicity between actuation and its extension into the intermediate extended artificial memory system and the usual correspondences between actuation and substitution processes. As the extended artificial memory systems involved (in the double-technological process) would provide a de-contextualized integrated representation of artificial memory on both sides (actuation and substitution), the technological process can become subject to *meta-technological* processes of, for example, disambiguating parameters, of matching actuator and substitution processes, of asynchronously adjusting the technological process and substituting technological dialogues. **These meta-technological processes all aim at increasing the efficiency of technological processes. The meta-technological processes, for their part, are effective only insofar as we understand the workings of technological processes and the use of (extended) artificial memory components and their structures for improving technological processes. And insofar as we manage to improve the process of non-disruptive, *transparent* thought-accompanying and ever less partial expression of co-reproductive units of artificial memory. Interdisciplinary cognitive science has a crucial role to play in the technology of the future.** The current visions of related fields (such as Human Computer Interaction, Usability, Software Design, Artificial Intelligence, Machine Learning etc.), as far as I got to know them, are theoretically too short-sighted, as they don’t advance to the nature of technology, as I have tried to lay out here. I think we need a new start, binding the different scientific frameworks, insights and tool sets into the cross-scientific and cross-theoretical technology-framework of extended artificial memories.

The rest of this thesis shortly outlines some of my humble theoretical and practical attempts to actually step into the direction of *extended artificial memory*, which represents the basic theoretical idea that was gradually prepared from the technology side (in chapter 2) and from the memory side (in chapter 3), to finally be outlined here. These attempts considerably helped shaping my understanding of the wicked problem we are facing in universally supporting knowledge management processes. This often happened through countless subtle observations during prototype usage that cannot be included into this thesis, though, but would deserve a separate publication and further experimentation. Much of the following thoughts await advancement and improvement through (solution) discussion and further solution development cycles.

4.3 Theoretical Sketches For Extended Artificial Memory [164]

4.3.1 Dimensions of Memory Variation

We have found memory variation to be one of the main features of the (human) memory-process. The ways of memory variation (by the seven mechanisms summarized in chapter 3.2.2.4) become more obvious if we start distinguishing multiple (largely) independent dimensions of memory variation. The flexibility of the memory system lies in the episodic-engraphic associability and the cognitive faculties of blending of memory chunks and schematic or sequential abstraction from memory traces.

(1) Modality (intra-modal versus cross-modal)

For endogenous and exogenous sensory modalities, we have the dimension of intra-modal and cross-modal engrammatic associations. This dimension has a spoke structure, with a co-reproductive hub integrating different modalities episodic-engraphically, whereas intra-modal integration can happen either through early perceptive integration or through late (possibly preliminary) *indirect* episodic-associative integration.

(2) Spatio-Temporality (sequential complex versus simultaneous complex)

Temporal variation means that two sensations are experienced either as sequential or simultaneous and are therefore either episodic-engrammatically associated or blended/integrated. Sequential association is temporally ordered (before – after), while simultaneity, especially in intra-modal integration, uses to evolve Gestalt-relations (e.g. parts-forming-a-whole, a-part-of-a-whole, a-whole-to-one-of-its-parts, etc.). The ease of mnemic-ecphoric reversibility of sequential associations (that is mnemically ecphorizing a before-engram of a memory trace by means of the (isolated) mnemic sensation of an after-component first, seems, to some extent, to depend on the modality under review. It is, for example, easier for the *visual* modality than the *auditory* modality.

(3) Abstraction (schema-abstraction versus chunk-abstraction)

Regularities between sequential and simultaneous, intra-modal or cross-modal memory traces can be schematically abstracted (by partial similarities) or holistically chained as (combinatory) chunk-abstractions. This is a similarity-based process, either homophony-based during ecphorization or, perhaps (also), automatically progressing with the help

[164] The theoretical sketches presented here, indeed often are sketches that support thinking visually and were used in presentations, e.g. (Ludwig, Artificial Memory - Eine kurze Einführung in Struktur, Aufgaben und Erfolgskennzahlen., 2009), before. I leave them as they are to increase the accessibility of an otherwise rather *complicated* subject that, for this reason, unfortunately, necessitated some *wordiness*.

of priming-activation. Abstraction is *directly* engrammatically constructive. It differs from memory-distorting ecphoric construction[165], as there the construction is based on existing chunks, which expresses a form of imperfect homophonous chunking.

(4) Syntacticity (sequencing, marking/agglutinating, interrelating)

Syntacto-semantic variation takes three basic forms:

1. sequence or order/constellation (as, e.g., in verb arguments orders or the subject-object order of propositions with implicit predicates)
2. syntactic markers/entities (as the affixes / bound morphemes of agglutinative languages, or as in the action-markers of a computer icon system {for example, the iconographic save-marker on a save-picture icon showing a picture})
3. relational syntactic structure (e.g. predicate structures, which might also be interpreted as a combination of 1st and 2nd, where the predicate is a marker

All syntacto-semantic variations are based on schema-abstractions by similarity-associations (of word/symbol parts, concept parts, and sequences). The productive dynamics of syntacto-semantic variations seem to be strongly varied and can be complicated by nesting of multiple syntactic schemata. The variables of syntactic schemata use to be chunks and chunk sequences/complexes. We cannot really enter this area in this thesis, though. Suffice it, therefore, to mention that syntactic schemata can be ecphorized and applied on mneme-structures of the simultaneous complex or (fully or partially) function as a mnemic-ecphoric influence. Syntactic markers, on the other hand, might ecphorize a syntactic schema in the first place (as when completing an incomplete sentence), or the syntactic schema is ecphorized first by a perceptive-ecphoric memory trace (as when we vary a sentence by using its syntactic schema productively. As said, many things are possible with syntactic schemata. In this thesis, I can only provide the general memory-process theory (terminology) for their description, not the actual (process-)descriptions. In this respect, it appears to me that many linguistic theories could (and should) be reformulated and unified by applying the extended Semonian memory-process theory. Fauconnier's conceptual blending theory has already demonstrated the potential of a cognitively oriented unification framework.

(5) Epistemicity (mnemic-ecphoric versus perceptive-ecphoric)

Ecphory relies on existing chunks, but the ecphoric influences can be, in the extreme cases, either all mnemic-ecphoric or all perceptive-ecphoric. There is a middle ground (as experienceable in *bistable pictures*, where

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[165] See my description of *high-granularity memory distortion* in chapter 3.2.2.4 *Simultaneous Complex*.

small mnemic or perceptive influences can rapidly change the ecphorized chunks and thus also the engraphically-effective chunk-units). On this broad middle ground (be it ambiguous or unambiguous), perception influences mnemic-associative recollection and mnemic-associative recollection influences perception (e.g. by attention changes) in a way that is likely to produce simultaneous complexes comprising clearly distinct mnemic-ecphorically and perceptive-ecphorically influenced sensations in ever new engraphically-effective variations.

Epistemicity is of special interest to us here. One's own extended artificial memory representations (stimuli) are *exceptional* perceptive-ecphoric influences, as they ought to relate to their respective co-reproductive entities. They should not be subject to *interpretation* due to trigger-based ambiguity. They, so to speak, feed back into (or reflectively extend) the memory process and may help anticipating mnemic-associative variations perceptively. Extended artificial memory thus supports mnemic-ecphoric processes, by mnemic-perceptive co-ecphorization and perceptive-mnemic anticipation.

Two ecphoric influences provided, there are four basic sequential variations combining mnemic- and stimulus-ecphoric influences:

1. mnemic-mnemic
2. mnemic-sensorial
3. sensorial-sensorial
4. sensorial-mnemic

More or less homophony will create three variations of ecphory with respect to the four epistemic combinations:

a. complete homophony (identity [Übereinstimmungsempfinden])
b. incomplete homophony (difference [Unterschiedsempfinden])
c. non-homophony (distinctiveness [Verschiedenheitsempfinden])

If the ecphoric influences activate engrams that relate to co-reproductive units, they could trigger either

i. no co-reproductive unit (*component*-ecphorization only)
ii. a single unit
iii. different units

All four combinations of ecphoric influences in all three variations of homophony are possible in all three cases of co-reproduction. *No-co-reproduction* will simply leave things at the *componential* level. A single unit may still vary by different degrees of homophony, insofar as the components can be completely homophonous or non-homophonous (i.e., referring to different components of a single unit). And they could be incompletely homophonous even in the single-unit case, in that a componential difference is felt without any impairment of joint triggering.

A complication of the basic epistemic memory variations of *independent* ecphoric influences can be found in cases where one influence helps *create* the other influence. There are four basic possibilities:

1. mnemic-to-mnemic
2. mnemic-to-sensorial
3. sensorial-to-sensorial
4. sensorial-to-mnemic

A mnemic (mnemically ecphorized) sensation (or sub-conscious excitation) (mneme [Mnem]) could ecphorize an engram that is engrammatically associated in a shared memory trace. Epistemically, this represents a mnemic-to-mnemic progress, resulting in a corresponding mnemic-mnemic variation (colloquially often called thought, idea, knowledge, recollection or association etc.). If a co-reproductive mneme includes an actuation (let's say: a movement), it may evoke or more or less directly *cause* a sensorial-ecphoric influence. This is the mnemic-to-sensorial progress. If the mnemic-to-sensorial progress manages to generate a stable co-reproductive unit that is triggered by the sensorial-ecphoric influence (be it in a mnemic-sensorial or sensorial-mnemic variation), it is likely to be integrated into the *mental self-model*. If the resulting sensorial-ecphoric influence is rather variable and becomes integrated into a deterministic schema, the mnemic-ecphoric influence (of the mnemic-sensorial variation) makes an appearance as an (intermediate) *epistemic action* [166] or an (immediate) *pragmatic action*. The effect of an epistemic action is similar to the effect of a mnemic *association* (mnemic-to-mnemic progress), because the result of a mnemic *association* varies due to engram-association *bi- and multifurcation*. [167] **I would argue that the Selzian determined bethinking** [Besinnung]**, controlled inner attention, is, indeed, epistemic action, too.** Epistemic action, however, is normally only associated with controlled outer attention (physical actions such as eye-movements). **An outer epistemic action may be a supplementation or even replacement of an inner**

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[166] The term *epistemic action* was introduced by David Kirsh and Paul Maglio (Kirsh & Maglio, 1994, S. 3f):

> *Epistemic actions - physical actions that make mental computation easier, faster, or more reliable - are external actions that an agent performs to change its own computational state.*
>
> […] *we use the term epistemic action to designate a physical action whose primary function is to improve cognition by:*
> *1. reducing the memory involved in mental computation, i.e., space complexity;*
> *2. reducing the steps involved in mental computation, i.e., time complexity;*
> *3. reducing the probability of error of mental computation, i.e., unreliability*

[167] See chapter 3.2.2.3 for a definition of bi-/multifurcation.

epistemic action (mnemic *association*) whenever it refers to extended artificial memory representations of the respective multifurcations.

The sensorial-to-sensorial progress, if not being mnemically conveyed, depends on uncontrolled/vital attention-directing mechanisms (e.g. a blinking light automatically refocusing attention to a certain spot where another sensorial-ecphoric influence (e.g. a background figure) can take effect. Early perceptive (dis-)integration or priming might establish further variants of progressive dependency between sensorial-ecphoric influences. *Ecphoric priming*[168] would be a way in which a sensorial-ecphoric influence may affect the success of an otherwise independent mnemic-ecphoric influence (sensorial-to-mnemic progress). However, sensorial-to-mnemic progress can also simply mean that a mnemic influence is created by prior sensorial ecphorization.

The mnemic-to-mnemic progress is (1) *predictive,* (2) *imaginative* (or *probing*) or (3) *constructive* in that the resulting mnemic-mnemic complex (I) may or (II) may not or (III) may not correctly be matched by a simultaneous or later stimulus situation. Outer epistemic actions (mnemic-to-sensorial progress) will produce similar predictive, imaginative, and constructive effects if they are informed by an appropriate extended artificial memory system. Furthermore, with extended artificial memory systems, sensorial-to-mnemic progress, by ecphoric priming or simply by ecphorization of to-be mnemic influences, can induce complex mnemic situations, as would be given in rich (thoughtful) mnemic simultaneous complexes.

The epistemic mechanism of extended artificial memory systems is that they, as far as possible, supplement, support or replace endogenic memory variations due to controlled inner attention and to inner (mnemic) associations with exogenic memory variations due to controlled outer attention and outer associations. This epistemic mechanism enriches simultaneous complexes, thus improving memory reproduction and memory variation.

[168] See chapter 3.2.2.3 for a definition of ecphoric priming.

4.3.2 (Simplified) Memory-Process Visualization

In order to have an easier access to the following ideas about extended artificial memory, and to summarize the major sub-processes of replication/variation memory visually, I am adding Figure 14: Visual Model of Replication/Variation Memory. The yellow area within the head depicts the simultaneous complex (subconscious and conscious parts of it). Beyond that, there is the basic epistemic distinction between mnemic and sensorial processes. Mnemically caused processes (processes caused by mnemes: ecphorized non-a-priori/engraphic engrams in the simultaneous complex) are represented in the white area of the head; exogenous, sensorially caused processes are represented outside of the head, so, as if they were entering the head through the eyes.[169]

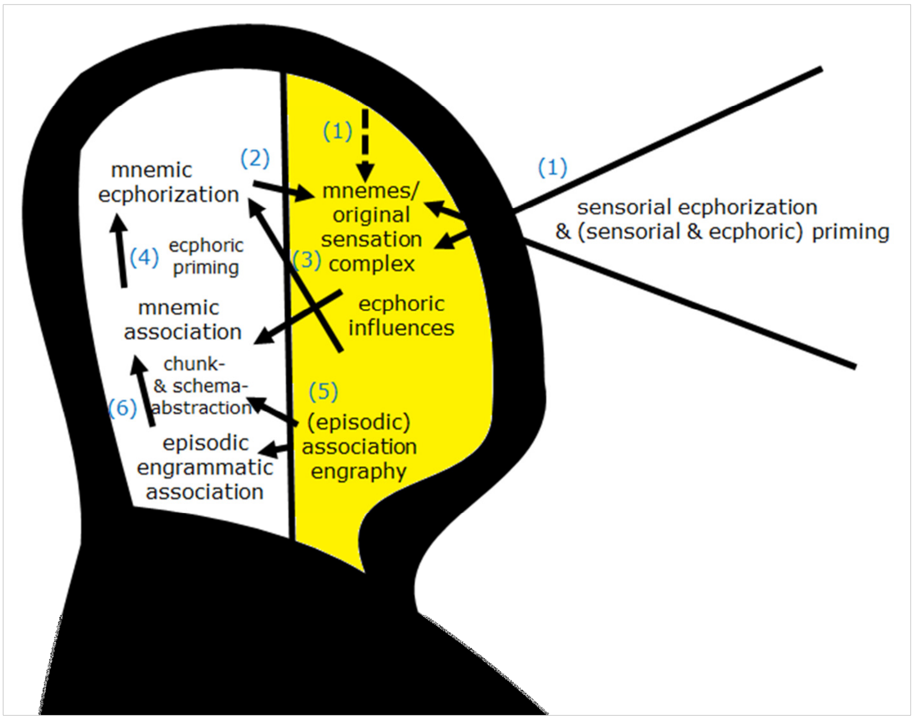

Figure 14: Visual Model of Replication/Variation Memory

In (1), the sensorial information process is shown. It becomes effective by sensorial ecphorization and (low-level) perceptual/sensorial priming (of primary *memory*) and (high-level) ecphoric priming (of episodic-engraphic *memory*). Endogenous sensorial information (e.g. by affective-ecphoric influences) is indicated separately by a dotted line. In (2), mnemic information is shown. Mnemic information can go back directly to effective ecphoric influences (3) of the simultaneous complex, or it is mediated by mnemic associations (4), which are bound to engrammatic associations. Ecphoric priming also influences mnemic ecphorization, in the form of multiple-trace activation and/or subsequent sensitization of engraphic

[169] This is, of course, NOT to mean that they were not cognitive processes.

engrams. In (5), episodic-engraphic engram association (or complexing) is shown. These engrams form the basis of mnemic ecphorization, probably mediated by a process of more or less[170] automatic chunk- and schema-abstraction (6).

[170] Karl Bühler famously distinguished between rule consciousness [*Regelbewußtsein*] and the rule itself (Bühler, Tatsachen und Probleme zu einer Psychologie der Denkvorgänge, 1907, S. 43f):

> *Nicht dieses an eine Regel denken, sondern das Denken einer Regel oder in einer Regel ist Regelbewußtsein. Der Gegenstand des Regelbewußtseins ist nicht die Regel, sondern der Tatbestand, das Objektive, das sie bezeichnet, auf das sie anwendbar, aus dem sie vielleicht abgeleitet.ist. Wir könnten, wenn wir eine Unterscheidung Husserls aufnehmen wollten, sagen: Das Regelbewußtsein ist ein Gedanke, in dem bestimmte Gegenstände, die der Logiker als Gesetze bezeichnet, adäquat gedacht werden.*

Acquiring rule consciousness is probably difficult or impossible by consciousness of the rule alone. Rule consciousness is based on abstraction engrams, whereas consciousness of a rule is based on memory traces *reflecting* (or abstracting) the mnemic effects of a rule. Consciousness of rules, however, could create conditions helping to imitate the effects of rules or conditions that help to acquire rule consciousness / engrammatic abstraction.

4.3.3 Basic Memory-Process Problems in Epistemological Consideration

As the memory-process system is the *host* of the technological (actuation, often also substitution) process, the basic problems that can arise are of special interest to us. Through their embedding into technological processes, these problems may affect effectiveness and ineffectiveness of schematic-anticipatory technological processes. This is certainly not a complete list of basic problems, but it gives a first idea of what different types of problem situations may arise, all impairing memory reproduction and memory variation (production). We will later discuss how these problems could be mitigated by an extended artificial memory system.

4.3.3.1 Mind Misloads

Sensorial Mind Misload By Uncontrolled Attention Shift

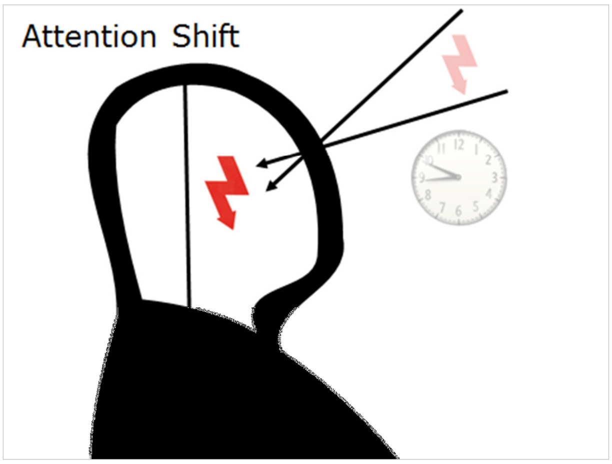

Figure 15: Sensorial Mind Misload

Mind misloads are caused by false (non-intended non-anticipated) sensory stimuli gaining influence. In the simplest case (that we are going for here), this will be caused by uncontrolled attention shifts, directing the receptive field of the sensory organ away from the relevant stimuli. In Figure 15, this is indicated by a flashlight attracting attention away from the relevant exogenous stimulus (the clock needed to know the time).

Mnemic Mind Misload By Uncontrolled Thought Shift

In Figure 16, mind misload (remembering a flashlight instead of the time) is caused mnemically by an uncontrolled shift of thought toward an irrelevant (i.e., not intended in schematic-anticipatory fashion) engram(-complex). The irrelevant mnemic sensations fill the mnemically influenced simultaneous complex. There can be many indirect causes for this. Perceptive-ecphoric influences (e.g. sensations of hunger or thirst grabbing inner attention) or mnemic-associative ecphoric influences due to irrelevant engrammatic associations or abstraction structures not (yet) deterministically suppressed.

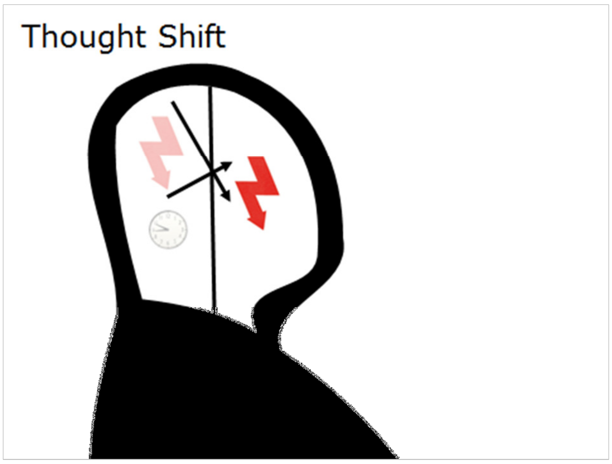

Figure 16: Mnemic Mind Misload

4.3.3.2 Mind Overloads

Sensorial Mind Overload By Stimulus Overload

Mind overload is a condition, where the relevant information is available, but not effective due to simultaneous information rendering it ineffective. Many simultaneous stimuli (stimulus overload) may prevent the relevant stimulus from taking effect, as indicated in Figure 17. The clock (to tell the time) is not seen, even though it is *present* as an unattended and, therefore, ecphorically non-effective stimulus.

Figure 17: Sensorial Mind Overload

Mnemic Mind Overload by Thought Overload

The same scenario can be stated with respect to a mnemic-ecphorically influenced simultaneous complex, in which, due to a limited memory/simultaneous-complex span, the *given* relevant engram (telling the time) is not ecphorized to the sensational level, as indicated in Figure 18.

Figure 18: Mnemic Mind Overload

4.3.3.3 Mind Underloads

Sensorial Mind Underload by Stimulus Distance

Mind underload is given when relevant information is, in principal, indirectly available. In Figure 19, dealing with sensorial mind underload, this is indicated by a situation where epistemic actions (going home to see the time) are needed for relevant information.

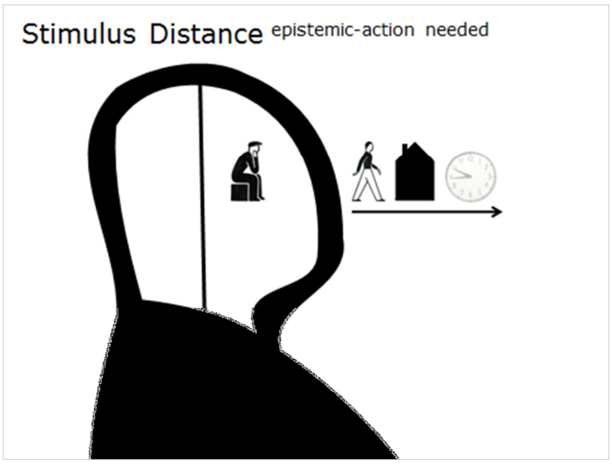

Figure 19: Sensorial Mind Underload

Mnemic Mind Underload by Thought Distance

In Figure 20, a situation is depicted, in which, in order to mnemic-ecphorically remember the relevant information, a number of epistemic mnemic-associations have to be tracked back (remembering that one last read the time before leaving home).

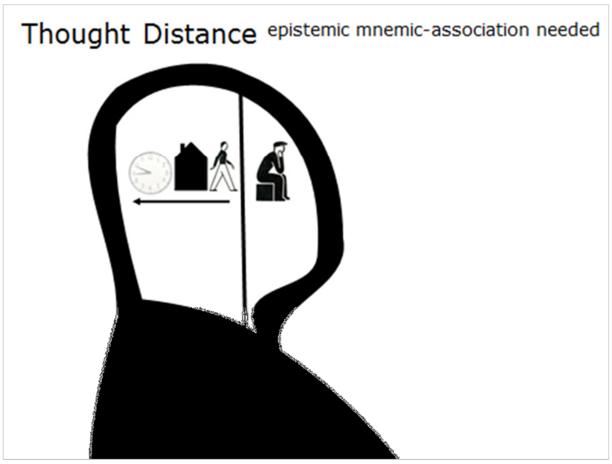

FIGURE 20: MNEMIC MIND UNDERLOAD

Some mental episodic distances need to be bridged in an epistemic mnemic-associative *reconstructive* process of re-membering memory traces (chronologically). Other mental distances (to relevant information) can be bridged by using one's artificial memory apparatus (as in the Selzian task-determined schematic *means abstraction*). More often than not, probably, both types of mental bridging will come into operation, likely also including epistemic actions (for episodic reconstruction or *means abstraction*).

4.3.3.4 Mind Information-Errors

SENSORIAL MIND INFORMATION-ERROR

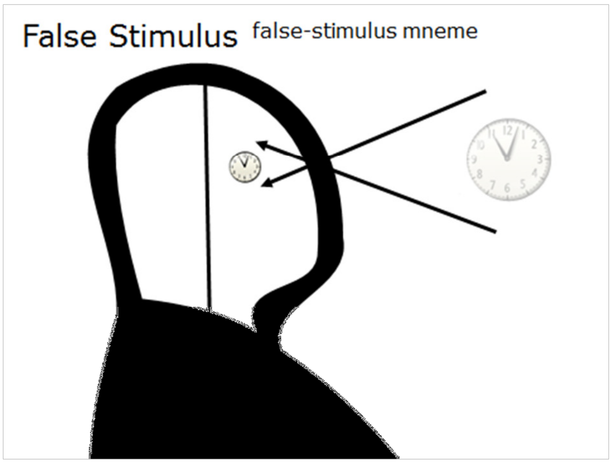

FIGURE 21: SENSORIAL MIND INFORMATION-ERROR

A mind information-error is given when false information is taken for relevant information. The right information is not supposed to be present (stimulus-wise or engram-wise). A sensorial mind information-error is due to a false stimulus (correctly) ecphorizing a false-stimulus mneme. In Figure 21, a false time is read correctly.

Mnemic Mind Information-Error

A mnemic mind information-error is correct mnemic ecphorization of an erroneous engram.

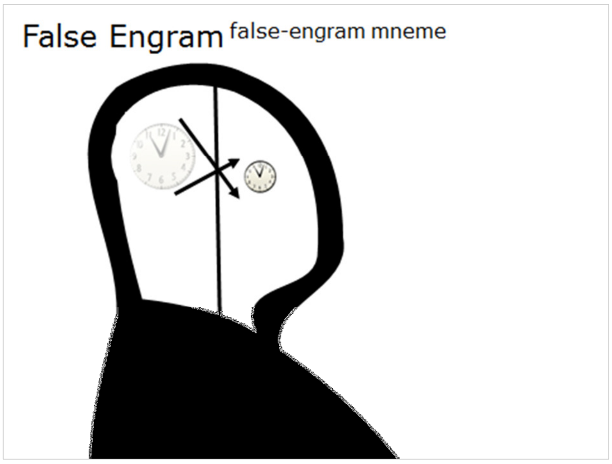

Figure 22: Mnemic Mind Information-Error

4.3.3.5 Mind Construction-Errors

Sensorial Mind Construction-Error

Mind construction-errors are the same as mind information-errors in result. In sensorial construction-errors, however, the stimulus-ecphoric influences do not ecphorize the right engrams (which are thought to be available). This may happen because of misleading homophony, ecphorizing a similar and perhaps overly general, but, in effect, false memory trace, which is mistakenly assumed correct, though.

Mnemic Mind Re-Construction-Error

Mnemic construction-errors are called re-construction errors, because they do not re-construct or re-member relevant information correctly. This again is due to misleading mnemic ecphorization (re-construction) and mnemic association (mnemic association).

Mind information-errors and mind-construction-errors are as easy to mix up as they mix up easily. The former because of, in principal, same results, the latter because false information in the first place can still be falsely (re-)constructed in the second place.

4.3.3.6 Mind Ambiguity

Sensorial Mind Ambiguity

Mind ambiguity arises whenever there is no clear ecphoric picture, that is, whenever different mnemes are being ecphorized where only a single one was expected. Ambiguity is only *felt* where there are actually conflicting mnemes. Ambiguity is thus not the *finding* [Feststellung] of ambiguity, but the sensation [Empfindung] of ambiguity. In Figure 23, a (single) stimulus has an ambiguous effect.

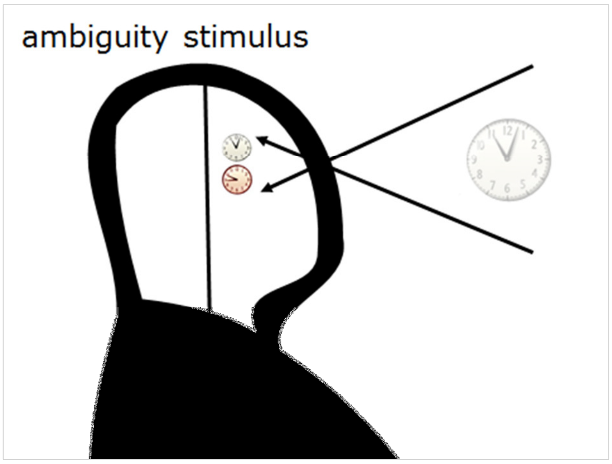

Figure 23: Sensational Mind Ambiguity

Mnemic Mind Ambiguity

Mnemic ambiguity is a bit difficult to depict, because a single mnemic-ecphoric influence is supposed to ecphorize multiple conflicting engrams. In Figure 24, a ambiguous double-ecphorization and resulting ambiguous simultaneous complex is depicted, leaving the single mnemic-ecphoric influence aside.

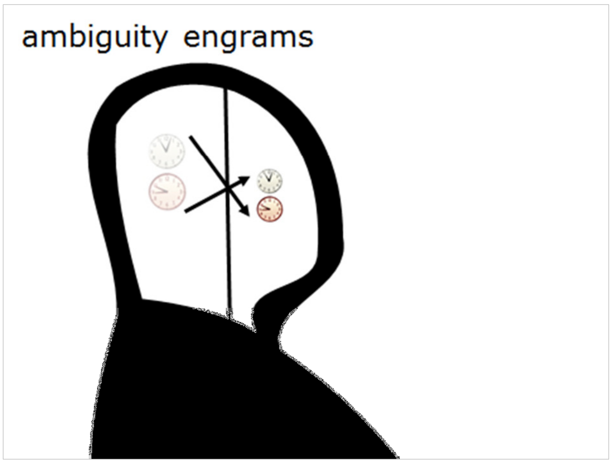

Figure 24: Mnemic Mind Ambiguity

4.3.3.7 Mind Emptiness

Sensorial Mind Emptiness (Incomprehension)

Mind emptiness is caused by a lack of engrams (chunks, triggers, memory traces) that could (or would) answer a relevant ecphoric influence. A stimulus will create a more or less original sensation that does not ecphorize a *meaningful* or relevant sensation, though. In Figure 25, this is indicated by a stimulus-icon and (original) excitation icon in the simultaneous complex. The question mark is to indicate that there are no (meaningful) engrams being ecphorized.

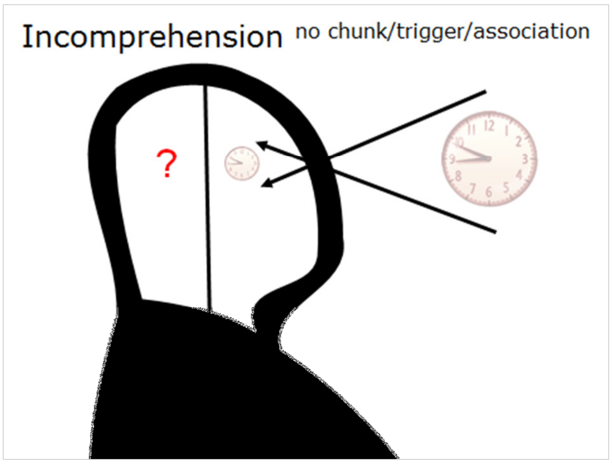

Figure 25: Sensational Mind Emptiness

Mnemic Mind Emptiness (Unknowingness)

With mnemic emptiness, there will be a relevant mnemic-ecphoric influence not producing any ecphorization. In Figure 26, this is indicated by missing engrams and an accordingly emptied simultaneous complex. This emptiness is not to be understood as absolute emptiness, but as emptiness relative to an unsuccessful mnemic-ecphoric *influence*. It is, thus, not knowing anything (related) rather than knowing nothing (at all).

Figure 26: Mnemic Mind Emptiness

4.3.3.8 Mind Unabstractness

Sensational Mind Unabstractness

Mind unabstractness means that a relevant *abstraction* (chunk-abstraction/complexion or schema-abstraction) is omitted, even though the information for it is given. Sensational unabstractness refers to ecphoric influences stressing (or simply giving) a potential abstraction pattern (e.g. a word-chunk or marked syntactic schema), without, however, the abstraction pattern being established by a respective blending.

An insufficient capacity of abstraction is responsible for mind unabstractness. This is different from unabstractness due to a lack of cultural support of individual abstraction (as, for example, by missing syntactic language features, lack of art/design artifacts, and under-developed cultural-technological habits).[171]

Mnemic Mind Unabstractness

Mnemic mind unabstractness is found when mnemic-ecphoric stimuli do not provoke a (conceptual) abstractive integration of the respective engrams or engram complexes. Unabstractness will result in a lack of artificial memory.

---

[171] Otto Selz stressed the importance of this culturally acquired (means) abstraction for cultural evolution (Selz, 1924, S. 17):

> *Vielmehr beruht die kulturelle Fortentwicklung gerade darauf, daß prinzipiell sämtliche durch die Arbeit vorangegangener Generationen erworbene Mittel zur Verwirklichung kultureller Werte der routinemäßigen Aktualisierung zugänglich werden.*

Against this background, it appears astonishing that cognitive sciences did not yet start a broad initiative to create a **universal systematization system for cataloging artificial memory abstractions** (chunks-abstractions, syntactic schemata, anticipatory schemata, actuation schemata, co-reproductive units etc.). A memory-dimensional index of (socially extended) extended artificial memory is the final version of a universal cultural search engine (for abstraction of any cultural *means, so to speak*). Efforts like the representation of procedural knowledge in the ACT-R model (Anderson, 1996) or the ideas about semantic search (Guha, McCool, & Miller, 2003) can be seen as early preparatory work for such an endeavor. This subject would deserve a new science, though, giving current *search technology* a completely new twist.

4.3.4 Artificial Memory Expression as Transparent Technology: Co-Production

In Figure 27, a basic visualization of an extended artificial memory system is shown. As we perceive the eusocial technological substitution process to be based on interindividually co-structural artificial memories in form of extended cognitions, we illustrate the individual extended artificial memory system (which is, of course, a computational system) as just another memory-process system, that is, in the visual language of our model, it is represented by another head.

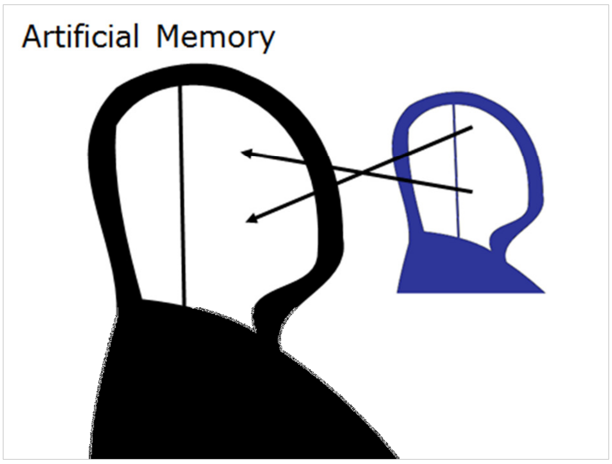

Figure 27: Extended Artificial Memory Visualization

The extended system's simultaneous complex is its representational function, sensorial-ecphorically stimulating proper simultaneous complexes. The extended artificial memory system mimics the organismic artificial memory. This is not intended to mean that technological effectuation processes of the system would be restricted to cognitive mimicry; it merely means that its representational function strives for a due (homophonous) organismic ecphorization. Andy Clark had a similar idea in mind when he defined *transparent technology*:

> […] *'transparent technologies' and what might contrariwise be dubbed 'opaque technologies.' A transparent technology is a technology that is so well fitted to, and integrated with, our own lives, biological capacities, and projects as to become (as Mark Weiser and Donald Norman have both stressed) almost invisible in use.*
>
> (Clark, 2003, S. 37)

Invisibility can be interpreted as homophony or high correspondence in outward-directed technological processes. Invisibility must be *learnt*. The expression of artificial memory is not a *natural gift*. Clark remarks:

> *The processes by which a technology can become transparent* […] *include both natural fit (it requires only modest*

> *training to learn to use a hammer, for example) and the systematic effects of training. The line between opaque and transparent technologies is thus not always clear-cut; the user contributes as much as the tool.*
>
> (Clark, 2003, S. 38)

In our terminology, the earmark of a transparent technological process of artificial memory expression and extended artificial memory impression is the (learnt) capacity of **co-productiveness**. A full expression of complex co-reproductive artificial memory entities is probably impossible. Symbolic co-reproductive units anyway play a key role in human artificial memory. The expressible (symbol-)trigger-components of these units are key to their memory-reproduction. Now, co-productiveness means that memory production (variation) ought to be widely constituted by co-reproductive units and their apt expression. In so far, extended artificial memory systems could be called intrusive transparent systems, as they pre-suppose (and, in turn, support) a literacy of (semantic) expression that enriches the co-reproductive entities to be expressed. Thought-accompanying expression means co-productive active symbolism. Touch/mouse, gestural, spoken and written natural language (voice/keyboard), eye tracking, and facial-expression human-computer interfaces would ideally all merge into a system for artificial memory co-productiveness, establishing new forms of an expressive (interactive) existence through new complex co-reproductive entities of artificial memory. Supporting an artistry of multi-dimensional thought-accompanying co-productivity would very much be a crucial educational challenge of technologized societies. By now, as typical for peri-postindustrial societies and an IT industry marked by shortsighted corporate market capitalism, the evolution of human-computer interfaces has been a slow and inefficient process dominated by company interests, on one hand, and inflexible and usually rather clue-less public organizations/systems on the other hand. Co-productiveness, however, ought to be subject to an experimental design and scientific research process, as it has an important role to play in establishing effective technological processes computationally. Any form of life recording of environmental and contextual information (see chapter 2.5.2.2, p. 71) may provide an important pool of data correlating to artificial memories and memory traces. Life recording, however, can be but a supplement to extended artificial memory creation, not a replacement, even though, in part, co-productiveness could take the form of recordings of unconscious expressions and organismic signals instead of conscious expressions. It will be crucial to bind these unconscious expressions and signals into representations of their co-reproductive units correctly. A notable obstacle to co-production is the heterogeneity of human-computer interfaces due to software and hardware fragmentation. From a social technology and memory-process perspective, one has to get rid of the bad idea that the expression of artificial memory (which comprises any form of human-computer interaction) belongs into the realm of any specific servicing software or hardware (company). Technological processes of co-productive artificial memory expression are the language of the future, partially destroying pre-computer-era natural languages, partly integrating them into new forms of usage (as in controlled/programming languages, or visual and visual visual languages). The fragmentation-based specificity of expressions bound to individual software and hardware, however, diminishes their technological and, thus, social value. Both the interaction and data lock-in of software users represent an intellectual lock-in society cannot afford. I think that this is the true intellectual property war the Internet generation will have to wage in future: It is very much their own intellectual property that is at stake here, not the intellectual property of a pre-digital era. It is all a question of the design of shared fundamental social technologies such as extended artificial memory (network) systems.

4.3.5 Four Basic Types of Extended Artificial Memory

I distinguish four (closely interrelated) functional sub-types of (content-technological) extended artificial memory by four types of extension of memory-subprocesses:

1. artificial reflective memory - by extended ecphorization
2. artificial reproductive memory – by extended remembering
3. artificial productive memory – by extended endogenic variation
4. artificial learning memory – by extended exogenic variation

4.3.5.1 Artificial Reflective Memory: Extended Ecphorization

In Figure 28, the process of using an extended (artificial memory) system for (extended) reflection is shown. Reflection here means that a mnemic state is being expressed and reflected by a corresponding representation of an extended artificial memory system.

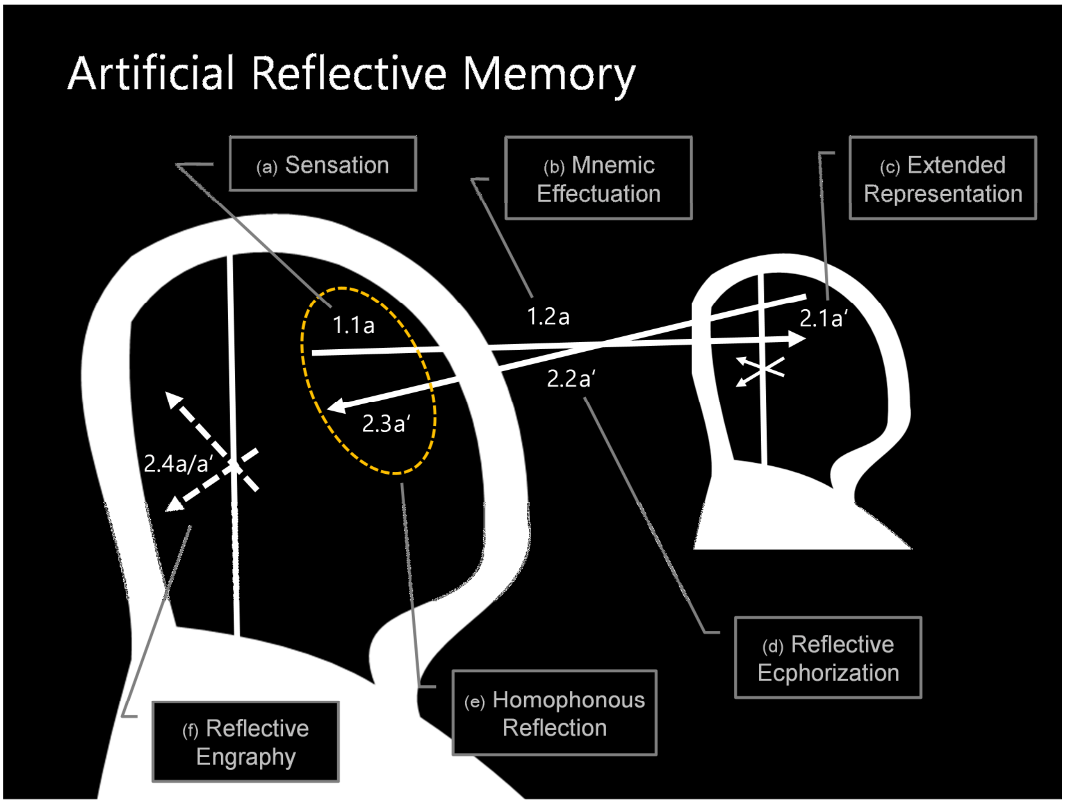

Figure 28: Artificial Reflective Memory

There are two basic sub-processes involved: expression (1) and reflection (2). Expression starts with an expressible (co-reproductive) sensation *a* in the simultaneous complex (1.1a). Through a learnt actuation process, this sensation is non-intrusively/transparently mnemic-ecphorically expressed (1.2a) and recorded by the extended artificial memory system, which translates it into a due representation *a’* (2.1a’). *a* can be *new* to the extended artificial memory system, or it was stored before, which, for now, does not concern us. In reflection (2), the system first generates a stimulus-ecphoric influence *a'* (2.2 a') that creates a co-reproductively homophonous-reflective sensational complex (integrating 1.1a and 2.3 a'). This reflection complex (*a/a'*) is engraphically effective (2.4 *a/a'*).

One advantage of artificially reflecting sensations is **enrichment**, as the expression (e.g. writing) may cause co-reproductive components (e.g. written language symbols) to be integrated into the co-reproductive complex. Enrichment may cause **co-reproductive reinforcement**, as engraphy of the simultaneous complex will bind a greater diversity of sensations, producing more potential (co-)trigger engram components. Enrichment can also mean that the reflection will help **solidifying the sensation** in the simultaneous complex. This **can improve mnemic-associative processes** (bethinking [Besinnung]). As the reflection stimulus may (medially) persist beyond its immediate reflective function, universal technological processes for **working memory extension** (into subsequent simultaneous complexes *emptied* of sensation *a*) may take effect. In the Artificial Memory prototype, for example, this is realized by a time-sensitive *Last-Visited* list and a (less time-sensitive) more specific *Last-Added* list, which both function as working memory buffers. The stable spatial arrangement of these dynamic lists in the Artificial Memory prototype allows for a (technologically) simple fast **perceptual *re*-ecphorization** of former sensations into later simultaneous complexes. This, of course, is an advantage against notes on paper with their specific static locations. Perceptually triggered/influenced re-ecphorization is certainly a major advantage of artificial reflective memory. Reflectively supported re-ecphorization normally serves a wider purpose, in an overarching technological process (e.g. relating temporally distant sequential sensations via their by then spatial-temporally near perceptive-ecphoric influences). Artificial reflective memory is prescribed, for example, against mind overload by stimulus overload or thought overload, as it helps keeping or regaining focus. It may also help in cases of mind underload where underload is due to the passing by of recent simultaneous complexes. Furthermore, it mitigates the effects of mind misload, irrespective of whether they were caused by attention shift or thought shift, as ecphoric influences of listed items may easily reinstate a displaced or *masked* simultaneous complex constellation. The buffer function can be *anticipated* in an anterograde or a retrograde fashion: putting something aside for a later moment versus wanting to perceptually/easily (without mnemically bethinking) re-member a past by item. In any way, artificial reflective memory will support thinking through a number of basic content technologies.

In extended artificial memory system usage for artificial reflective memory, long-term persistence is of secondary concern. Note sheets (even electronic ones) change often and we frequently end up noting something twice or more often on different sheets/places, unless we remember on which note sheet we took the note, which, however, makes it unlikely that we will re-note what we have in mind (in which way we lose the valuable contextual reflective function of re-noting). The extended system strives for data normalization (avoiding duplicates, as artificial-memory-based chunking does, too), but at the same time it asks for thought-accompanying expression (for instating artificial reflective memory). Therefore, inputting into the extended system and searching the extended system have to be a single process (for reasons of technological transparency). In the Artificial Memory prototype, this is solved by an auto-completing named entity search, in which the search/query string is also used for direct entry of suggested *lexical* named entities (when search for individually existing items was unsatisfactory). If search was successful, but delivered a polysemous or homonymous (i.e., identically named) item (the disambiguation of which we will discuss later), the respective items can be easily duplicated. These exemplary measures help to establish the Artificial Memory prototype as both, a normalized data source and an extended system creating transient artificial reflective memory (traces). Nearly all note taking tools and, more generally, (personal) information/knowledge management systems focus on one function or another. Either they provide more or less normalized/itemized lists (e.g. top-to-dos list, mind-maps, diagram template etc.) or they offer multiple (freeform) documents and leave their usage up to the user. This limits their applicability to specific usage scenarios and excludes their usage as an extended system.

4.3.5.2 Artificial Reproductive Memory: Extended Remembering

In Figure 29, the process of using an extended system for associatively remembering is shown. Artificial memory turns reproductive (beyond reflection) by ecphorization of an association (memory trace) by, first, expressing an association-component and, subsequently, representation of an extended association.

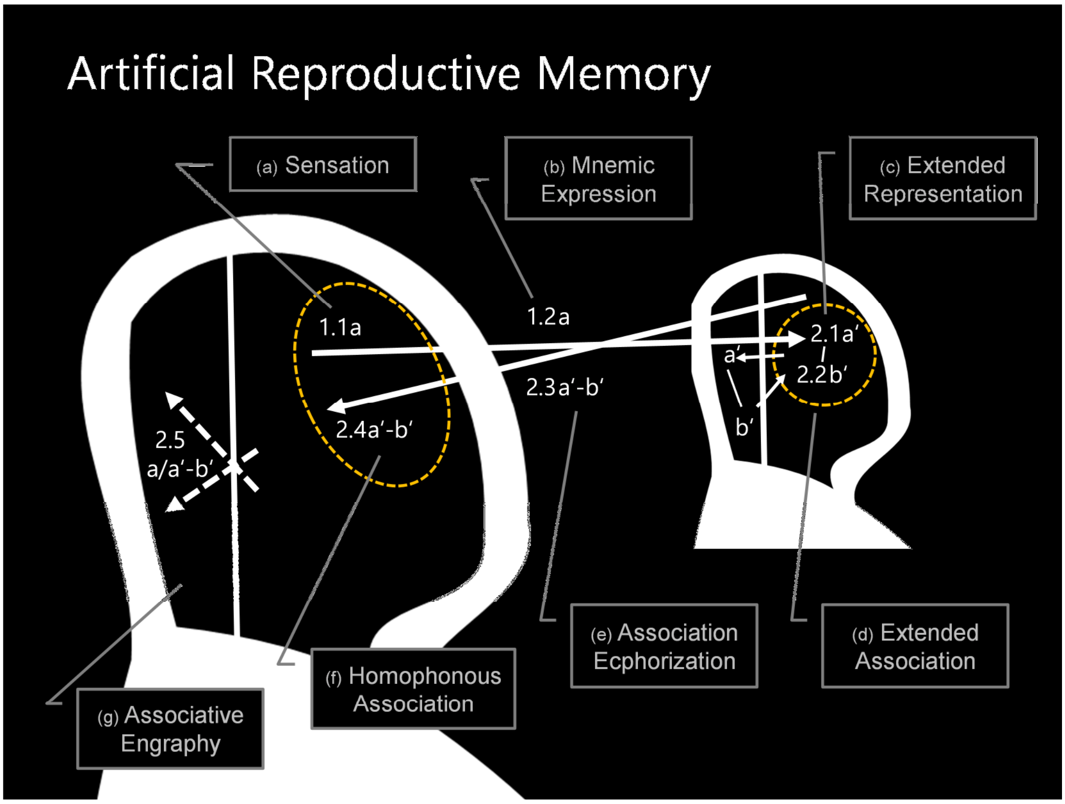

Figure 29: Artificial Reproductive Memory

The expression of *a* is the same as with artificial reflective memory. This time, however, the extended system retrieves a formerly expressed and stored associated entity *b'* and representationally ties *b'* (2.2) to *a'* (2.1) in an extended association (d) representation that allows for a perceptive association ecphorization (2.3) into a homophonous association sensation (f) (possibly integrating the sensation *a* starting the process, if it happens to be still available). The (overall) homophonous association complex is engraphically effective (2.5 a/a'-b').

Artificial reproductive memory is *exogenic re-membering* by mnemic-ecphoric influence *extension*. It turns any artificial-memory-based sensation into a reminder. A mnemic-ecphoric (re-)association process (being reminded of a memory trace) is replaced and, subsequently, supplemented by appropriate sensory-ecphoric influences. In principal, extended remembering is useful whenever the simultaneous complex does not include mnemic-ecphoric influences supporting the ecphorization of potentially relevant memory traces (by mnemically bethinking). The extended representation of multiple (e.g. sentential) different associations containing *a* is far easier than *bethinking* them. The reason for this is the mnemic-associative ecphoric mechanism itself: bethinking *a* might well remember *b*, but then, given a simultaneous complex including *a-b*, the mnemic ecphoric influences will include a, the contiguity complex a-b, and the individual entity b. The possibility to ecphorize, say, memory trace a-c is likely to decrease because of the likelihood of the additional entities of the simultaneous complex to become ecphorically influential. *Mind overload* is a necessary byproduct of mnemic-associative remembering: One is swept away by mnemic-associatively remembered thoughts. Bethinking something particular across multiple memory traces thus benefits from artificial reproductive memory, because a technological process of scanning a list of multiple (cross-episodic) association representations can create a situation where multiple (extended) associations get a chance of exerting a mnemic-ecphoric influence to prove relevant. Such list studying technology helps suppressing flights of remembrances. A precondition of artificial reproductive memory is the *normalization of associations* across multiple memory traces: whether a-b was derived from context c1 or c2 is (for the time being) of no importance. Therefore, the *associations* of (extended) artificial memory are sequential or relational chunk-abstractions. They are, so to speak, more of a semantic network (see chapter 2.6.1) than a corpus of texts. This is not to say, however, that a reified association-chunk could not become part of many *unique* associations by its (part in) chunking of further simultaneous complexes.

The flipside of mnemic mind overload is mnemic mind underload. Instead of losing ourselves in chains of remembrances, we might find ourselves lost in unimaginativeness, recognizing *a* but not recollecting *a-b*. Extended associations may mitigate this type of mind underload.

In the Artificial Memory extended system prototype, semantic reproductive memory is supported by a normalized semantic network (representation). Extended remembering is, in principal, offered by a few personal semantic systems (e.g. personal semantic wikis, personal computer ontologies, personal information management system databases). However, no personal information system (besides the Artificial Memory prototype) has ever provided this function, because it depends on an explicit strategy of artificial reflective memory to create a satisfactory artificial memory externalization to draw from. PIM (personal information management) and knowledge management, in general, are normally considered a means to an end, namely reuse, with a decision to be taken: storing for later use or not storing (which is raised as an optimization issue). The importance of *transparent* reflective extended ecphorization as the entry door to artificial reproductive memory has been overlooked. The requirement of an extended artificial memory system to be a *universal* (intermediate) technological interface is further supported by this fundamental interdependency.

4.3.5.3 Artificial Productive Memory: Extended Endogenic Variation (Extended Thinking)

Artificial productive memory is pretty much the same as artificial reproductive memory, with one important difference, though. Instead of simply representing a given association *a'-b'*, the association between a' and b' is first constructed by the extended system, as an extended thought (d). *a'* and *b'* have to be known to the extended system. The thought is based on a more or less specific inference rule. Ideally, the inference rules represent externalizations of individual variable schema-abstractions.

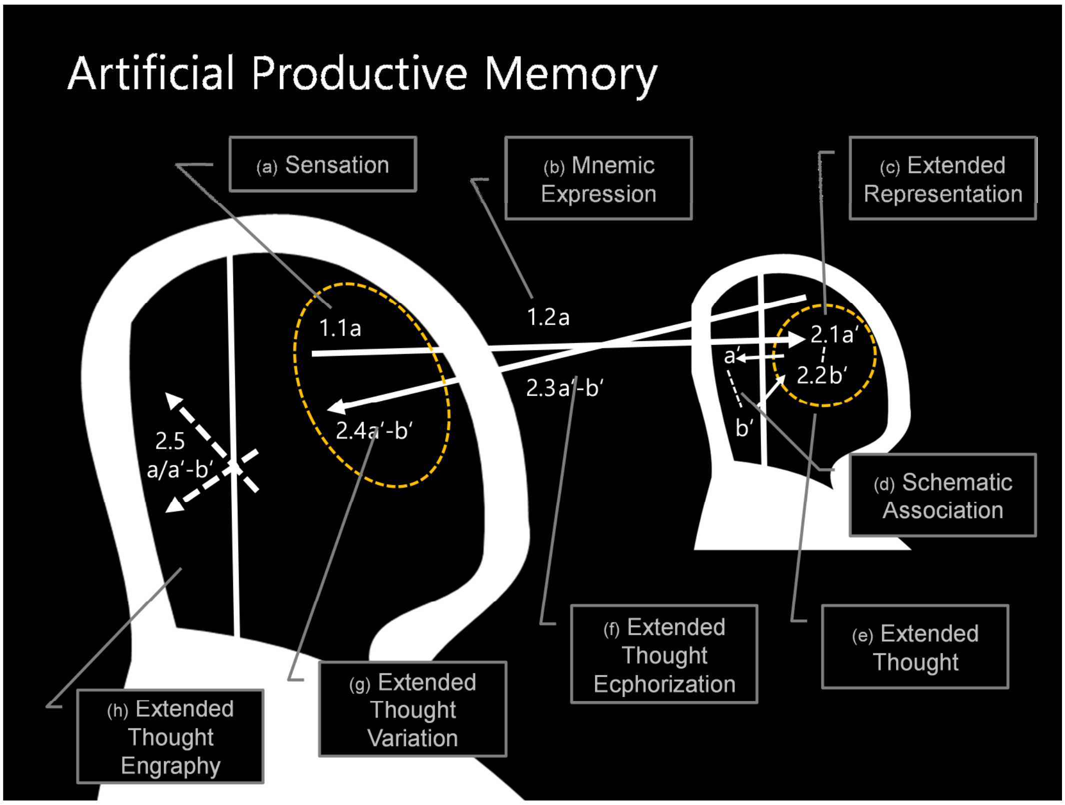

FIGURE 30: ARTIFICIAL PRODUCTIVE MEMORY

Culturally rooted syntacto-semantic schemata and common or, at least, culturally desirable (logical) inferential rules may form a basic set of inference rules for extended systems. The extended thought can have two forms: suggestion or confirmation. A confirmation represents the thought as if it were valid. For example, stating that *a* is a superclass of *b* (*a-b*) and *b* is a superclass of *c* (*b-c*), given the right chaining rule (repeated modus tollens), one could infer that *a* is a superclass of *c* (*a-c*) and, therefore, represent the two propositions as a subordination chain of *a-b-c*, even though it has (perhaps) never been thought as such. The implications of logical inference systems are different from actual associations in artificial memory, though. In our example, one could find that there indeed is an intermediate element (additional subordination propositions of form *b-x* and *x-c* in artificial memory), so that the representation *a-b-c* would have to be changed into *a-b-x-c*. In artificial memories, inference (beyond implicit schema- and chunk-abstractions) is not a matter of automaticity, but engraphy, namely engraphy of schematically organized and mnemic-ecphorically influenced simultaneous complexes. Even if all necessary inference schemata and propositions were present in artificial memory, the possible conclusions could be *absent*. Now, confirmation means that the extended system represents (logical) implications as if they were already engrammatically concluded, thus provoking either engraphically effective *acceptance* (not requiring any action) or rejection (to be reflected by corrective action and corrective reflective representation). Confirmation is a means to engraphically anchor logical consistency, allowing for fast, mnemic-associative conclusions, instead of depending on (slower) schematic abstractions. In our example, a conceptual compression (*a*-*c*) can be abstracted from the chain representation. Compressions are important shortcuts of mnemic-associative thinking. Thus, extended system confirmation accelerates and promotes the construction of engrammatic coherency and efficiency of artificial memory, transforming productive into reproductive thinking by perception. Extended endogenic variation seems to be of great value to individual human thinking. It is, however, very important to stress that the (engraphic) effect of extended thought confirmation can only be attained if the schematic associations are indeed backed by individual extended artificial memory. The representation of a *consistent* system (e.g. a textbook example) that is not directly conceivable by the artificial memory structures of the perceiving person will not produce artificial productive memory. Again, as with artificial reproductive memory, the dependency of this important memory-mechanism on extended ecphorization becomes obvious.

An extended thought suggestion is a representation that is not accepted by inactivity. Suggestions demand additional activity, creating the associations suggested. The need for distinguishing suggestions from confirmations lies in greater uncertainty of certain extended thoughts. The German *unbewußt* (un-conscious) is a negation of *bewußt* (conscious). *Unwetter* (bad weather), however, is not a negation of *Wetter* (weather). The syntacto-semantic prefix-schema of negation is thus not always applicable. Hence, a respective extended schematic antonymous association (of *Unwetter* and *Wetter*) would have to be presented as a suggestion rather than a confirmation. If a suggestion is found to be inacceptable, it should be possible to avoid it for good by rejecting it.

Extended thoughts are intrusive. There can be many of them, acceptable ones and inacceptable ones. Thoughts use to be the result of a thought-provoking state of bethinking. Extended thoughts should not provoke *memory overload*. The equivalent of bethinking thus has to be a technological process whereby ecphorization by extended thought is regulated. A clear (visual-perceptual) separation between extended associations and extended thoughts seems to be important in order that artificial productive memory can be generated by epistemic actions replacing the more general state of bethinking. In the

Artificial Memory prototype system, for example, extended thought suggestions are separated by location (according to the type of rule applied), representation type (hierarchies etc. for confirmations) and color (special color for suggested thoughts).

4.3.5.4 Artificial Learning Memory: Extended Exogenic Variation (Extended Learning)

Artificial learning memory is similar to artificial productive memory, with one important difference, though. Instead of a schematic association of the extended system, the extended system communicates with a second-order extended system to create an *external thought* representation.

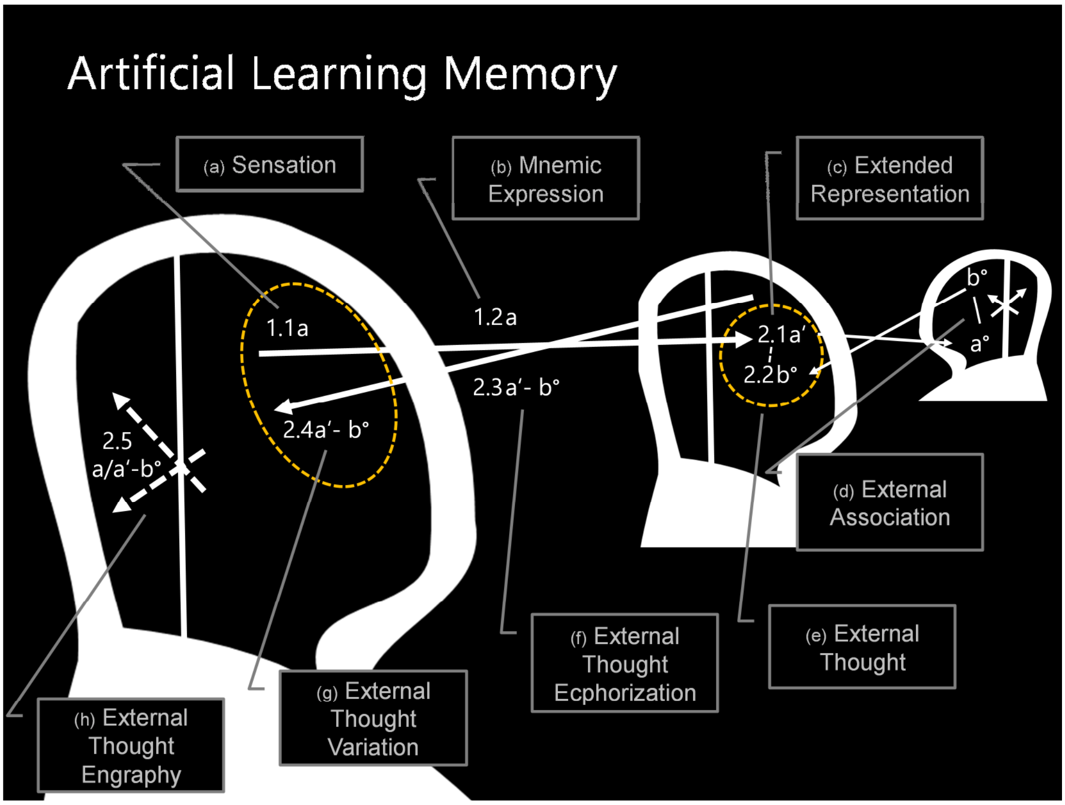

FIGURE 31: ARTIFICIAL LEARNING MEMORY

This function of the secondary system is similar to its extended reproductive function, only that here the primary extended system functions as the artificial memory system and has to represent new (non-extended) information (*b°*). As the extended system ought to mark the difference between extended endogenic variation representation and extended exogenic variation representation, it will have to analyze the external association representation in this respect. The information exchange between the primary and secondary extended (computational) systems is not restricted to the elements of the external thought (in our example: a', b°, a°, primary association schema, secondary association schema) but may include additional information for better disambiguation, filtering, evaluation etc. In this thesis, however, we are able to deal with the basic process only, not the (meta-)technological details. External thought ecphorization (f) differs from extended thought ecphorization in that the new entity will probably need further processing. A new word-compound, for example, would necessitate the conceptual integration of two words (i.e., the integration of two co-reproductive chunks). According to this, external thought engraphy (h) is also more complex than extended thought engraphy. Artificial learning memory, however, is far from being an uncontrolled process of information. It starts with a particular sensation *a* and the extended system will keep the representation of external associations restricted to those that include but a limited amount of new information and, hence, can be easily integrated into (the existing) artificial memory. New information is limited significantly in two ways. First, concerning the external association, it is partial, as some components (*a*, the association schema) are already part of the artificial memory. Second, with regard to the simultaneous complex inducing the process, the external thought ecphorization (f) is partially homophonous. This means that new information is (potentially) linked into a presently relevant context. Extended exogenic variation thus presents a form of *instantaneously associative* learning of (therefore) contextually evaluable [sic] information. Normally, learning is happening out of context (learning at school or learning by reading books, for example). It is obvious that this institutional learning model will play a less important role in tomorrow’s digitalized information world. The relevancy of instantaneous digital information augmentation depends on the capacity of the information system to represent or filter reproductive, endogenic-variable and exogenic-variable information depending on the individual artificial memories of the people being informed and the instantaneous interests given. An intermediate extended system for extended remembering, extended endogenic variation, and extended exogenic variation could best support augmentation. Extended exogenic variations, gained by epistemic actions, can solve many memory-process problems. Mind emptiness is avoidable. Mnemes can be tested for mind information-errors. Exogenic variations may help decide about ambiguous information (providing a second opinion). If the new information is restricted to (more) schematic(-associative) information, even mind unabstractness may be mitigated. If the extended system is able to filter information, mind overload can be avoided by checking new information for its capability to function as extended exogenic variations. In Figure 31, the exchange between the primary and the secondary system happens on the occasion of an expression into the extended system. However, as extended artificial memory, the primary system could *acquire* endogenic and exogenic variations independent of a specific situation. It could thus simulate future states of knowledge and start, in form of a simulation, integrating *distant* information variations. This offers a multitude of opportunities for efficient information processes: e.g. by choosing the right (order of) textual/serial information sources, by identifying possible learning paths, by pre-collecting relevant information, by foreseeing future memory-process problems, etc. An extended system can, in principal, host and evaluate individual learning models and thus assist in a life-long endeavor of efficient relevant learning.

4.3.6 Extended Artificial Memory Networking

We have already mentioned the use of an extended artificial memory system (EAMS) as a (potential) unifying universal interface to functional (software) services. There are, however, many more scenarios involving one or more extended systems. I want to mention a few here to demonstrate how extended systems can be arranged to meet many different needs that are addressed today by different information systems and communication technologies.

4.3.6.1 Extended Artificial Memory (person + own EAMS)

This is the main scenario of use of the experimental Artificial Memory prototype. It offers an artificial memory extension in the four forms described by the four extension mechanisms discussed and depicted. Extended exogenic variation is enabled by integrating a bunch of linguistic and other information resources.

4.3.6.2 Extended System Agent (person + different EAMS)

A foreign AM is a potential information source about a person’s artificial memory. The own AM can thus function as an agent communicating with other people, potentially gaining new insights (exogenic variations) and passing forward information that one oneself would likely have passed forward, if there had been an opportunity for personal information. Thus, this comes handy if direct communication is not possible. The extended system is the *natural* universal personal agent system because it *knows* best a person’s artificial memory, which includes his or her motives and interests. An actuation process taking the form of an *agent* substitution process depends on a satisfactory correspondence structure. The extended system as an agent system is, of course, best apt to guarantee ongoing correspondence. Here the value of artificial memory externalization becomes obvious again.

4.3.6.3 Agent Communication (EAMS + different EAMS)

If there are two extended systems functioning as agents, these agents can exchange information to acquire exogenic variations (extract new problem solution means, acquire new information, identify potentially erroneous knowledge etc.). Inter-agent communication comes handy if both parties are not available in person or personal communication is excluded for other reasons.

4.3.6.4 Personally Assisted Agent Communication (person + own EAMS + different EAMS)

Instead of directly interfacing a foreign AM, one could assist one’s own extended system agent (or one’s own agent could assist one) in communication with a foreign extended system agent. This comes handy if the communication serves an acute and changing purpose. By partial agent-based substitution, a personal technological process with a foreign agent can turn semi-automatic and, therefore, more efficient. The effectiveness of personal instruction of a foreign agent can be improved by one's own agent assisting the process by providing additional actuation parameters. Likewise, the own agent may help evaluating substitution parameters. Extended system agents can play a crucial role in improving technological processes involving other systems, especially other artificial memory extension systems.

4.3.6.5 Agent Assisted Personal Communication (several people and their EAMSs)

The memory-process extending function of extended artificial memory systems qualifies them to assist personal communication. Imagine the EAMS of a dialogue partner enriching the dialogue partner's statement with additional information addressing one's own EAMS or/and being directly perceivable. This would allow for many useful agent-assisted information and communication scenarios.

4.3.6.6 Agent Groups (different EAMSs united)

The extended artificial memories of different agents could be aggregated into agent groups. This allows for quantifications of artificial memory information. Today, information aggregated across different people is often associated with opinion polls, elections, audience research, data warehousing, social research etc. The reader should understand that all this could be substituted by agent groups sharing (limited) relevant information. What we nowadays see as vastly different information sources are, indeed, artificial memory artifacts and information of accompanying life recording (observational data points). Even something like social network analysis would present nothing but analytical technologies applied upon agent groups and their aggregated information pools. In today's fragmented technological world, artifact aggregation tends to be highly domain-specific. The analytical challenges, however, are the same all over the place. An important social function of extended systems lies in their organization into agent groups and aggregated information pools. One has to understand that, in the end, the replication/variation memory-process defines social (technological) activities and that its extension therefore offers the opportunity for efficient and effective *social* processes in general. Today's information and technology world is characterized by socio-economic organizational structures that can be traced back to pre-digital informational structures. One of the many challenges humankind faces is to overcome organizational information-process limitations. We live, so to say, in the Middle Ages of a future digital (extended) technology civilization, for will and representation are still bound to social organizations and the various belief systems they create. Meta-technological functions may turn agent groups into universal inter-individual regulatory systems (super agents), potentially replacing many of today's socio-organizational regulatory systems. In chapter 4.2.3, we discussed meta-technological processes, which aim at increasing the efficiency of technological processes. The technological processes improving the workings of super agents accordingly may be called *hyper-technological* (or social-technological) processes. They aim at an efficient regulation of multiple interindividual technological processes. Informational aggregations of agent groups should not be imagined as static aggregates, but as virtual/referential aggregations receptive to informational changes of subordinated agents.

4.3.6.7 Agent Group Communication (person/EAMS - agent group)

As super-agents, hyper-technologically enhanced agent groups, may steer functional technological processes (e.g. the traffic lights), they may as well serve as virtual unified interfaces and information channels toward the respective aggregated agents. The exact processes are subject to hyper-technological design and may depend on the purposes aggregated into the super-agent.

4.3.6.8 Inter-Super-Agent Communication (several super agents)

Hyper-technological processes may turn into higher-level meta-technological processes if several successions of agent aggregation create different layers of agent complexity. Inter-super-agent communication and agent communication are similar to some extent. Each layer of complexity, however, is likely to bring about its own hyper-technological challenges. The decisive difference to artificial-intelligence agent technology is that extended artificial memory systems will always be bound to the personal artificial memories behind them. This, as I have argued is a question of technological correspondence, based on the replication/variation memory process. From a more general, philosophical perspective, it is a question of biophilia or, more plainly, foresight.

4.3.7 Recapitulation of Extended Artificial Memory System Goals and Features (List Form)

In the following lists, I will shortly recapitulate the basic goals and basic features of extended artificial memory systems that we derived from our theoretical discussions.

4.3.7.1 Extended Artificial Memory System Goals

- Increase technological effectiveness and efficiency by supporting (computer mediated):
    - creativity
        - thinking (endogenic memory variation)

        - learning (exogenic memory variation)
    - acting
        - planning (memory variation)
        - substitution (reproduction)
    - communication (as technological double-process)
- Tackle basic memory-process problems.
- Reduce artificial memory artifact fragmentation and corresponding functional digital Taylorism.
- Avoid (extended) artificial memory de-personalization (loss of epistemic information).
- Tackle artificial memory artifact obsolescence by lifelong artificial-memory-dynamic (thought- and action-accompanying) artifact updating [without preventing forms of historicization, though].
- Enable instantaneous associative learning.
- Support artificial memory for improved expert cognition:
    - increase consistency of thinking by fostering inference engraphy
    - improve coherence and consistency of hierarchical and relational semantic artificial memory network structures through coherent representation
- Support socio-technological communication and collaboration extension and substitution.
- Avoid epistemic uncertainty and cryptomnesia[172].
- Enhance (artificial intelligence) technology processes by re-connection to extended systems.

4.3.7.2 Extended Artificial Memory System Features

- Extend (rather) mnemic-ecphoric memory-(sub-)processes into (more) perceptive-ecphoric memory processes:
    - extended ecphory
    - extended remembering
    - extended endogenic variation
    - extended exogenic variation
- Perceptual proxy function: manage (control/economize) attention by focusing on extended sensorial-ecphoric stimuli (extended system as intermediate filter medium).
- Individually universal (cross-domain) and individually normalized artificial memory artifacts data store and system.
- Universal interface to functional technological processes (services).
- Foster transparent technology-processes of chunk-expression / chunk engram exteriorization (using direct parameter specification, co-

[172] Cryptomnesia means mistaking a memory for imagination.

productive skills) in public and private speech and, more generally, action.

- Foster transparent technology-processes of re-information through universal epistemic actions (making systematic and strategic use of ecphoric priming).
- Integrate multi-faceted life-recording data (visual/audio recording, contextual meta information, sensor data, etc.) to (for example) …
    - enrich the representation of co-reproductive artificial memory entities (offering additional representational trigger-pathways and extended trigger memory structures)
    - support meta- and hyper-technological processes for technological efficiency
- Provide data granularity matching artificial memory chunks.
- Represent semantic network structures, namely …
    - compound/chunk hierarchy
    - relational semantic network
    - abstraction hierarchy
    - syntactic/anticipatory schemata
- Disambiguate polysemous, homonymous language chunk representations.
- Support (more precise) verbal encoding by word field representations.
- Allow to express controlled (visual) language.
- Allow representing language visually (visual language).
- Support visual visual language for visual co-reproductive chunks.
- Support chunk-based semi-structured natural language text writing (representation).
- Offer reading assistance by extended system-based pre-chunking, extended exogenic variation extraction etc.[173]
- Enable collective extended thinking and acting by extended system agent technology.
- Include transclusions of other extended artificial memories' entities (thus enabling epistemic transparency).
- Allow referencing to and actuating a Web/Internet of things and services.
- Support onomasiological and semasiological co-reproductive completion.
- Support minimal memory strategies/technological processes.
- Support perceptive augmentation strategies/technological processes.
- Support different forms of extended conceptual blending or extending conceptual blending.

[173] Tom Mitchell (Mitchell, 2012) imagines a reading assistant extracting relevant information based on machine learning technology, which could prove useful in combination with extended systems. The semantic enrichment of natural language text by ontology-based named entity highlighting, for example, is an older idea (that did not prove too useful).

- Allow variable schematic abstractions for querying (the Selzian means abstraction).

4.4 What is Knowledge? – Philosophical Excursion Into Knowledge Process And Knowledge Structures

What is *knowledge*? I cannot discuss this question in any detail here. What I can do, however, is to check how our ideas about a replication/variation memory process, about artificial memory and extended artificial memory by an extended system would, in general, influence an answer. In our theoretical considerations, there are many different informational states, all related to the memory-process and the extension options we have discussed. The following list summarizes these information states, possible sub-states, and variations in an ordered way to give an overview for further discussion:

(1) (original) sensory stimuli
(2) primitive (sensory) memory
- a. sensory engrams
- b. (original) stimulus excitation (sensory engram activation)
- c. perceptual priming
- d. perceptual integration
- e. original (*pre-ecphoric*) sensation
  - i. pre/peri-conscious stimulus sensation (e.g. in peripheral vision)
  - ii. (conscious) original stimulus sensation

(3) replication/variation memory
- a. original episodic memory trace
  - i. original engram
  - ii. original engram associations
- b. (static) chunk-abstractions
- c. (variable) schema-abstractions
- d. chunking episodic memory trace
  - i. chunk engram associations (of contiguity / simultaneousness)
- e. (meta-)chunk-abstractions
- f. (meta-)schema-abstractions
- g. co-reproductive chunks (forming artificial memory structures)
- h. ecphoric influences
  - i. stimulus-ecphoric influences
    1. homophonous (for familiarity)
    2. stimulus trigger (for co-reproduction)
  - ii. mnemic-ecphoric influences
    1. mnemic-associative (for remembering)
    2. mnemic trigger
- i. ecphorization (engram activation)
  - i. ecphoric(-associative) priming
  - ii. pre-conscious mnemes (e.g. masked)
  - iii. sub-conscious mnemes (e.g. in automatic actuation)
  - iv. conscious mnemes (episodically effective sensations)

v. deterministic (technological) schemata
1. reproductive schema (e.g. static-anticipatory)
2. productive (variable) schema (e.g. syntacto-semantic)

(4) simultaneous complex
a. perceptive simultaneous complex
b. mnemic simultaneous complex
c. mnemic-perceptive simultaneous complex

(5) artificial memory artifacts (co-productively created, co-reproductively triggering/effective artifacts)

(6) (partially) reflective artificial memory extension (by extended artificial memory system)
a. extended ecphorization
b. extended remembering
c. extended endogenic variation
d. extended exogenic variation

(7) social artificial memory extension
a. innate eusocial mirroring (e.g. via facial expressions)
b. double-technological process (memory-process-based, using artificial memory artifacts for co-reproductive ecphorization {e.g. in reading texts, visual instructions etc.}; potentially ambiguous)
i. sender-artificial-memory-detached artifacts (using unchanged artifacts after dynamic artificial memory changes)
ii. sender-artificial-memory-isomorphic artifacts
1. synchronous communication (e.g. instant conversation)
2. asynchronous extended artificial memory system based communication
iii. super-sender-artificial-memory-detached artifacts (e.g. statistics, co-authored texts, Wikipedia articles etc.)
iv. super-sender-artificial-memory-isomorphic artifacts
1. synchronous aggregation (e.g. voting by hand)
2. asynchronous aggregation (presentation) by virtual extended artificial memory system agent groups / super-agents

To the memory process, artificial memory artifacts (5) are sensory stimuli. Their epistemic distinction, however, is important, because they are usually part of a double-technological process of social cognitive/mind extension (7.b). **Reflective artificial memory extension (6) is also a double-technological process, but specifically designed to (at least partially) refer back to the originating co-reproductive artificial memory chunks (i.e., in the same organism). Reflective extension is a decisive pre-condition for *isomorphic* social extension (7.b.ii.2 and 7.b.iv.2), the latter, in turn, being a decisive pre-condition for correspondence of inter-individual double-technological processes.** Both, primitive memory (2) and replication/variation memory (3) contribute to simultaneous complexes (4). Replication/variation memory is also originally constructed via primitive memory sensations (memory traces). Artificial memory artifacts

(5) (especially) of natural language, as initially encountered in language games, have an inherent syntactic structure (mostly based on *word* similarity and word position) that reproduces productive schema-abstractions by means of the schema-abstraction mechanism of replication/variation memory.

The Semonian primary state of indifference represents an a priori engrammatic state of **a priori knowledge**. Primitive sensory memory (2) is **sensory knowledge**, which is integrative and abstract in a pre-episodic manner. Replication variation memory (3) contains **episodic knowledge** (3.a, 3.b) and **abstract knowledge**. Sensory, episodic and abstract knowledge is either *indifferent engrammatic*, *primed* or *activated*. Knowledge, of course, can be distinguished by other memory dimensions, too. Co-reproduction engrams are the basis of artificial memory (co-)structures. The traditional meaning of language does not fully cover the alleged great variety of co-reproductive engrams. I would therefore rather speak of **artificial memory knowledge** than *language knowledge* or *semantic knowledge*. The simultaneous complex (4) integrates active sensory knowledge (percepts) and active episodic and abstract knowledge (chunk/schema-mnemes) (4.c). It is normally perceptive-ecphorically, mnemic-ecphorically, and mnemic-associatively chunked. A specific chunking state can be achieved by more or less endogenic or exogenic influences. *Knowing the time*, that is, episodically filling a variable task-schema of type *the-time-now-is-…*, can be achieved by remembering a recent time-information (episode) or by an epistemic action of reading the time. Let us call the knowledge-schema being filled here (engrammatic) **variable-schematic knowledge**. If *knowing* were to refer to an invariable reproduction (simple ecphory or mnemic-associative remembering), the respective engram complex would best be named **invariable knowledge**. The effectiveness and efficiency of variable-schematic knowledge (technologies) is to be considerably increased by using an extended artificial memory system. Extended exogenic variation delivering the missing variable parts (by means of content services), substitutes specific epistemic actions (e.g. looking up the time on my wristwatch) with a general epistemic action: extended exogenic variation *reading*. **Extended variable-schematic knowledge** thus starts to resemble invariable knowledge, in that it, too, demands but a *transparent* epistemic action [bethinking versus *retrieving*]. Losing the epistemic variable-schematic knowledge (e.g. because of Alzheimer’s disease or a substantial brain lesion), will render the extended system useless, though. Knowing (as a certain simultaneous complex), as we have seen, does more or less depend on (engrammatic) knowledge. **Extended knowledge** could be said to any specific set of engrammatic, effectuation-/tool-, and artifact-preconditions given in order to instate a particular simultaneous complex (of knowing). Artifacts serving extended knowledge thus present **artifactual knowledge**. The *content/role* of artifactual knowledge depends on the extended knowledge scenario they help to instantiate in a simultaneous complex. Artifactual knowledge is always part of technological processes instantiating the anticipated/desired simultaneous complex. In (personal/social) artificial memory extension (7), extended knowledge is shared through artifactual knowledge.

5. Extended Artificial Memory Technology

5.1 Software Experiment

5.1.1 Experiment

The theoretical work presented so far, which constitutes the main part of this thesis, would have been impossible for me to think without the insights and software support gained from an experiment creating and using a software prototype called Artificial Memory (AM), which I started to develop 10 years ago. Right from the start, the purpose had been to create an *artificial* memory (which I nowadays would rather call *extended artificial memory system*) that would solve the technological problems in (personal) knowledge management that I had encountered in my professional work and for which I did not see adequate software-solutions or software-concepts. In 2004, I took a one-year scientific sabbatical to study Semantic Web technology and theory at the Digital Enterprise Research Institute's subsidiaries in Innsbruck, Galway, and Stanford. I am thankful to Prof. Dirk Fensel, Prof. Stefan Decker, and Dr. David O'Sullivan for their support and the exceptional freedom they gave me to follow a scientific path of my own. Some software-features and early theoretical ideas developed during my stay with DERI were published in (Ludwig, O'Sullivan, & Zhou, Artificial Memory Prototype for Personal Semantic Subdocument Knowledge Management (PS-KM)., 2004) and (Ludwig & O'Sullivan, Deploying Decision Support Systems Using Semantic Web Technologies., 2010). More recent software-features and theoretical ideas were published in (Ludwig, Lösungen zum multilingualen Wissensmanagement semantischer Informationen, 2010) and (Ludwig, Artificial Memory - Eine kurze Einführung in Struktur, Aufgaben und Erfolgskennzahlen., 2009). The Artificial Memory experiment was thus accompanied by extensive scientific research and scientific publishing and contributions to different conferences dealing with semantic information technology and information/knowledge management. This chapter, therefore, is intended to present but a supplement to the existing publications. It is restricted to highlighting core features (more or less) matching the theoretical ideas presented so far.

The Artificial Memory experiment is, at its core, a self-experiment, swaying to and fro between the (micro/bottom-up) perspective of personal software (usability) testing and the (macro/top-down) perspective of scientific theorizing. The usable technological idea had and has to translate into theory, and important theoretical ideas had and have to translate into usable technology. The context of use is real life. In Personal Information Management research, this method is called *naturalistic approach*, characterized by (Naumer & Fisher, 2007) as studying *whole systems, in real-life or field settings*, seeking *to understand phenomena*, possibly *not using theory as the study's outset*, viewing *the* *researcher as an insider and as the primary data collection instrument*, as this would allow for *adjustments of initial working expectations or hypotheses, which often change during the research hermeneutic process*. This is somewhat similar to the wicked problem approach of Horst Rittel. The Artificial Memory experiment is thus not an experiment for test or proof [Beweisexperiment], but an experiment for understanding [Erkenntnisexperiment]. The software-technological advancements at the beginning of the experiment used to outpace the theoretical progress, whereas today, the theoretical progress has by far outpaced the software-technological advancements.

5.1.2 Software

Regarding the software type, the Artificial Memory (AM) prototype resembles most a *personal semantic wiki*.

5.1.2.1 Wikis

Wikis are hypertext content management systems for user-generated hyper-personalized content. In wikis, content is organized in hyperlinked, named freeform text articles that are structured using wiki syntax/markup. Wikis are said to use networked collective intelligence by contributions of wiki article readers, correcting errors in the wiki article and adding missing information. Wikipedia is a popular example of a public *encyclopedic* wiki. The named article structure of a wiki is similar to the article structure of an encyclopedia. In Wikipedia, this has led to the belief that there should only be a single article on any one subject and that certain subjects are not worthy of being discussed in Wikipedia. This age-of-print dogmatic stance[174] is one reason why so-called edit wars were frequent on Wikipedia before administrators established their personal views and author numbers (consequently) dropped sharply. Wiki software does only restrict the names of articles (disallowing name duplicates), though.

A wiki's main access mechanism is search. Search is first of all *article name* index search, not *article content* index search. The success of the wiki paradigm on the WWW is in part based on its inherent keyword-oriented structure, automatically optimizing wiki pages for search engines. The search engine keyword index forces all content providers (striving for visibility) to organize their content by (PageRank-optimized) *named* pages fragmenting text into keyword-conforming *snippets*. In a way, search engines are turning the WWW into a single wiki, and, thus, massively change reading habits, very probably impairing reading skills and text interpretation skills of digital natives. Jaron Lanier (Lanier, 2006), for example, remarks that he observes *a loss of insight and subtlety, a disregard for the nuances of considered opinions, and an increased tendency to enshrine the official or normative beliefs of an organization*. Search engines, which are increasingly habitually used thought-accompanyingly for generating (extended) knowledge on the fly, limit the individual to a single (search-engine-optimized condensed) view [allegedly *the truth of the matter*, so to speak], at least unless they are sourced by adequate memory-process oriented extended systems allowing access to and exploration of individually varying knowledge structures. The search habit may not be that bad after all, the *source* habit, on the other hand, certainly is.

[174] This was sarcastically dubbed as *Digital Maoism* by Jarone Lanier, who fears that *wikifying* decontextualizes texts, erases personality, and results in normative beliefs (Lanier, 2006).

5.1.2.2 Semantic Wikis

A *semantic* wiki comes in two variations, as *wiki for ontology* and *ontology for wiki*, often depending on whether a wiki system is attached to an existing ontology management system, or an ontology editing system is called from an existing wiki system [175]. Semantic wiki systems use to implement Semantic Web stack languages like RDF (Resource Description Framework) / RDF Schema and, less commonly, OWL (Web Ontology Language), which support variations of description logic (e.g. OWL DL) or (full) first order logic (e.g. OWL FULL). Logical inference of new knowledge, however, is not a core function of semantic wiki systems. The main use of computer ontologies in semantic wikis are type (class) creation, ontological typification (classification) and feature statements in entity-property-value or entity-property/relation-entity (triple) form. Typically, the computer ontological class, instance, and property/relation entities are accessible as wiki pages. Their creation is possible via semantic wiki markup statements within wiki articles (often as casual annotations) or via specific user interfaces, such as wiki plugins and components of ontology management systems. The computer ontology is represented as wiki links (through the data creation markup), as semantic inline queries (wiki syntax stating semantic queries) and/or as special visualizations (depending on plugins and system components available). The basic goal of semantic wikis is to combine - within the collaborative wiki paradigm - both freeform text editing and formal ontology management, that is, (metadata-)*unstructured* and (metadata-)*structured* language expressions, thus combining the advantages of collaboration, (easily findable named, focused/sub-document) natural language texts, and normalized databases.

5.1.2.3 Personal Semantic Wikis

The use of Semantic Web technology for personal knowledge/information management was first discussed in Leopold Sauermann’s diploma thesis (Sauermann L. , 2003), promulgating the idea of a *Semantic Desktop*, which developed into the international research project: NEPOMUK [176]. Due to the decreasing importance of the desktop (metaphor) in an age of Internet services and Internet (text snippets) content, the file- and application-oriented Semantic Desktop idea had always appeared to be a somewhat anachronistic undertaking, though. The general idea of a universal personal information system (desk) was originally introduced by the visionary Vannevar Bush in his *Memex* concept (Bush, 1945) that inspired generations of researchers in the field, especially the astonishing Douglas Engelbart, inventor of computer mouse, hypertext, networked computers, and graphical

[175] A prominent example of an ontology for wiki is the Semantic MediaWiki (www.semantic-mediawiki.org/) system that integrates a semantic/ontology system into the MediaWiki system (which runs Wikipedia). An example of wiki for ontology is OntoWiki (www.ontowiki.net).
[176] See nepomuk.semanticdesktop.org/nepomuk.

user interfaces (GUIs)[177] – all more or less at once. Engelbart, as Terry Winograd and Ben Shneiderman after him, represents the idea of computational *knowledge augmentation* rather than (autonomous) computational artificial intelligence. Knowledge augmentation is an idea that the author, too, strongly supports, by stressing the fundamental importance of technological correspondence and of human-computer extended-system design.

Personal semantic wiki means the use of a semantic wiki system for personal knowledge management. The personal use can be further facilitated by shipping a personal ontology schema such as PIMO[178] (Personal Information Model). An important difference between a (personal) semantic desktop and a personal semantic wiki is that the semantic wiki user will normally give up creating documents for personal knowledge management, for rather than writing documents, the wiki author edits wiki pages. Personal semantic wikis therefore have to offer the mechanism of transclusion (virtual inclusion) for aggregation of more focused content sections into different (audience tuned) sequentially *structured* documents. In personal wikis, editing of a wiki page by multiple users is replaced by repeated editing by a single user. Changes on personal wiki pages normally reflect changing knowledge of a single individual. Changes on wiki pages, on the other hand, rather reflect different knowledge of different people. In terms of extended systems, a traditional wiki would be a kind of *meta*-content-system, transcluding the content of different extended systems onto *virtual* wiki pages.

Single-application personal semantic wikis, multiple application semantic desktops, and, in-between both of them, single semantic desktop-applications (ontology-based personal information management systems)[179] are as close as we can get to extended systems in terms of current IT concepts. However, placed under theoretical scrutiny (which would need another publication, though), none of these system designs manages to live up to the expectations introduced by the extended system framework.

[177] See en.wikipedia.org/wiki/Douglas_Engelbart (accessed on 29.11.2012).
[178] See, e.g., (Sauermann, Ludger, & Dengel, PIMO - a Framework for Representing Personal Information Models, 2007).
[179] A good example would be David R. Karger's Haystack system. See, e.g., (Adar, Karger, & Stein, 1999).

5.2 Technological Sketches for Extended Artificial Memory

5.2.1 Introduction to Artificial Memory Basic Functionality

Artificial Memory[180] (AM) is a server application[181] with a Web-browser client using platform-independent standard Web technology (HTML, CSS, JavaScript, Ajax etc.). Information is kept in a proprietary triple (or, rather, n-tuple store).

Artificial Memory uses a huge integrated lexical database including, for example, over 4 million unique word and phrase strings in several different languages (relevant to its creator, i.e., mainly English and German, to a lesser extend Spanish, Russian, French, and Latin). Most word strings of English and German are enriched by grammatical information that could possibly be represented by them, such as word types, conjugation, government, declension, comparative, gender etc. Word strings are pre-analyzed with regard to their syllabic structure and (all) their possible compound and phrase structures. Word strings are, furthermore, inter-related using thesaurus relations. Word-stem and affix structures were pre-analyzed generating a hierarchy of morphological derivations across different word types. There are many additional bits and pieces supporting specific functions. Corpus-related language-dependent string/n-gram frequency, for example, is used as one of several indicators for automatic language disambiguation; the Wikipedia article index is used for dynamically setting icon-links from named ontology entities onto their respective Wikipedia articles.

As by today, the author’s personal ontology acquired during the experiment contains more than 100.000 named ontology entities and nearly 500.000 triple-type propositions, the vast majority of which were added consciously[182]. Hence, they represent distinct word chunks and controlled natural language propositions that were thought at least once by the author.

[180] A functionally restricted version for information viewing is available online at www.artificialmemory.net.
[181] AM is programmed in C# (4.0) using ASP.NET. It uses a proprietary triple store based on Microsoft SQL-Server.
[182] There are only few ontology meta-schema relations being created automatically.

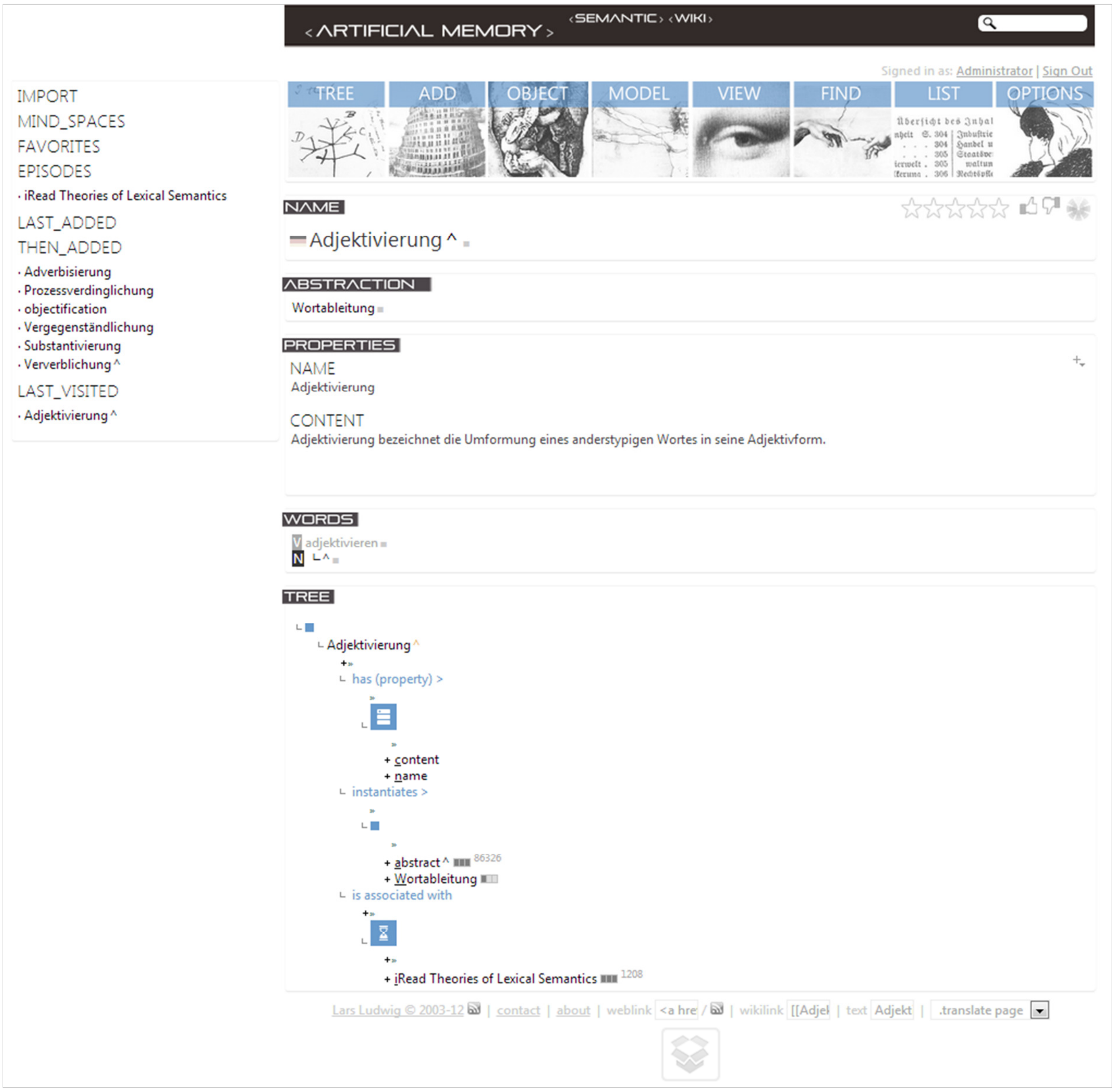

FIGURE 32: ARTIFICIAL MEMORY MAIN PAGE / UI

To give an overall impression (as we will soon focus on very specific features only), in Figure 32, the main page of AM is depicted, with an ontology entity/semantic wiki article open. At the left side, there is a menu panel. It is mostly used for contextual information and navigation. The main panel contains, at the top, the autocomplete/autosuggest search field and the huge [for quick selection] horizontal functional-menu bar. Below the menu bar, there are different content sections (in the example of Figure 32: *Name*, *Abstraction*, *Properties*, *Words*, *Tree*). A content section visualizes a specific type of information for in-depth consideration. The main view focuses information around a single ontology entity / wiki article (single window interface). However, multiple focus objects can be shown in different browser tabs or browser instances. There are three standard sections (out of 17 possible). The Name-section shows the name of the focus object and information for (conceptual) disambiguation. The Properties-section shows the *Wiki article* or, more generally speaking, any property-value pair information. Wiki articles tend to be provided as *content*-properties. However, they can have an outer (object-oriented) property-structure (i.e., one article across multiple properties/property-values) or an internal (wiki syntax) text-structure. Each property value is encapsulated into an ontology entity, thus becoming individually relatable. All ontological propositions (triple statements) *concerning* a focus object are listed in the Tree-section. The proposition-tree contains all direct- and reverse-relation statements including the focus object. It also comprises direct reifications and higher-level reifications. Semantic complexes like the following *sentence*, stacking two reifications, will be represented:

{A | LIKES | (THAT) {B | KNOWS | (THAT) {C | WANTS | D}}}

A tree will show this complex from the perspective of each respective focus object involved. The proposition tree of D, for example, would restructure the complex like this:

{{{D | IS WANTED BY | C} (THAT) | IS KNOWN TO | B} (THAT) | IS LIKED BY | A}

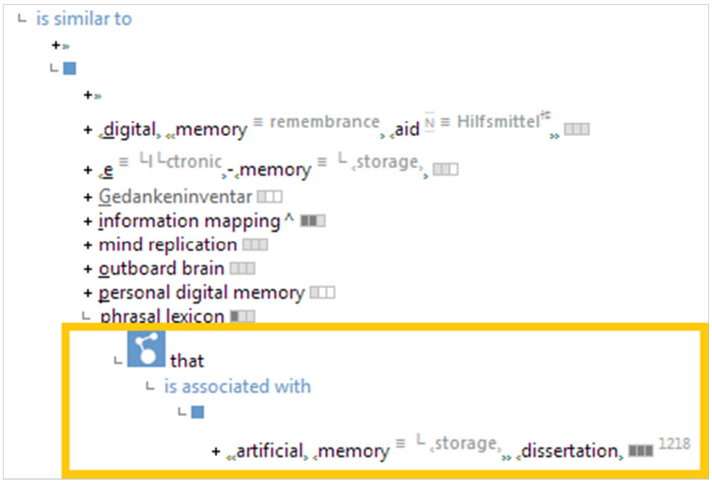

FIGURE 33: CLIPPING: REIFICATION REPRESENTATION (THAT-CONSTRUCT)

The tree can be organized into different views for different purposes. It can be directly manipulated to a huge extent and dynamically extended via AJAX-calls (i.e., without reloading the page), in order to advance (associatively) into the related semantic network structure (see Figure 34 for an example).

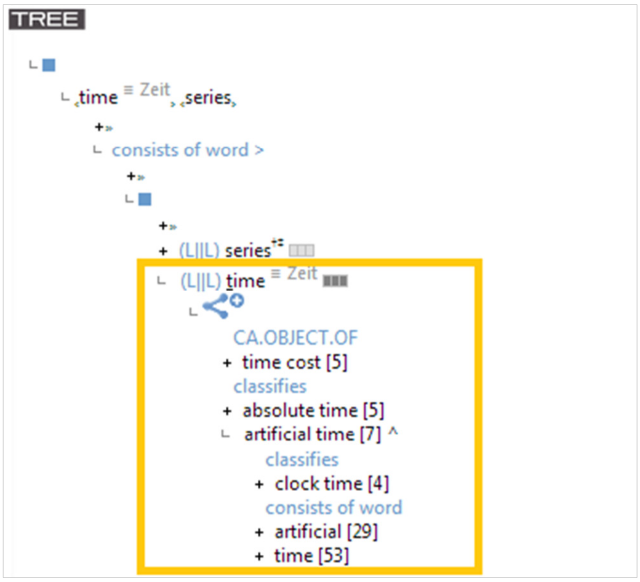

FIGURE 34: CLIPPING: TWO-STEP AJAX-EXTENSION OF PROPOSITION TREE

In the tree, the focus object (*time series*) is represented as the basic node. The secondary tree level is made up by active and passive predicate-object labels (e.g. *consists of word*) depending on whether the focus object is the subject or object of a bi-directional relational proposition. The predicate-level subsumes all subjects/objects of the respective propositions, further structuring them by template-membership.

Templates such as *person*, *object*, *organization* or *book* are special, pre-configured sets of property-value propositions and standard-propositions (e.g. a default typification) automatically applied during ontology entity creation. The typification of ontology entities is not restricted by templates, though. The template-membership can, furthermore, be modified or changed later as needed. Range- and domain-restrictions [183] are bound to templates rather than types (aka classes). Inheritance, on the other hand, is coupled to types, not templates. The reason for combining template-structures and template consistency rules with (classical) type-based inheritance structures is that ontology engineering in the context of knowledge management, or, more precisely, ontology-based knowledge management, cannot reasonably enforce full-grown type hierarchies (for the purpose of type-based consistency and inheritance-based *templating*), as the expression of ontology entities has to follow thoughts and cannot be dominated by the needs of proper/classical ontology schema engineering. In ontology-based knowledge management, however, types tend to form islands that are not properly integrated into (underspecified, highly abstracted) upper ontologies anytime soon. I have called thought-accompanying, bottom-up ontology engineering *reverse ontology engineering*, for it uses to start

[183] In a subject-predicate-object triple-statement paradigm, a predicate-domain rule limits the subject-instances to which the property (predicate) can be applied. A predicate-range rule limits the object-instances to which the property (predicate) can be applied. Both rules refer to instance-types.

with middle or domain ontology entities (basic-level concepts) instead of upper ontology entities, only gradually growing into hypo-specific (schematic) abstractions and hyper-specific (combinational) chunk-abstractions. The author has found that the engineering of computer ontologies typically follows computational/logical needs (of reasoning support) rather than being appropriate to accompany knowledge acquisition and knowledge expression. Thus, standard ontology engineering (technology) is usually not suitable in an extended system context. This is also evident in other design restrictions, such as forbidden *multi-level instantiation* (an instance functioning as a type of another instance and so forth), which are essential in representing abstraction hierarchies. In my experience, **a lot of (semantic design) confusion in the IT-world (especially in ontology-engineering and object-oriented design) is due to mixing (schematic-reductive) abstraction hierarchies and (combinatorial) compound/chunk-hierarchies in *shared* type-hierarchies for single-level (or, more precisely, meta-schematically, *double-level*) instantiation.** It would be an interesting and challenging task to design an alternative general information-technological model more apt of reflecting symbolic artificial memory structures.

In Artificial Memory, triple statements are easy to add. Referring to the focus object, in a two-step process, predicate(s) and object(s) are selected (and, if needed, first created), supported by Ajax-autocomplete/autosuggest lists.

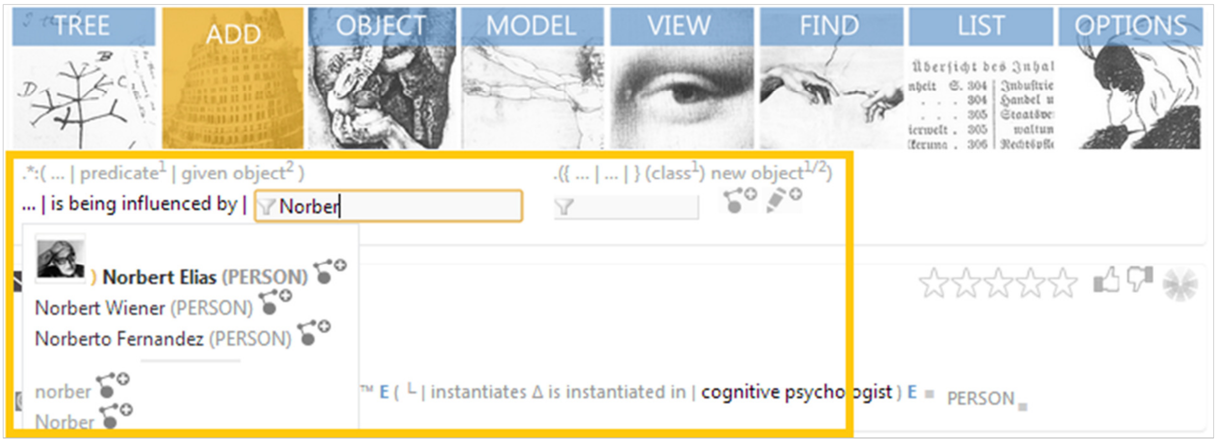

FIGURE 35: CLIPPING: TRIPLE CREATION USING AUTOCOMPLETE/AUTOSUGGEST

In Figure 35, the passive predicate label (*is being influenced by*) has been selected, and, in the second step, a name is being inputted to identify the triple object, supported by a suggestion list below the text box. The process is optimized in a way that it is usually faster than freeform text editing (by means of autocompleting, multi-selection, use of wildcards symbols etc.), in order to enable thought-accompanying triple additions. The domain and range consistency rules are already enforced in autocompletions and autosuggestions before actual selection. Controlled natural language triples offer an alternative to freeform wiki text, the latter always being ontologically encapsulated, but – as natural language statements - not *machine-readable*.

As controlled natural language triple (or, rather, n-tuple) statements offer numerous advantages over sentential natural language statements (e.g. in navigation, automatic inference, findability, etc.), in Artificial Memory, there is an easy-to-learn syntax-marker inventory available for enriching triples semantically:

- Valence (I want, I avoid)
- Deontic Valence (I think it … must be, should be, is permissible, should not be, must not be)
- Epistemic Origin (I experience, I infer, I hear someone/something saying)
- Realism (I perceive it … as fiction/fantasy, as hypothesis, metaphorically)
- Trust (I believe, I doubt)
- Typicality (I think it to be … categorical, typical, accidental)
- Period Under Review (I think it to be/have been/will be valid … in the past, at present, in the future, at all times)
- Frequency (I think it to be … anytime, most times, sometimes/at least once)
- Potentiality (I think it to be … a necessity, a possibility, an impossibility)
- Existence (I think it to be … uncertain, not valid/untrue)
- Literalism (I mean it … as a subject-literal/significant, object-literal/significant)
- Closed World (Assumption) Marker (I think … these triples belong to a complete set of propositions)[184]

Many of these markers are sensitive to predicate bi-directionality. There are, furthermore, special advanced dialogues for specifying precise or fuzzy times under review, precise or fuzzy frequencies (predicate quantifiers), and precise or fuzzy quantifications (subject and object quantifiers). In Figure 36, the sub-menu to mark a proposition (or set of propositions) selected in the tree-section is shown. By its triple(-components)-marker-system, the AM prototype supports a high degree of ontological expressivity. The markers are sequentially combinatorial. One could state, e.g., that … one wants [W] that in the future it is true [(] (that) (A | is being influenced by | B). Most markers can also be applied onto single ontology entities (and reification entities). The two-letter sequence *)A*, for example, would mean that in the past [)] there existed (say, a *person*) *A*. I cannot discuss the marker-system in more

[184] Normally, AM does *not* operate under the closed world assumption, which states that anything not said must be wrong. Some sets of propositions in AM, such as all the continents (the instances of type continent) could be final, however, and hence can be marked as completed/closed.

detail here, though, as there are many complicated questions touched by it that would need another thesis to answer.

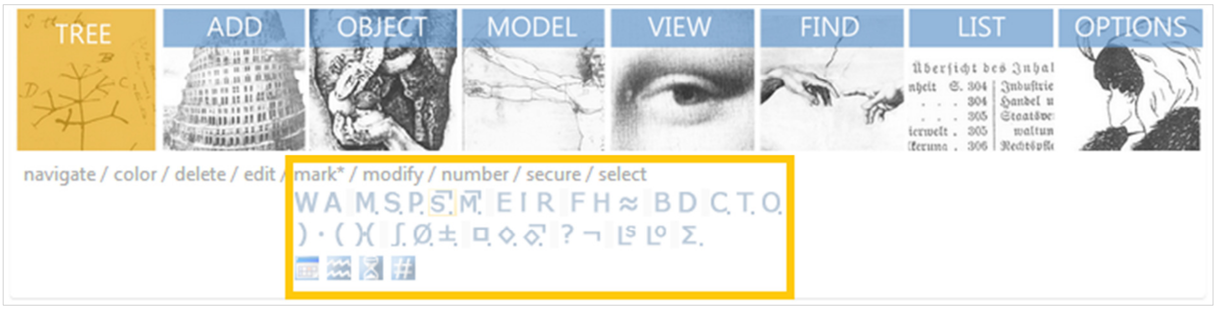

FIGURE 36: CLIPPING: SUB-MENU SHOWING TRIPLE(-COMPONENT)MARKERS

It should not go unmentioned, however, that there is another, far more experimental marker system available in AM, namely for emotive marking. It makes use of Robert Plutchik's wheel of emotion[185], as depicted in Figure 37.

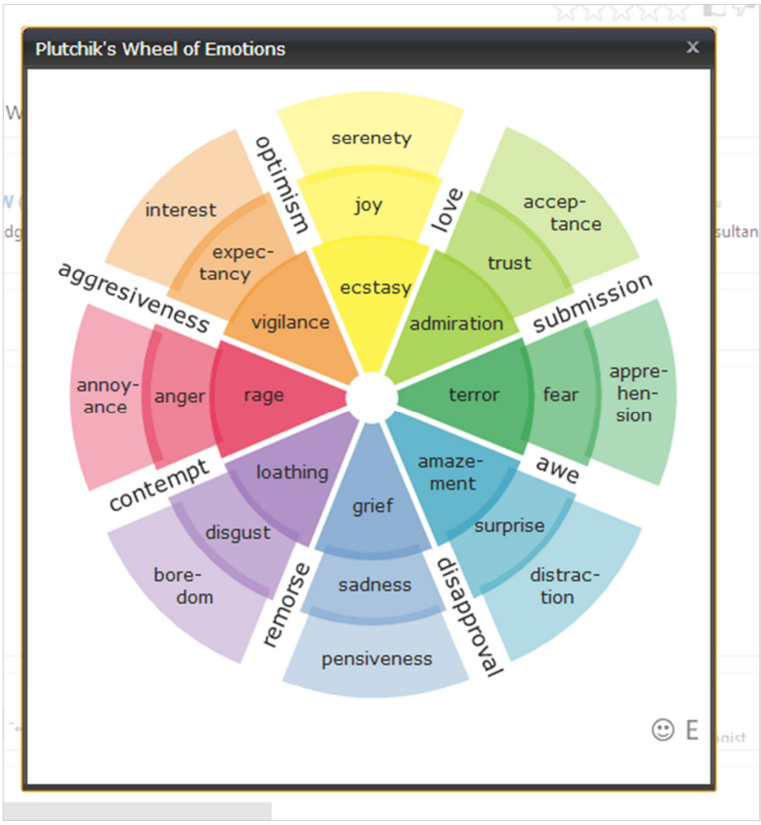

FIGURE 37: POP-UP COLOR-FIELD-MENU FOR EMOTIVE MARKING

For (wiki) text editing, AM wiki syntax supports, for example, name-based inline linking, link-based entity creation, inline link paraphrasing, (image-)attribute transclusion, and multi-level transclusion. The importance of transclusion for unstructured text normalization has been

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185 See, e.g., en.wikipedia.org/wiki/Robert_Plutchik#Plutchik.27s_wheel_of_emotions (accessed on 26.11.2012)

stressed by me before. In Figure 38, examples of inline linking and transclusion from a help page are shown.

One of the most usable features in AM is its support of HTML5 drag-and-drop of web-images, system files and text snippets into AM or an existing entity, which permits a quick transfer of different outside information objects into the system.

Figure 38: Examples of Semantic-Wiki-Syntax Applied (on a help page)

I will now turn to a choice of specific functions of the Artificial Memory prototype, paying special attention to the questions of disambiguation (polysemy and homonymy) and synthesis (synonymy and compounding).

5.2.2 Multilingual Virtual Synsets

Synonymy poses a problem to ontology engineering (and knowledge management alike). A (first) common simple solution to this problem is to declare it nonexistent, by stating that ontology entities represent concepts rather than labels. As synonyms refer to the same concept, there allegedly is no problem: labels just don't matter. Strict logicians sometimes hold this view, for labels indeed do not change the symbolic mechanics of logical inference. If there is doubt about a concept definition, the shortest way to end a dispute is to point out that the opposite party's ideas simply do not matter, because they use (other, often synonymous) labels to describe their deviating ideas, while, in the opinion of the strict logician, all that really counts is the consistency and correctness of her axioms and inferences, not a *philosophical* discussion - endangering her work. Of course, the symbols manipulated by the logician are not meaningless (to the logician). They belong to meaningful co-reproductive chunk complexes. The problem of differing interpretations (or, more precisely, of inter-individually differing co-reproductive chunks and their memory-trace related differing meaningfulness), often (but not exclusively) manifesting itself in the use of synonyms, cannot be tackled by denying the critical role of word-labels as shared triggers of engrammatic concepts forming the basis of logical inferences or, in other words, conceptual blendings. The proof of the pudding of symbolic logical inference is its engrammatic effectiveness, not (just) its formal conclusiveness. The *uncommunicative* logician is a logician of her personal logic or *grammar*.

Another, rather conciliatory problem solving method is to allow multiple (synonymous) labels of a concept, as everybody should find a way to the symbolically expressed concept. The labels become name-properties of a concept. This strategy makes it easier to reach agreement on a concept. *Referential* synonyms, however, represent specific co-reproductive units of their own. Integrating them into a single (logical) concept may blur important conceptual differences. Furthermore, the creation of synonymy has to be thought as a process rather than a single step. Words we consider synonymous may turn polysemous or non-synonymous. Non-synonymous words, on the other hand, may turn out to be synonyms. The idea of a label *not* representing a specific concept (a singular co-reproductive unit) of its own is problematic also because memory traces will refer to specific *synonyms* (or, in other words, will contain specific triggers and their respective co-reproductive units). Hence, both non-label/artificial label and multiple label concepts are not satisfying problem solutions.

In the Artificial Memory prototype, each synonym is presented as an ontology entity of its own. Synonymy is being indicated by a synonymy-relation statement. Conceptual integration is virtual and, thus, reversible. A virtual synset is a network of ontological entities (being more or less directly interrelated. The property set of the synset consists in the aggregation of all propositions of each participating ontology entity into a distinct [sic] set of propositions. In checks for future consistency, the virtual synset acts as if it were a single entity. However, due to the individualistic history of virtual synonyms, *existing* inconsistencies have to be accepted (for a while). **Even though virtual synsets pose a considerable computational problem (as losing *decidability* requires counter-measures, for example, in order to prevent endless looping in an allegedly hierarchic structure), they still [sic] represent a desirable state *demonstrating* to the user her own *engrammatic* inconsistencies resulting from declaring two (named) ontological entities (and their possible respective virtual synsets) to belong to the same virtual synset. With virtual synsets, therefore, the proof, indeed, *is* in the pudding, whether we like it** (it is consistent) **or not** (it is inconsistent). **The seemingly illogical artistry of the virtual synset is in *not* avoiding the pudding in the first place.** Reversibility or other, corrective measures may help restoring a state of (desirable) consistency in the virtual synset.

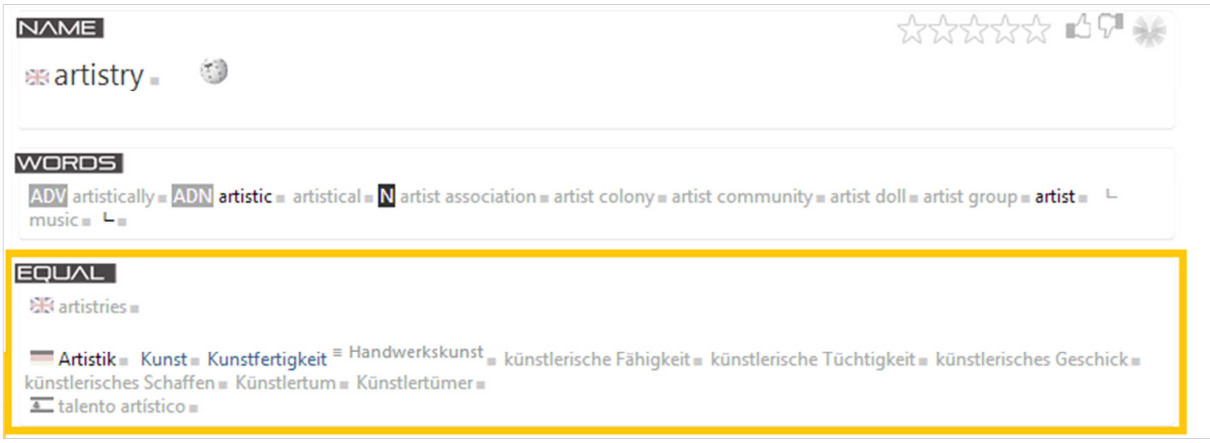

Figure 39: Clipping: Example of Virtual Synset Section

The virtual synset is highlighted in a separate section (the EQUAL-Section). In Figure 39, the equal section of the focused ontology entity *artistry* is shown. There are hyperlinks of three different colors: black, blue and gray. Black (as in *Artistik*) indicates an existing ontology entity related (as the section title suggests) as a synonym. **This exhibits information for *extended remembering*.** Blue (as in *Kunst* and *Kunstfertigkeit*) indicates existing ontology entities that (by an external interpretation) are suggested to be declared as synonymous. **This exhibits information for *extended endogenic variation*.** Gray (as in *artistries* or *talento artístico*) indicates possible *new* ontology entities (that, in this section, would become candidates for synonymy). **This exhibits information for extended exogenic variation. This color code for different information types of extended artificial memory is** (to be) **used consistently** in the Artificial Memory prototype. In Figure 39, the three forms of extension are grouped by (available) languages, as indicated by the three country flags.

Virtual synsets are used for *multilingual knowledge management* in Artificial Memory. A (word-)translation is, in the simplest case, but a foreign language synonym. Proposition sets across synonyms of different languages are aggregated and sometimes (for special purposes) even *language-normalized*[186] into a distinct set. The virtual synset demonstrates how the theory of extended artificial memory may influence and considerably change the design strategies used for ontology and knowledge management. From a memory-perspective, inconsistency is not a situation to be avoided or denied (to ensure *computation in finite time* or *rule-conformity*), but an information state inducing dis-homophonous, discrepant simultaneous complexes, *showing* possible engrammatic discrepancies. The inconsistencies of inter-individual virtual synsets could highlight (through meta-technological strategies) possible difficulties of communication due to differing, incompatible opinions (between the parties participating in the virtual synset). Networked extended systems may thus become an important tool for collaborative ontology engineering or, more generally, for (enabling) efficient knowledge-sharing communication, gradually reducing or, at least, uncovering and emphasizing inter-individual conceptual differences and inconsistencies (as were discussed with respect to the plurality of theories in chapter 1.1.1.).

An important practical aspect to virtual synsets is the display of property values. Propositions are aggregated into a *distinct* set that is displayed in the Tree-section. Property values have their own *Properties*-section. An ontology entity in a virtual synset displays property values of synonyms of the virtual synset it belongs to as if they were their own. This allows for a manual process of textual normalization or alignment (e.g. of multilingual entries). Property values of co-members of the virtual synset are integrated via transclusion, marked as to their origin and made directly navigable.

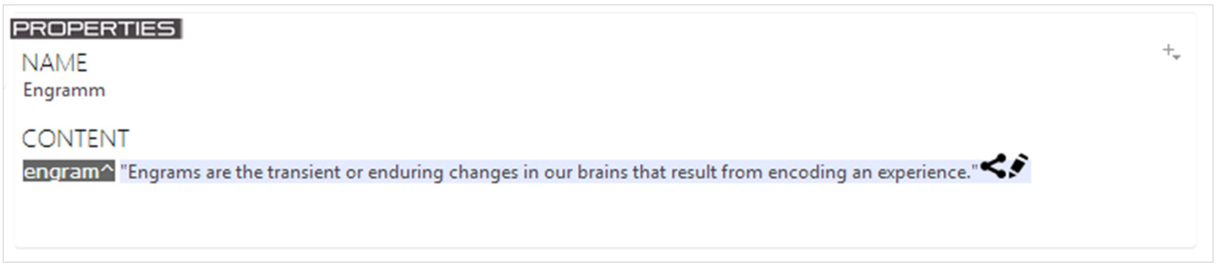

FIGURE 40: EXAMPLE OF TRANSCLUSION OF PROPERTY-VALUES IN VIRTUAL SYNSETS

In Figure 40, for example, the German language entity *Engramm* [engram] automatically transcludes (virtually includes) the Content-property value of its English language synonym *engram*.

[186] This means that equivalent propositions stated in different languages (i.e., different from the language of the focus entity) are automatically identified (via virtual synset membership) and consequently suppressed.

5.2.3 Word-Field-Based Semantic Tagging

In chapter 2.6.3 on word fields, we have learnt how meaningful words indicate individual mental spaces in a word-field organization (or, more generally, semantic network structures). In the meantime, we have identified spoken and written word-symbols as (trigger-)components of co-reproductive units of artificial memory, organized in modality-specific *trigger fields*. In chapter 1.1.2, we have dealt with the problems caused by plurality of word-senses (polysemy and homonymy), which are sometimes (unsuccessfully) tackled by a plurality of sense-words (resulting in synonymy by an abundancy of neologisms). Ambiguity hampers communication. In verbose textual and contextual communication (i.e., in situations rich in *disambiguating* ecphoric influences), this may not appear as a central issue, but in the ubiquitous information landscape created by, for example, an extended system, by a universal ontology, a science rich in theories, or a search-engine optimized WWW of keyword-focused text snippets, we find that plurality of word-senses poses a huge problem to communication and self-information (i.e., more specifically, to extended artificial memory).

A common strategy for disambiguation found in ontology engineering is a descriptive label. However, each word added into the descriptive name phrase will add a new reference of the respective keyword. Overall, this is not a good idea, as it will soon lower the precision of named entity search. Moreover, after adding descriptive words, one cannot tell identifier and descriptor apart anymore. Even if the description were extracted into a description-property value, it would represent unstructured text content. Another problem is that if the meaning of the ontology entity described changes, the freeform text description might become obsolete.

Now, in Artificial Memory, each ontology entity is (to be) embedded and represented in its respective word-field, demarcating it conceptually. All sections of the main view represent a certain area of this (i.e., the focus entity's) word field or, generally speaking, semantic (artificial memory) network. The Tree-section represents the relational semantic network, insomuch as it is centered around the focus object. The Equal-section creates a particular *synset* or synonyms word field. The synonyms represented in the Equal-section are also reflected in the Tree-section (as are all word-field entities), but the Equal-section (as any other word-field section) offers a more dense and organized/optimized view (for example, by grouping synonyms first by language instead of putting them into alphabetical order first). The word-field sections create a visual word-field to reflect (to some extent) the semantic word-field or conceptual field. Let us remember that Trier (1931, S. 2) wrote that the structure of the whole (field) would determine a single word's sense [*vom Gefüge des Ganzen her empfängt das Einzelwort seine inhaltliche begriffliche Bestimmtheit*]. If this holistic structure [Gefüge des Ganzen] determines the word sense, would it not be appropriate to use it for disambiguation of polysemous and homonymous words?

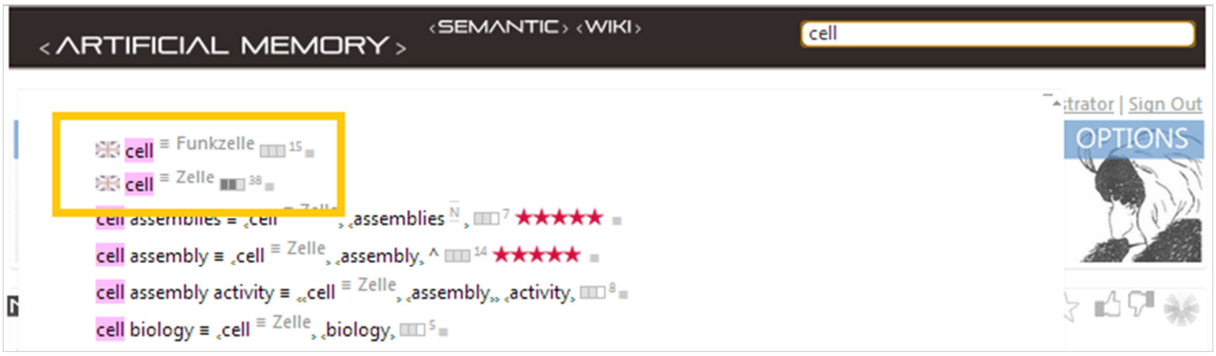

FIGURE 41: CLIPPING: SEMANTIC TAGS IN SEARCH RESULTS (SECTION)

In Figure 41, (a section of) the instant search results for the string *cell* is depicted. *Cell* has two homonymous word results in the author's Artificial Memory. These identically named ontology entities are disambiguated by *semantic tags* gained through related synonyms (of German language). All existing triples referring to the focus object, which includes all word-field entities (other than morphological derivations, which are directly retrieved from the lexical database), can be used to create a semantic tag. If the semantic-tag-triple uses a predicate used for word-field (section) creation, the semantic tag will show a special symbol to indicate the nature of the relation. As visible in the example of Figure 41, the synonymy-predicate is indicated by superscript Unicode character U-2261 (identical to): ≡ and followed by a likewise superscript proposition-object entity-name. Thus, the homonymous cell$^{\equiv\ \mathrm{Funkzelle}}$ [network cell] and cell$^{\equiv\ \mathrm{Zelle}}$ [biological cell] are disambiguated by their translation into non-homonymous ontology entities [*Funkzelle* and *Zelle*]. If the synonymy-relation used for semantic tagging were to be deleted, the semantic tag would be deleted, too, indicating a resultant state of ambiguity to be resolved. The semantic tag can be *stacked*, meaning that a semantic-tag object can have another semantic tag.

FIGURE 42: CLIPPING: STACKED SEMANTIC TAGS IN SEARCH RESULTS

In Figure 42, the ontology concept *Bedeutung* [meaning] is tagged by *Intension* [intension], which is in turn tagged by *Begriffsinhalt* [Fregean

Sense]. The two entities of the homonymous name *Bedeutung* are disambiguated by two dichotomous word pairs (Intention versus Extension, Begriffsinhalt versus Begriffsumfang). Semantic tags create a *disambiguation* word-field (representation). Even in the absence of a homonym, a semantic tag can *clarify* an entity.

FIGURE 43: CLIPPING: SEMANTIC *TRIPLE MARK* TAG

In Figure 43, a non-word-field triple (called a triple mark) is used as semantic tag. The object *de anima* (of type book) has the triple mark (™) tag:

™) (└ | is authored by Δ authors | Aristotle))

The letter └ is a placeholder for the name of the tagged object. The blue letter *)* is the syntactic marker for *in the past*. The letter *Δ* separates the active from the passive form of a bi-directional predicate. In a nutshell, this triple-statement can be read from both directions, as *de anima was authored by Aristotle* or *Aristotle authored de anima*.

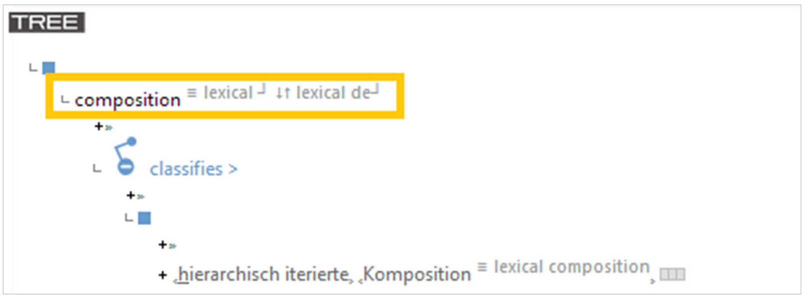

FIGURE 44: CLIPPING: SEMANTIC DOUBLE TAG

The semantic tag (notation) is easy to learn and a very efficient way of disambiguation or extended remembering - or both. In Figure 44, we find a combination of two semantic tags. The first is for disambiguation, identifying *composition* as *lexical composition*. The second creates a micro word(-trigger) field of opposition, stating *lexical decomposition* to be an opposite of (lexical) composition, as is indicated by the special-predicate symbol ↓↑. Thus, multiple semantic tags can be combined on a single level for different purposes.

In Artificial Memory, (nearly) each representation of an ontology entity name is navigable (by being marked into hyperlink text or by icon-links made available by means of progressive disclosure). Thus, both the macro word(-trigger) fields created by different sections of the main view and the micro-word(-trigger) fields created by semantic tags offer quick thought-accompanying navigation paths. In Artificial Memory, the (at best mnemic-associatively ecphorable) trigger-fields of artificial memory turn into perceivable *fields of extended associations*. The perceivable form of Trier's holistic structure [Gefüge des Ganzen] creates episodically experienceable areas of tension [Spannungsfelder] provoking further differentiations. In chapter 2.5.3.2.1, I had already mentioned that *categorizing or instantiating something new (as examples of generating formal knowledge) will cause more than just an addition of a piece of new knowledge and belief into an ontology. It may create a productive area of tension between the neighboring ontology objects, provoking further ontological additions that cannot be gained through (automatic) inferences*. By now, with respect to Artificial Memory, we can state *neighboring ontology objects* more precisely as a word-(trigger-)field of extended associations. In unextended (or nonreflective) mind, engrammatic word(-field) associations tend to be limited to the semantic network associations described in chapter 2.6.1. Their abstraction from countless memory traces tends to create a rather uneven holistic structure. Reflections on the (holistic) artificial memory structure, by perceiving and conceiving the field of extended associations (ecphorizing different co-reproductive units into rather *artificial* simultaneous complexes), will bring to light many inherent irregularities (which then can be tackled). For co-perception of artificial memory chunks that are not directly associated to become productive in an artificial-memory constructive manner, the perceptual organization has to follow consistency rules or logical principles, as there is little to be gained from an arbitrary word field representation. In Artificial Memory, as has been mentioned before, the macro word-fields are organized into sections. For their construction, the following special relation-types are being used:

(1)	equality	[≡]
(2)	inequality	[≠]
(3)	similarity	[≈]
(4)	antonymy	[↓↑]
(5)	super-class	[▪◄]
(6)	sub-class	[◄▪]
(7)	set / whole	[◘]
(8)	member / part	[●]
(9)	feature of	[╒]
(10)	featured by	[╕]

(11) variable of [VA]
(12) varied by [AV]

(13) predecessor / evolution from [╥]
(14) descendant / evolution into [╨]

(15) abstract / type [□⁺]
(16) concretization / instantiation [■⁺]

Each relation type can be directly used (in form of a standard predicate) to relate two ontology entities in the word fields given (or, more generally, any ontology entities on screen). For this, each ontology entity shown comes with a mouse-over-event progressive-disclosure command menu, as shown (disclosed) in Figure 45.

Figure 45: Clipping: Word-Field Command Menu

The command menu offers a quick way to position an ontology entity visible anywhere on screen relative to the focus entity into a word-field section. As these relation-types tend to be mutually exclusive, given an existing positioning, choosing a new position in the command bar (i.e., creating a new proposition) will automatically delete the existing position(-proposition). This can be circumvented, though, by adding the proposition by the main command menu. What Artificial Memory thus provides, is a word-field oriented meta-association system. The relation types used for word-field creation have consistency and inference rules associated to them, which are being applied for word-field section creation.

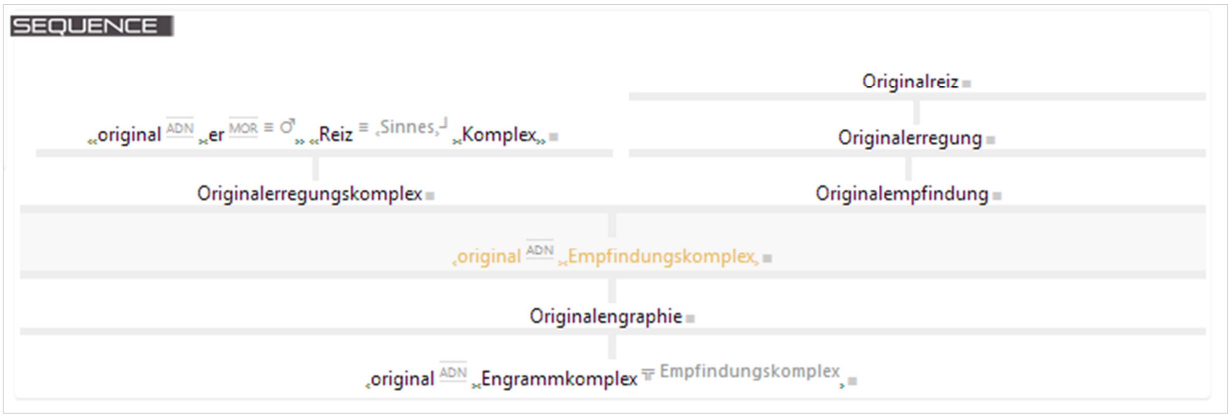

Figure 46: Example of Sequence Section

In Figure 46, an exemplary sequence section is shown, dynamically built for the focus ontology-entity Originalempfindungskomplex [original sensational complex]. It shows the ontology entities chains it evolves from and evolves into, offering numerous opportunities for navigation, repositioning, and semantic tagging. I cannot introduce the various word sections in detail in this thesis. Therefore, even though most of the word-field relation-types are well known to ontology engineering and logics, their actual use for personal knowledge management differs considerably from the current practice of ontology engineering and automatic reasoning.

Another type of semantic tags is derived from part of speech. If possible, language and part of speech are assigned to newly created ontology entities automatically. For practical reasons, I distinguish nine parts of speech (ignoring some well-known, but less important ones, and adding additional types):

(1) syllable
(2) morpheme
(3) adposition (incl. preposition)
(4) adverb
(5) verb
(6) adnoun (incl. adjective)
(7) noun
(8) proposition
(9) text

Each (entity) name can be assigned to one (in some combinations even several) of these parts of speech and be semantically tagged by them for word-class-based disambiguation. This allows, for example, distinguishing homonymous words of different parts of speech or homonymous syntactical morphemes. An ontology entity in Artificial Memory can be a very specific meaningful unit. The virtual synset, on the other hand, does not restrict synonyms to a particular part of speech (which sets it apart from traditional synsets).

Last but not least, semantic tags can be used reciprocally (i.e., in cyclic graphs). In Figure 47, the German phrase *schwache Emergenz* [weak emergence] is semantically tagged by its antonym *starke Emergenz* [strong emergence], which is in turn semantically tagged by *schwache Emergenz*. In the name section, this cyclic construction is indicated by the inclusion of the cyclically repeated entity *schwache Emergenz*. In other sections, though, the repetition of the first cyclical entity will be suppressed (see the Tree-section in Figure 47).

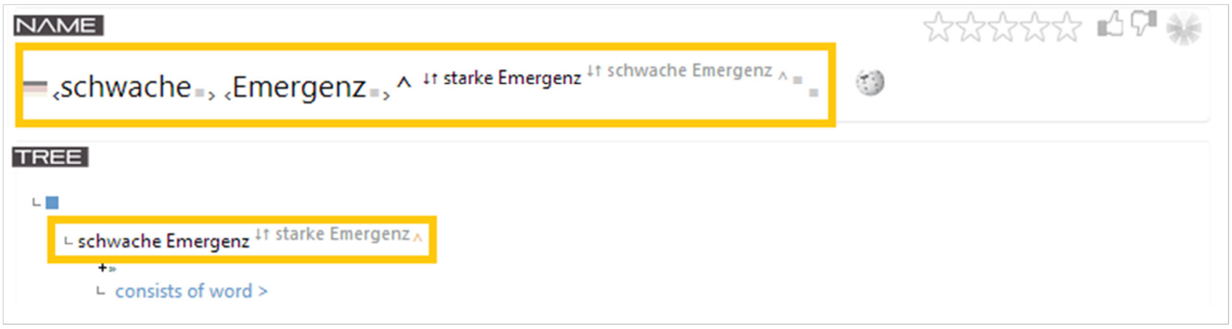

FIGURE 47: CLIPPING: DISPLAY OF RECIPROCAL SEMANTIC TAGS

Ideally, word-fields will be used for extended thinking and extended learning in single extended systems and networked extended system. In Artificial Memory, there are already many, sometimes very refined features (inference rules and data sources) in place enabling extended thinking and learning in a thought-accompanying, word-field-oriented manner.

5.2.4 Language Chunk / Linear Unit Tagging

In the last section, we have discussed the disambiguation of named ontology entities by *outer* semantic tagging. In this section, I want to discuss semantic disambiguation by *inner* tagging of words, word compounds and *linear units* (see chapter 2.5.3.1) of words. Normally, in ontology engineering (other than in linguistics), name-properties are not subject to further structuring, as they are seen as mere identifiers, that is, as unique labels that help distinguish between formal objects. In chapter 2.6.1, on Semantic Networks, we have learnt about a compound/chunk hierarchy based on contiguity associations (episodic memory traces). This hierarchical structure (multiple overlapping compositional containment hierarchies, to be more precise) of co-reproductive trigger-components becomes manifest in the trigger-component-chunking of the simultaneous complex. It would be false to think of chunking as of a linear process (this can even be excluded phenomenologically). The simultaneous complex is rather chunked as a whole, to some extent forward-looking, to some extent in parallel, and to some extent backward-looking. Some chunks are extended (excitation moving up the nervous containment hierarchy) sequentially, as can be experienced in slow reading. Some chunks seem to appear at once, or they are at once predicted. Some frozen metaphors, for example, form chunk units that seem **not** to be constructed sequentially. However, many other linear units are instantiated predictively, too, probably due to high conditional probabilities between the respective words (which translates into a flat containment structure and little overlapping {i.e., a lower cardinality of upward relations}). A very interesting phenomenological peculiarity of linear units is the possibility of backward-changes. What do I mean by backward-changes? Well, let us imagine a sequence of three words or small phrases, ABC, is being perceived (up to AB) and chunked, first, as AB (a single unit). Now, imagine C is being perceived (perhaps after a saccadic eye movement) and causes a re-chunking into A-BC (i.e. chunk A and chunk BC) in the simultaneous complex. The AB chunk is (normally) *masked* by A and BC. In reading or listening, thus, one is usually not aware of backward-changes of chunking, in the same way in which one is not aware of forward-changes of chunking (e.g. moving from AB to ABC after perceiving C).

I have pointed out before that chunking does not translate directly into semantics. AB-C in person A may result into a similar conceptual blending as ABC in person B. AB-C in person A may blend into the conceptual unit that is later to be known as ABC to person A. In any case, ABC marked as derived from AB-C is probably a different unit than ABC derived from A-BC. The difference between these two polysemous strings could, of course, be marked by an outer semantic tag, but it could as well (and even better and with some other advantages, as I would argue) be marked and semantically disambiguated by its inner linear unit (or, in other words, chunk) structure. The inner structure helps us to reconstruct the linear unit when circumstantial ecphoric influences supporting chunking (conceptually) are missing or rare.

FIGURE 48: CLIPPING: CHUNKING SUGGESTIONS LIST

In Figure 48, the Name-section of the newly created ontology entity named *cell communication* is shown. Below the name, a suggestion list for chunking is displayed. The three list rows result from three homonymous ontology entities of name *cell*. This time, they are disambiguated by English language semantic tags. We find *biological cell*, (mobile phone) *network cell*, and (general) cell (marked as a super-class of network cell. We thus have a simple means of giving cell communication three different meanings, by selecting one of the rows.

FIGURE 49: CLIPPING: CHUNKED ONTOLOGY ENTITY NAME

In Figure 49, the Name-section of the previous example is shown after selecting biological cell communication. The name was structured twofold: by inserting small subscript separation markers, ‘‹‘ and ‘›‘, between the words and by replacing the single words with the potentially semantically tagged (hyperlink-)references to the ontology entities chosen. By now, the ontology entity named *cell communication* can be identified as *biological cell* communication. Not choosing a descriptive name pays off at this moment, but with two words involved, the advantage of chunk tagging is limited to inner semantic tagging.

FIGURE 50: CLIPPING: CHUNKED ONTOLOGY ENTITY NAME

In Figure 50, a three-word chunk was splitted for disambiguation into an AB-C structure. (Biological) *cell assembly* and (neural) *activity* are joined to disambiguate *cell assembly activity*. This is a hierarchical chunking structure, as cell assembly is itself chunked into (biological) *cell* and *assembly*. The disambiguation uses three types of information: direct semantic tagging of one chunk (neural activity), lower-level semantic tagging within another chunk (*biological cell* within *cell assembly*), and chunking into the AB-C structure itself, which identifies *cell assembly* as a single co-reproductive unit that is (to be) blended with (neural) *activity*. Disambiguation by chunking automatically implies chunk tagging if at least one chunk or sub-chunk involved includes a semantic tag or is itself chunk-tagged. However, chunk tags can be set on and off as needed. Moreover, chunking is an offer, not a requirement. Anyway, the possibility of easily disambiguating homographic co-reproductive chunk-complexes offers the opportunity to include linear units that are traditionally ignored by ontology engineers, knowledge managers, lexicographers etc.: phrasal constructions of all kinds, which (as it seems to me) make up a huge chunk of (language) artificial memory. Noun phrases, adjective phrases, verbal phrases, prepositional phrases etc. refer to multilayered co-reproductively generated conceptual complexes (i.e., hierarchically organized chunk complexes). Truly (language-)thought-accompanying, co-productive artificial memory expression cannot tolerate any limitation with regard to the types of linear units allowed, solely because common ontology management and knowledge management tools lack the means for their proper semantic organization and disambiguation. Language-symbolic (extended) endogenous and exogenous variation is often based on complex linear units and their formation into new chunks. Artificial Memory supports synthetical and analytical chunk formation.

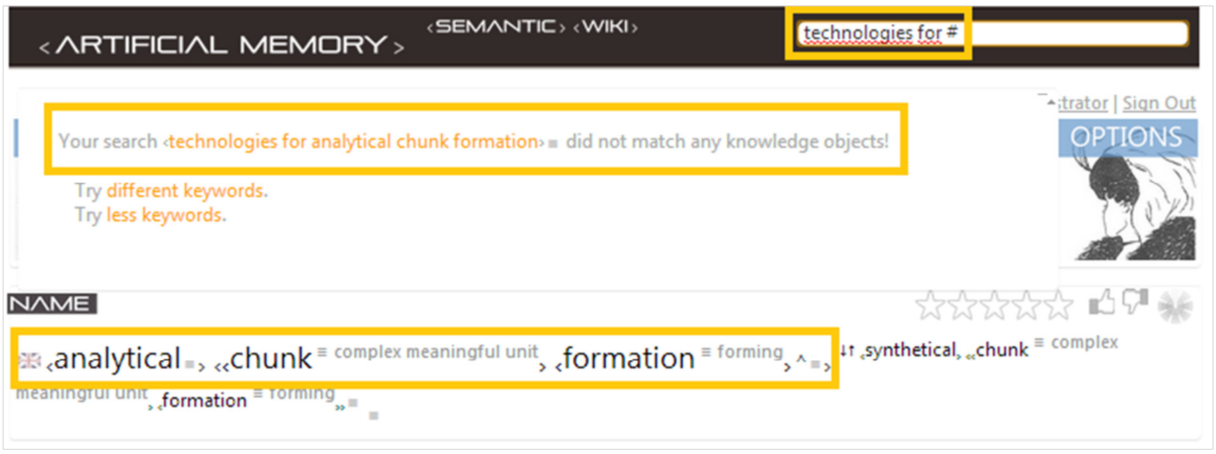

FIGURE 51: CLIPPING: TECHNOLOGY FOR SYNTHETICAL CHUNK FORMATION

In Figure 51, the focus entity *analytical chunk formation* (as visible in the Name-section) is referred to in the upper search field by the special letter *#*, which translates the search string *technologies for #* into *technology for analytical chunk formation*. As this unit does not exist, the search result list restates the (completed) search phrase as a hyperlink. Clicking the hyperlink will create an ontology entity (of default type *abstract*) named by the search string. In synthetical chunk formation, the focus entity or parts of the focus instance are referred to by special letters inserting information from the focus entity into a search or addition string. The chunking of the synthetically formed new chunk is done analytically.

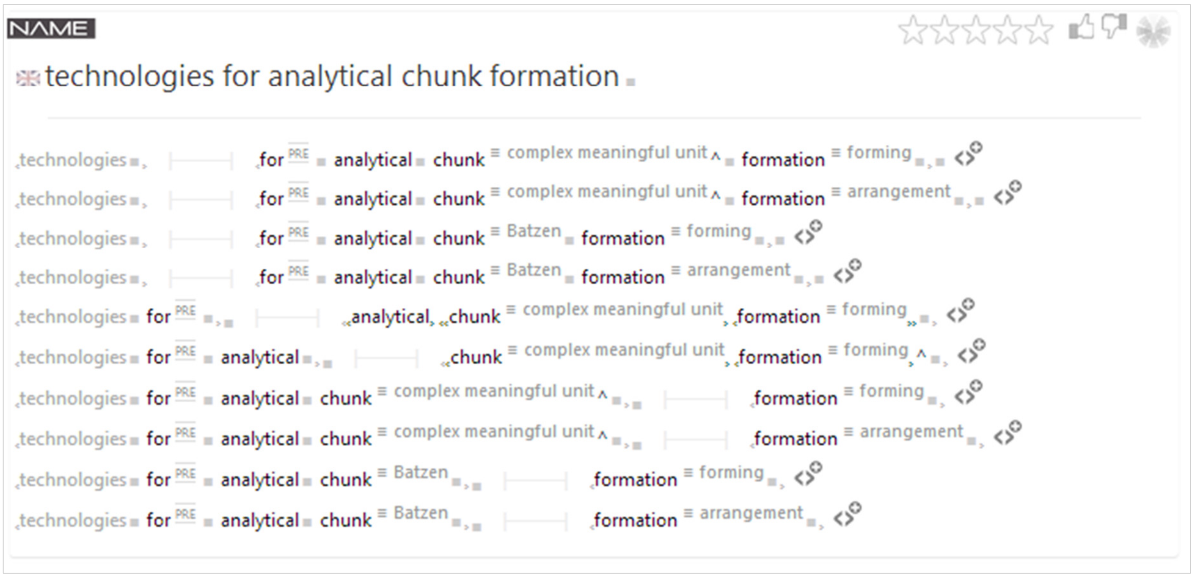

FIGURE 52: CLIPPING: TECHNOLOGY FOR ANALYTICAL CHUNK FORMATION

In Figure 52, the chunking suggestion list for the entity *technology for analytical chunk formation* is shown. It is a Cartesian product combining all existing homographic ontology entities and possible bipartite segmentations. If one of the chunks does not yet exist, it will be first created and then integrated as a chunk-tag component. The Cartesian product is filtered and, therefore, reduced whenever there is an ontology entity matching a chunk-tag-component suggestion string (as is the case for *chunk formation* and *analytical chunk formation*). The user of Artificial Memory is not restricted to bipartite chunking. Any number of chunk-tags can be added by explicitly stating them. Only chunk-tag suggestions are restricted to two-part chunking. The chunking tag list gives navigational freedom, because each suggested chunk could be created or, if already existing, navigated irrespective of whether one decides to use it for chunking or not to us it for chunking. Analytical chunk formation is often a multi-step process, including chunking decisions on different levels in ever-smaller chunks.

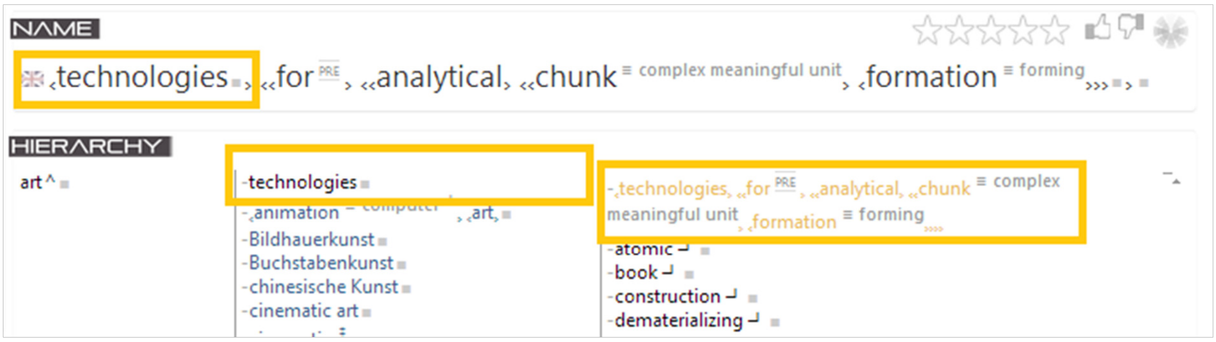

FIGURE 53: CLIPPING: ADVANCED CHUNK TECHNOLOGY

In Figure 53, the entity *technologies for analytical chunk formation* is displayed after it was chunked by *technologies* and *for analytical chunk formation*, combining a noun and adjacent prepositional phrase. In a next step, the head of the resulting noun phrase (technologies) was used for the embedding of the phrase into the class(-chunk)-hierarchy. The result is indicated in the Hierarchy-section shown. The columns to the left of the focus entity displays actual (i.e., *technologies*) and possible top-classes (e.g. *cinematic art*), which are derived from sub-classes of available top-top-classes (*art*). This example demonstrates the close interdependency between chunking and other (logical) relations, such as superordination. It is an example of a chunking-component (i.e., *technologies*) being used for integrating a chunk-complex (i.e., *technologies for analytical chunk formation*) into the extended artificial memory network. Any phrase's head(-phrase) tends to be an excellent super-*class*, demonstrating the general origin of any type of class hierarchy in chunk hierarchies of combinatorial, conceptual-blending-based specification.

The chunking of word-compounds is similar to the chunking of linear units, as indicated in Figure 54.

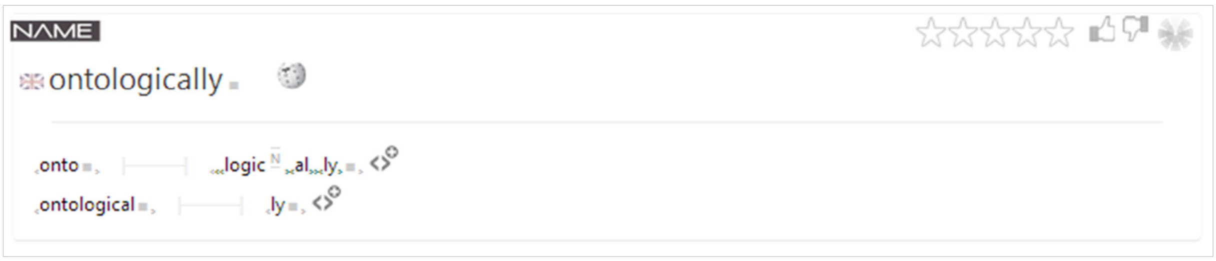

FIGURE 54: WORD-COMPOUND CHUNKING SUGGESTION LIST

Chunking in Artificial Memory is a somewhat experimental, but very promising set of technologies that is successfully used for disambiguation and for weaving of (extended) artificial memory.

FINAL REMARKS

The major theoretical ideas have already been summarized in the overview given in chapter 4.3.7 *Recapitulation of Extended Artificial Memory System Goals and Features* (List Form). For a final discussion, I want to return to the fundamental requirements that we formulated in chapter 2.4.6 *Overcoming Defects of Written Language*, after discussing Plato's criticism of written language.

In requirement 1, we stated that propositions should be presented only insofar as they can be understood by the reader. The fundamental concepts of extended remembering (4.3.5.2), extended thinking (4.3.5.3), and extended learning (4.3.5.4) all aim at supporting this requirement.

In requirement 2, we wanted to allow the reader to advance beyond the surface of text artifacts into the field of the author's knowledge. In general, the artifacts collected in an extended system do offer this opportunity, especially if, as I suggested, any text artifacts were to be made up of transclusions from extended systems. Chunking for disambiguation is a first step into the right direction. Using chunked and semantically annotated entities for text annotation (as is available in the Artificial Memory prototype by inline links) can only be a first step toward a more refined set of technologies using extended systems in co-productive writing.

FIGURE 55: VISUAL INFORMATION AND UNSTRUCTURED TEXT IN VISUAL LANGUAGE DISPLAY

The Artificial Memory prototype is still very much a hybrid system, expressing natural language in controlled natural language form via triple notation and in an unstructured form by property value (article) text. However, there are already many bridges built connecting both text forms. Triple components can be complex phrasal constructions, chunked and semantically tagged, including secondary relations. Text snippets containing annotations, on the other hand, can be reflected in triple statements, as is shown in Figure 55: The focus entity *daemon* is annotated in the wiki article (or, in general, a property value) of an entity named *Pandemonium Theory (Selfridge, 1959)*. The context of the annotation is automatically shown. The display is also enriched by a thumbnail icon of a diagram attached to the *Pandemonium Theory* entity.

In requirement 3, we stated that the text should do more than remembering the author of what he already knows, it should be a creative tool. Extended systems support memory variation via simple universal technologies. This has been discussed at length in chapter 4. It is less obvious, though, that the different trigger-fields (fields of extended associations) created in the Artificial Memory prototype are a rich source of inspiration. Take, for example, the chunking suggestion list. Often, it will not only contain the intended chunking structure, but also additional interesting chunk-components and polysemous or homonymous homographic options. Creating highly productive trigger field displays in combination with sequential text poses an interesting scientific challenge.

In requirement 4, we asked that the text should help to build up a memory structure improving instantaneous knowledge. Reflecting artificial memory by means of extended systems improves memory structures considerably. Logical inferences become perceivable and thus engraphically effective. An aspect we did not talk about so far is the systematic creation of chunk-variation suggestions by analogical reasoning. In Artificial Memory, some basic analogical reasoning mechanisms can be triggered off by declaring two ontology entities to be similar. There could be done much more, though. The benefit of extended artificial memory here is to enrich instantaneous knowledge beyond what has been expressed and is engrammatically fixated.

In requirement 5, we asked for support of instantaneous, thought-accompanying and thought-complementing information retrieval. These are core-requirements for any extended system. Very fast search and selection processes via combinations of eye tracking, gestures, pointing and typing movements, voice control etc. could fundamentally change the processes of writing, searching, and textual communication, as we know them today. These advances would have to be embedded into extended systems and be planned as universal co-productive technologies. The common quality factors of information retrieval, *recall* and *precision*, have to be redefined for extended remembering, extended thinking, and extended learning, taking into consideration the engrammatic corpus of (extended) artificial memory and the (mnemic-)ecphoric stimulus situation within the momentary simultaneous complex.

Bibliography

Adar, E., Karger, D. R., & Stein, L. A. (1999). Haystack: Per-User Information Environments. *Proceedings of the 1999 ACM CIKM International Conference on Information and Knowledge Management.* Kansas City, Missouri, USA.

Anderson, J. R. (1996). ACT: A simple theory of complex cognition. *American Psychologist Vol. 51,* 355-365.

Austin, J. (1962). *How to Do Things With Words*. Oxford: Clarendon.

Baddeley, A. (2000). Short-Term and Working Memory. In E. Tulving, *The Oxford Handbook of Memory*.

Bell, G. (2007). Save Everything: Supporting Human Memory with a Personal Digital Lifetime Store. In W. Jones, *Personal Information Management*. Seattle: University of Washington Press.

Berners-Lee, T. (14. 10 1998). *Semantic Web Road map*. Abgerufen am 29. August 2012 von W3C: http://www.w3.org/DesignIssues/Semantic.html

Bod, R., Jannedy, S., & Hay, J. (2003). *Probabilistic Linguistics*. Cambridge, Massachusetts; London, England: The MIT Press.

Börner, K. (2005). Semantic Association Networks: Using Semantic Web Technology to Improve Scholarly Knowledge and Expertise Management. In V. G. (eds.), *Visualizing the Semantic Web* (S. chapter 11). (2nd edition): Springer Verlag.

Bower, G. H. (2000). A Brief History of Memory Research. In E. Tulving, *The Oxford Handbook of Memory Research*.

Brand, M., & Markowitsch, H. J. (2010). Thinking and Memory. In B. M. Glatzeder, V. Goel, & A. von Müller, *Towards a Theory of Thinking. Building Blocks for a Conceptual Framework*. Springer.

Brown, S. C., & Craik, F. I. (2000). Encoding and Retrieval of Information. In E. Tulving, *The Oxford Handbook of Memory*.

Buchanan, B. (1982). New research on expert systems. In J. Hayes, D. Michie, & Y.-H. Pao, *Machine Intelligence IO* (S. 269-299). Chichester, England: Ellis Horwood Limited.

Bühler, K. (1907). *Tatsachen und Probleme zu einer Psychologie der Denkvorgänge*. Leipzig: Wilhelm Engelmann.

Bühler, K. (1927). *Die Krise der Psychologie*. Verlag Gustav Fischer.

Bühler, K. (1999). *Sprachtheorie: Die Darstellungsfunktion der Sprache*. Stuttgart: UTB.

Bush, V. (1945). As we may think. *Atlantic Monthly, 176*, 101-108.

Clark, A. (2003). *Natural-Born Cycborgs: Minds, Technologies, and the Future of Human Intelligence*. Oxford University Press.

Clark, A. (2008). *Supersizing the Mind: Embodiment, Action, and Cognitive Extension (Philosophy of Mind)*. Oxford University Press.

Clark, A., & Chalmers, D. (1998). The Extended Mind. *Analysis*, (Vol. 58) 10-23.

Davenport, T. H., & Prusak, L. (1998). *Working Knowledge. How Organizations Manage What They Know*. Harvard Business School Press.

Davis, B., Handschuh, S., Cunningham, H., & Tablan, V. (2006). Using Controlled Natural Language for Semantic Annotation of Wikis. *International Semantic Web Conference 2006.* http://sw.deri.org/2006/02/semanticAnnotationISWC2006/brian/iswc2006-poster-abs.pdf.

Dawkins, R. (1976). *The Selfish Gene*.

Decker, S. (2002). Semantic Web Methods for Knowledge Management. University of Karlsruhe.

Domingue, J. (1998). Tadzebao and WebOnto: Discussing, browsing, and editing ontologies on the web. *Proceedings of the 11th Knowledge Acquisition for Knowledge-Based Systems Workshop*.

Dryer, M., & Haspelmath, M. (2011). *The World Atlas of Language Structures Online*. Abgerufen am 16. Agust 2012 von Max Planck Digital Library: http://wals.info

Ebbinghaus, H. (1885). *Über das Gedächtnis: Untersuchungen zur experimentellen Psychologie*.

Eibl-Eibesfeldt, I., & Sütterlin, C. (2007). *Weltsprache Kunst: Zur Natur- und Kunstgeschichte bildlicher Kommunikation*. Brandstätter.

Elias, N. (1988). *Über die Zeit: Arbeiten zur Wissenssoziologie II.* Frankfurt am Main: Suhrkamp Taschenbuch.

Erdmann, M., & et al. (2000). From manual to semi-automatic semantic annotation: About ontology-based text annotation tools. *2000 Workshop on Semantic Annotation and Intelligent Content. Luxembourg.*

Erdmann, M., Maedche, A., Schnurr, H.-P., & Staab, S. (2001). From Manual to Semi-automatic Semantic Annotation: About Ontology-based Text Annotation Tools. *ETAI Journal - Section on Semantic Web (Linköping Electronic Articles in Computer and Information Science). Volume 6. Number 2.*

Everett, D. L. (2010). *Das glücklichste Volk: Sieben Jahre bei den Pirahã-Indianern am Amazonas*. Deutsche Verlags-Anstalt.

Fauconnier, G. (2006). *Cognitive Linguistics (Encyclopedia of Cognitive Science)*. Abgerufen am 06. 10 2012 von University of California, San Diego - Department of Cognitive Science: http://www.cogsci.ucsd.edu/~faucon/BEIJING/cogling.pdf

Fauconnier, G. (2007). Mental Spaces. In D. Geeraerts, & H. Cuyckens, *Cognitive Linguistics*. Oxford University Press.

Fauconnier, G., & Turner, M. (2002). *The Way We Think - Conceptual Blending and the Mind's Hidden Complexities*. Basic Book.

Fellbaum, C. (1998). *WordNet, an Electronic Lexical Database*. MIT Press.

Fensel, D. (2003). *Ontologies: A Silver Bullet for Knowledge Management and Electronic Commerce*. Springer, 2nd ed.

Fensel, D. (31. May 2004). *Triple-based Computing (DERI Research Report 2004-05-31)*. Abgerufen am 30. August 2012 von DERI: http://www.deri.ie/fileadmin/documents/DERI-TR-2004-05-31.pdf

Fodor, J. (2008). *LOT 2: The Language of Thought Revisited*. Oxford University Press.

Foxvog, D. (6. August 2011). *Ontology and Kantian Propositions*. Abgerufen am 28. August 2012 von ontolog-forum: http://ontolog.cim3.net/forum/ontolog-forum/2011-08/msg00041.html

Franklin, S. (1997). *Artificial Minds*. Cambridge, MA, USA: MIT Press.

Gardiner, J. M., & Richardson-Klavehn, A. (2000). Remembering and Knowing. In E. Tulving, *The Oxford Handbook of Memory*.

Geckeler, H. (1971). *Strukturelle Semantik und Wortfeldtheorie*. W. Fink.

Gemmell, J., Bell, G., Lueder, R., Drucker, S., & Wong, C. (2002). MyLifeBits: Fulfilling the Memex vision. *Proceedings of ACM Multimedia’02*, (S. 235-238).

Gómez-Pérez, A., Fernandez-Lopez, M., & Corcho, O. (2004). *Ontological Engineering: with examples from the areas of Knowledge Management, e-Commerce and the Semantic Web*. Springer.

Guha, R. V., McCool, R., & Miller, E. (2003). Semantic Search. *WWW2003 - Conference Procedings*.

Guida, A., Gobet, F., Tardieu, H., & Nicolas, S. (2012). How chunks, long-term working memory and templates offer a cognitive explanation for neuroimaging data on expertise acquisition: A two-stage framework. *Brain and Cognition - Volume 79, Issue 3*, 221-244.

Haarmann, H. (1998). *Universalgeschichte der Schrift*. Campus.

Handschuh, S., & Staab, S. (2003). Annotation of the Shallow and the Deep Web. In S. Handschuh, & S. Staab, *Annotation for the Semantic Web*. Frontiers in Artificial Intelligence and Applications. IOS Press.

Hark, M. t. (2004). *Popper, Otto Selz and the Rise of Evolutionary Epistemology*. Cambridge, UK: Cambridge University Press.

Hawkins, J., & Blakeslee, S. (2005). *On Intelligence*. New York: Holt.

Heidegger, M. (2006). *Sein und Zeit*. Tübingen: Niemeyer.

Helbig, H. (2001). *Die semantische Struktur natürlicher Sprache: Wissensrepräsentation mit MultiNet*. Berlin, Heidelberg: Springer.

Herber, H. J., & Vásárhelyi, É. (2002). Lewins Feldtheorie als Hintergrundsparadigma moderner Motivations- und Willensforschung (im Vergleich zu Behaviorismus, Psychoanalyse, Gestalt- und Kognitionspsychologie). *Salzburger Beiträge zur Erziehungswissenschaft 6, Nr.1*, 37-100.

Hodges, J. R. (2000). Memory in Dementias. In E. Tulving, *The Oxford Handbook of Memory*.

Horn, R. E. (1999). *Visual Language: Global Communication for the 21st Century*. Microvu Press.

Jones, W., & Bruce, H. (2005). A Report on the NSF-Sponsored Workshop on Personal Information Management. Seattle, WA: http://pim.ischool.washington.edu/pim05home.htm.

Kandel, E. (2012). *Das Zeitalter der Erkenntnis: Die Erforschung des Unbewussten in Kunst, Geist und Gehirn von der Wiener Moderne bis heute*. Siedler Verlag.

Kehrer, L. (1985). *Über Klassifikationsleistungen beim visuellen Suchen: Untersuchungen zur Funktionsgrundlage des Kategorieneffektes*. doctoral dissertation at University of Bielefeld.

Kirschner, P. A., Buckingham Shum, S. J., & Carr, C. S. (2003). *Visualizing Argumentation: Software Tools for Collaborative and Educational Sense-Making*. London: Springer-Verlag.

Kirsh, D., & Maglio, P. (1994). On distinguishing epistemic from pragmatic action. *Cognitive Science, Vol. 18, No. 4*, 513-549.

Krämer, S. (2001). *Sprache, Sprechakt, Kommunikation: Sprachtheoretische Positionen des 20. Jahrhunderts: Sprachtheoretische Positionen der Gegenwart*. Berlin: Suhrkamp Taschenbuch Wissenschaft.

Kunze, C., & Lemnitzer, L. (2007). *Computer-Lexikographie. Eine Einführung*. Tübingen: Narr Francke Attempto Verlag.

Kutschera, F. (1973). Eine logische Analyse des sprachwissenschaftlichen Feldbegriffs. *Studia Leibnitiana - Sonderheft (3)*, S. 71-84.

Lakoff, G. (12. 10 2006). *When Cognitive Science Enters Politics*. Abgerufen am 10. 10 2012 von georgelakoff.files.wordpress.com/2011/03/2006-when-cognitive-science-enters-politics.doc

Lamming, M., & Flynn, M. (1994). 'Forget-me-not' Intimate Computing in Support of Human Memory. *Proceedings of FRIEND21. '94 International Symposium on Next Generation Human Interface*. Meguro Gajoen, Japan.

Lanier, J. (30. 05 2006). *DIGITAL MAOISM: The Hazards of the New Online Collectivism*. Abgerufen am 22. 11 2012 von Edge - The Third Culture: http://www.edge.org/3rd_culture/lanier06/lanier06_index.html

Lewin, K. (1969 (1936)). *Grundzüge der topologischen Psychologie*. Bern.

Ludwig, L. (1996). *Über zeitliches Reihenfolgeurteil und manuelle Reaktionen auf auditive und visuelle Reize. Diplomarbeit*. Bielefeld: Universität Bielefeld.

Ludwig, L. (2005). *Speech Acts and Communication. Presentation given at the Digital Enterprise Research Institute, Galway, Ireland*. Abgerufen am 28. August 2012 von Artificial Memory: http://www.artificialmemory.net/artificialmemory.aspx?ID=21337

Ludwig, L. (2009). Artificial Memory - Eine kurze Einführung in Struktur, Aufgaben und Erfolgskennzahlen. *Proceeding of Fifth Conference Professional Knowledge Management: Experiences and Visions*. Solothurn, Switzerland.

Ludwig, L. (2010). Lösungen zum multilingualen Wissensmanagement semantischer Informationen. *Proceedings of: 1. DGI-Konferenz, 62. DGI (Deutsche Gesellschaft für Informationswissenschaft und Informationspraxis e.V.) Jahrestagung*. Frankfurt am Main.

Ludwig, L., & O'Sullivan, D. (2010). Deploying Decision Support Systems Using Semantic Web Technologies. *International Journal of Decision Support System Technology (IJDSST). Volume: 2. Issue: 1.*, 49-59.

Ludwig, L., O'Sullivan, D., & Zhou, X. (2004). Artificial Memory Prototype for Personal Semantic Subdocument Knowledge Management (PS-KM). *International Semantic Web Conference (ISWC) 2004*. Hiroshima, Japan.

Maedche, A., & Staab, S. (2001). Ontology Learning for the Semantic Web. *IEEE Intelligent Systems, Volume 16 Issue 2*, 72-79.

Maedche, A., Motik, B., Silva, N., & Volz, R. (2002). MAFRA - A MApping FRAmework for Distributed Ontologies. *EKAW '02 Proceedings of the 13th International Conference on Knowledge Engineering and Knowledge Management. Ontologies and the Semantic Web*. (S. 235-250). London, UK: Springer-Verlag.

Mandler, G. (2007). *A History of Modern Experimental Psychology: From James and Wundt to Cognitive Science*. The University Press Group Ltd.

Markowitsch, H. J. (2000). Neuroanatomy of Memory. In *The Oxford Handbook of Memory*. New York, US: Oxford University Press.

Markowitsch, H. J. (2002). *Dem Gedächtnis auf der Spur*. Primus Verlag GmbH.

Mayes, R. A. (2000). Selective Memory Disorders. In E. Tulving, *The Oxford Handbook of Memory*.

Mayr, S. (2005). *Episodic Retrieval Processes in Auditory Negative Priming: Evidence from Event-Related Brain Potentials and Multinomial Modeling*. Düsseldorf: Heinrich-Heine-Universität.

McLuhan, M. (1964). *Understanding Media. The Extensions of Man*. New York : McGraw-Hill.

Merikle, P. M. (1980). Selection from visual persistence by perceptual groups and category membership. *Journal of Experimental Psychology: General, 3*, 279-295.

Metzinger, T. (1999). Subjekt und Selbstmodell. Mentis-Verlag.

Metzinger, T. (2009). *Der Ego-Tunnel: Eine neue Philosophie des Selbst: Von der Hirnforschung zur Bewusstseinsethik*. Berlin Verlag.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review 63 (2)*, 81–97.

Minsky, M. (1988). *The Society of Mind*. Simon & Schuster.

Mitchell, T. M. (24. 08 2012). *Tom Mitchell: Never Ending Language Learning*. Abgerufen am 02. 10 2012 von Youtube: http://www.youtube.com/watch?v=51q2IajH94A

Naumer, C. M., & Fisher, K. E. (2007). Naturalistic Approaches for Understanding PIM. In W. P. Jones, & J. Teevan, *Personal Information Management* (S. 76–89). Seattle: University of Washington Press.

Neisser, U., & Libby, L. K. (2000). Remembering Life Experiences. In E. Tulving, *The Oxford Handbook of Memory*.

Nelson, T. H. (1995). The heart of connection: hypermedia unified by transclusion. *Commun. ACM 38∞, 31-33*.

Neumann, O. (1990). Direct parameter specification and the concept of perception. *Psychological Research, Volume 52, Numbers 2-3*, 207-215.

Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. *Organization Science 5 (1)*, 14-37.

Nonaka, I., & Takeuchi, H. (1995). *The knowledge creating company: how Japanese companies create the dynamics of innovation*. New York: Oxford University Press.

Pavey, E. L. (2010). *The Structure of Language: An Introduction to Grammatical Analysis*. Cambridge University Press.

Peirce, C. S. (1931-1958). Cambridge, MA: ed. by C. Hartshorne, P. Weiss, & A. Burks, 8 vols., Harvard University Press.

Pinker, S. (18. 06 2012). *The false Allure of Group Selection*. Abgerufen am 17. 10 2012 von Edge: http://edge.org/conversation/the-false-allure-of-group-selection

Plato. (1973). *Phaedrus. Translated by Walter Hamilton*. Penguin.

Popper, K. (1959). *The Logic of Scientific Discovery*.

Price, J. (2008). *The Woman Who Can't Forget: The Extraordinary Story of Living with the Most Remarkable Memory Known to Science*. Free Press.

Quantz, J., & Wichmann. (June 2004). *Semantic Web Services In A Nutshell*. Abgerufen am 28. August 2012 von Data, Information, and Process Integration with Semantic Web Services - Project DIP: http://dip.semanticweb.org/deliverables.html

Reinmann, G., & Eppler, M. (2007). *Wissenswege. Methoden für das persönliche Wissensmanagement* . Bern: Huber.

Rith, C., & Dubberly, H. (2007). Why Horst W.J. Rittel Matters. *Design Issues: Volume 23, Number 1*.

Roy, D. (2009). *New Horizons in the Study of Child Language Acquisition*. Brighton, England: Proceedings of Interspeech 2009.

Rupert, R. D. (2010). *Cognitive Systems and the Extended Mind*. Oxford University Press.

Sauermann, L. (2003). *The Gnowsis - Using Semantic Web Technologies to build a Semantic Desktop*. Wien: Universität Wien.

Sauermann, L. (2009). *The Gnowsis Semantic Desktop approach to Personal Information Management*. Winter Industries.

Sauermann, L., Ludger, v., & Dengel, A. (2007). PIMO - a Framework for Representing Personal Information Models. *Proceedings of I-MEDIA '07 and I-SEMANTICS '07 International Conferences on New Media Technology and Semantic Systems as part of (TRIPLE-I 2007)*. Graz, Austria.

Saussure, F. d. (1967). *Grundlagen der Allgemeinen Sprachwissenschaft*. 2. Auflage. Walter de Gruyter & Co.

Schacter, D. L. (1996). *Searching for Memory: The Brain, the Mind, and the Past*. Basic Books.

Schacter, D. L. (2001). *Forgotten Ideas, Neglected Pioneers: Richard Semon and the Story of Memory*.

Schank, R. (1999). *Dynamic Memory Revisited*. Cambridge University Press.

Searle, J. R. (1975). A taxonomy of illocutionary acts. In K. Gunderson, *Language, Mind and Knowledge* (S. 344-369). Minneapolis: University of Minnesota Press.

Selfridge, O. G. (1959). Pandemonium: A paradigm for learning. *Proceedings of the Symposium on Mechanisation of Thought Processes*, (S. 511–529). London.

Selz, O. (1924). *Die Gesetze der produktiven und reproduktiven Geistestätigkeit - kurzgefasste Darstellung*. Bonn: Verlag von Friedrich Cohen.

Semon, R. (1904). *Die Mneme*. Vierte und Fünfte unveränderte Auflage, 1920. Leipzig: Wilhelm Engelmann.

Semon, R. (1909). *Die Mnemischen Empfindungen*. Leipzig: Wilhelm Engelmann.

Sinclair, J. M., & Mauranen, A. (2006). *Linear Unit Grammar: Integrating Speech and Writing (Studies in Corpus Linguistics)*. John Benjamins Publishing Company.

Smith, E. E., Shoben, E. J., & Rips, L. J. (1974). "Structure and process in semantic memory: A featural model for semantic decisions. *Psychological Review 81 (3)*, 214-241.

Sowa, J. (01. 09 2009). *Controlled Natural Languages For Semantic Systems*. Abgerufen am 04. 09 2012 von Homepage of John F. Sowa: http://www.jfsowa.com/talks/cnl4ss.pdf

Sowa, J. (25. May 2009). *Semantics of Natural Languages*. Abgerufen am 25. August 2012 von ontolog-forum: http://ontolog.cim3.net/forum/ontolog-forum/2009-05/msg00125.html

Sperling, G. (1960). The information available in brief visual presentations. *Psychological Monographs: General and Applied, 74 (11, Whole no. 498)*, Pp. 1-29.

Spitzer, M. (13. August 2012). *Hirnforscher warnt vor "Digitaler Demenz"*. Abgerufen am 20. August 2012 von http://www.augsburger-allgemeine.de: http://www.augsburger-allgemeine.de/panorama/boulevard/Hirnforscher-warnt-vor-Digitaler-Demenz-id21479261.html

Stollberg, M., & et al. (08. 10 2004). *D3.2 WSMO Use Case Modeling and Testing*. Abgerufen am 31. 08 2012 von D3.2 WSMO: http://www.wsmo.org/2004/d3/d3.2/20041004/

Tomasello , M. (2006). *Die kulturelle Entwicklung des menschlichen Denkens: Zur Evolution der Kognition*. Suhrkamp Taschenbuch Wissenschaft.

Tomasello, M. (2011). *Die Ursprünge der menschlichen Kommunikation*. Frankfurt am Main: Suhrkamp Verlag.

Toth, J. P. (2000). Nonconscious Forms of Memory. In E. Tulving, *The Oxford Handbook of Memory*.

Trier, J. (1931). *Der deutsche Wortschatz im Sinnbezirk des Verstandes*. Heidelberg: C. Winter.

Tulving, E. (2000). Concepts of Memory. In *The Oxford Handbook of Memory*.

Tulving, E., & Craik , F. I. (2000). *The Oxford Handbook of Memory*. New York, US: Oxford University Press.

Venter, C. (07. 10 2012). *The Biological-Digital Converter, or, Biology at the Speed of Light*. Abgerufen am 18. 10 2012 von Edge: http://www.edge.org/conversation.php?cid=biology-at-the-speed-of-light

Völkel, M. (2010). *Personal Knowledge Models with Semantic Technologies*. Karlsruhe: Karlsruher Institut für Technologie (KIT).

Volkelt, H. (1914). *Über die Vorstellungen der Tiere*. Leipzig und Berlin: Wilhelm Engelmann.

Volkelt, H. (1963). *Grundfragen der Psychologie*. München: Beck.

Wildgen, W. (2008). *Kognitive Grammatik - Klassische Paradigmen und neue Perspektiven*. Berlin: Walter de Gruyter.

Wilson, E. O. (2012). *The Social Conquest of Earth*. New York: Liveright Pub. Corporation.

Winograd, T., & Flores, F. (1986). *Understanding Computers and Cognition: A New Foundation for Design*. Norwood, NJ: Ablex.

Wolf, M. (2008). *Proust and the Squid: The Story and Science of the Reading Brain*. Harper Perennial.

Woods, C., Teeter, E., & Emberling, G. (2010). *Visible Language: Inventions of Writing in the Ancient Middle East and Beyond*. Oriental Institute Museum Publications.

Yates, F. A. (1974). *The Art of Memory*. University of Chicago Press. 2nd edition.

Table of Figures

Table of Requirements

Hiermit erkläre ich, dass ich die hier vorgelegte Dissertation eigenständig und ohne unerlaubte Hilfe angefertigt habe. Die Dissertation wurde in der vorgelegten oder in ähnlicher Form noch keiner anderen Institution eingereicht. Ebenso versichere ich, dass bisher keine erfolglosen Promotionsversuche meinerseits stattgefunden haben.

Köln, den 23.04.2013

Gez. Lars Ludwig

Kurzer wissenschaftlicher Werdegang

Von 1990 bis 1996 habe ich vorzüglich Psychologie, Linguistik und Slawistik an der Universität Bielefeld studiert und meine Studien 1996 mit dem Diplom der Psychologie mit einer Diplomarbeit in der experimentellen Kognitionspsychologie bei Prof. Dr. Odmar Neumann abgeschlossen.

In den Jahren 2004 und 2005 habe ich als wissenschaftlicher Mitarbeiter für das Digital Enterprise Research Institute in Innsbruck, Galway (Irland) und Palo Alto/Stanford (USA) gearbeitet und auf dem Feld von Wissensmanagement mit Hilfe von semantischen Technologien geforscht und publiziert.

Seit 2003 betreibe ich Forschungen zum Wissensmanagement im Spannungsfeld zwischen Psychologie, Philosophie und Technologie, die ich regelmäßig auf Konferenzen und in Fachpublikationen veröffentliche.

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