Transitions versus dissociations:

A paradigm shift in unconscious cognition.

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Abstract: Since Freud and his co-author Breuer spoke of dissociation in 1895, a scientific paradigm was painstakingly established in the field of unconscious cognition. This is the dissociation paradigm. However, recent critical analysis of the many and various reported dissociations reveals their blurred, or unveridical, character. Moreover, we remain ignorant with respect to the ways cognitive phenomena transition from consciousness to an unconscious mode (or the reverse). This hinders us from filling in the puzzle of the unified mind. We conclude that we have reached a Kuhnian crisis in the field of unconscious cognition, and we predict that new models, incorporating partly the relevant findings of the dissociation paradigm—but also of dynamic psychology—, will soon be established. We further predict that some of these models will be largely based on the pairs representation-process and analog-digital.

Key words: Conscious and unconscious cognition, scientific paradigm, dissociations, transitions, representations – processes, analog – digital, dynamic aspects

1. Introduction

For well over a century now, the field of unconscious cognition has been steadily growing and has attained some stability in both theory and methodology (Augusto, 2010). As a matter of fact, it appears to have been working within a scientific paradigm (Kuhn, 1962) essentially based on the dissociation logic, that is, the assumption that the optimal—if not the sole—way to approach unconscious cognition is by checking the diverse manners in which it dissociates from conscious cognition (Timmermans & Cleeremans, 2015). However, a critical analysis of this dissociation logic shows that the concept of dissociation can be only partially—and therefore cautiously—applied to unconscious cognition (Augusto, 2016).

In effect, conscious and unconscious cognition share too many properties, at both the ontological and structural levels, to be seen as strictly dissociating (Augusto, 2013, 2014). This is only in agreement with the basic (often implicit) assumption in cognitive science that we are endowed with *one single* mind, modular as its processing might be (e.g., Newell, 1990). This suggests that conscious and unconscious cognition should be seen as integrated rather than dissociated, and an obvious way to carry out this approach is by focusing on the transitions between the two modes of cognition. If such a scientific program gains momentum, we predict that a scientific revolution in the field of unconscious cognition is bound to take place. In particular, we predict new, more appropriate ways of addressing the puzzle of the unified mind.

2. The puzzle of the unified mind and desiderata for models of the unified mind

By "the unified mind" we mean that various cognitive phenomena (e.g., seeing, tasting, reasoning, desiring, fearing) appear all to contribute to a *psychological singleness*, be it a *single experience* (e.g., the tasting of an apple), or be it a *self* (roughly, a sense of personal identity and uniqueness). This constitutes a puzzle because, on the one hand, the various cognitive phenomena appear both to be segregated (modular, in psychological jargon), or capable of being so to some extent, and their combination is not explainable in a matter-of-fact way. For instance, it is extremely difficult to identify what it is one is eating (e.g., a piece of apple) by tasting alone without the contribution of one's eyes and, especially, nose. Why taste, vision, and olfaction appear to be required to "bind" in this single experience—the *binding problem*—does not have a straightforward answer. The same is true in cases involving a single modality (e.g. various features of an object, such as color, shape, etc., binding into a single visual image). On the other hand, without such a phenomenal variety integrating both spatial and temporal dimensions, it is not evident how we would be able to attain a mental picture of some particular cognitive experience and, ultimately, a sense of ourselves.

Originally a philosophical question,[1] this puzzle soon became central in psychology, given the recognition of clinical conditions such as multiple personalities and split brains (e.g., Benner & Evans, 1984; Gazzaniga & LeDoux, 1978). The digital computer and the associated emergence of artificial intelligence turned the puzzle of the unified mind into an even more pragmatic quest. Cognitive robotics, to name but one of the most recent quests, requires a scientific account of the binding of diverse cognitive features in a single cognitive state—if not already in a sense of self (e.g., Wermter, Palm, & Elshaw, 2005).

Such an account, in turn, depends on bio-ecologically motivated, cognitively realistic, and eclectic cognitive architectures (e.g., Sun, 2004). Models of the unified mind have to be guided by the same principles, which, in a few words, mean that they have to address the ecological-evolutionary problem of why we developed the cognitive experiences we have now, abstracting from a plethora of details that otherwise make the idea of a model unfeasible, and being non-committal to a particular stance, at least in the early stage of cognitive modeling we are (still) in.

[1] E.g., Hume (1739/1978, Book I, Part IV, 3): "All [our particular perceptions] are different, and distinguishable, and separable from each other, and may be separately considered, and may exist separately, and have no need of anything to support their existence. After what manner, therefore, do they belong to self; and how are they connected with it?" Other philosophers who "puzzled" over this before it became a problem also for psychology were Descartes and Leibniz.

3. The dissociation paradigm

3.1. The notion of a scientific paradigm and a crisis in the field of unconscious cognition

Science is routinely done within a highly constrained context of rules, authorities, and, more recently, handbooks. This means that there is a—often implicit—consensus regarding *what* a particular subject of research must or should be, *how* it is to be approached and how its results should or must be interpreted, and also often *who* is sanctioned to carry out those tasks, and *where*. This is a rough reformulation of Thomas Kuhn's notion of a *scientific paradigm* (Kuhn, 1962). Taken in a stricter sense, a *paradigm* in the Kuhnian sense is a collection of theoretical principles and experimental practices that "frame" the research carried out in a certain (sub)field. In a critical view, assumed by Kuhn himself (Kuhn, 1962), these principles and practices can be seen as essentially "pre-conceptions" or "biases" containing hidden assumptions and elements that work in the minds of scientists as quasi-metaphysical constraints.

But no paradigm is everlasting. At some point in the progress of a scientific field, things are bound to take a turn. This—a *paradigm shift*—may take place because, say, the authorities of the previous paradigm have eventually left the field (due to retirement or death, for instance), but more likely because a competing theory has overridden its rival paradigmatic theory in the sense that its results, anomalous though they might be with respect to the former reigning theory, can actually accommodate or subsume its "old" results. In other words, the new theory explains results or resolves paradoxes that were unexplained and unsolved by the old theory. A *crisis* has been overcome, and we enter a new period of so-called *normal science* (Kuhn, 1962).

Have we reached a Kuhnian crisis in the field of unconscious cognition?

In an empirical setting, we have typically approached unconscious cognition by studying how it dissociates from conscious processes and representations (Augusto, 2010, 2016). This is commonly referred to in the literature as the *dissociation paradigm* (e.g., Bargh et al., 2001; Erderlyi, 1986; Reingold, 2004; Reingold & Sheridan, 2009; Simons et al., 2007; Snodgrass, 2004). The word "paradigm" here has at first sight not a different meaning from the *paradigms* that abound in psychology. In effect, we speak of a paradigm in this sense when some theoretical principles and/or experimental results constitute a framework or template for further work. For instance, we say that some work into perceptual interference is conducted within the Stroop paradigm to mean that the principles and results of Stroop's original work (Stroop, 1935) serve as guidelines for this work.

Such a paradigm can turn into a Kuhnian paradigm for many and complex reasons, not the least of which is a theoretical cornerstone that is exclusive and dominant to the point of monopoly. There is indeed such a cornerstone in the field of unconscious cognition. This is known as the *dissociation logic*, which dictates the *only* reasonable thing to do in research into unconscious cognition (e.g., Timmermans & Cleeremans, 2015; see below for an elaboration).[2]

However, it is now obvious that often dissociations are not as clear-cut as claimed, and reported findings are not replicable, or are too easily amenable to conflicting interpretations. These and other issues (see Augusto, 2016) are rooted in the dissociating perspective that sees unconscious cognition as essentially distinct from conscious information processing (see Augusto, 2013), and the lack of (more) explicit methodological and theoretical frameworks has aggravated the confusion that reigns in the field despite many positive results.

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[2] That we know of, we are the first to talk explicitly of the dissociation paradigm in a Kuhnian sense. Holender & Duscherer (2004) write about a "paradigm shift" in unconscious perception, but do not explicitly relate this expression to Kuhn's work.

In particular, the methods believed to assure us that in tasks of unconscious cognition *only* unconscious processes and representations, and *all* unconscious processes and representations involved—the *exclusiveness* and *exhaustiveness assumptions*, so fundamental in the dissociation paradigm (see Augusto, 2016)—are detected have been at the center of controversy. For instance, some criticize the less stringent character of tasks conceived for demonstrating unconscious cognition (e.g., Buchner & Wippich, 2000), while interpretational problems are often seen as an obstacle by others (e.g., Figner & Murphy, 2011, question the many and diverse interpretations of skin conductance responses). Also, our incomplete understanding of neural processes leaves the door open to challenges; for example, it is *still* not clear how much of the task performance in blindsight research must, or can, be attributed to residual vision (e.g., Campion, Latto, & Smith, 1983; Fendrich, Wessinger, & Gazzaniga, 1992). As shown in Augusto (2016), these problems are so pervasive and long-standing in the dissociation paradigm that they have acted as an obstacle to the reception of reported findings.

Importantly, the dissociation logic is largely out of pace with our current understanding of the brain as a complex, parallel, non-linear system of information processing. We believe it to be *complex* because of the sheer number of processing units and connections thereof, i.e. approximately 10^{11} neurons and 10^{14} synapses, and the many functions that emerge from these connections; it is *parallel* because it could not be otherwise, given the multiple operations carried out simultaneously and the several representations that may co-occur (e.g., I now am aware of the whiteness of my desk, of the annoying fan-sound of my overheated laptop, of my being late for work, etc.); it is *non-linear* because more often than not there is no linear function from the inputs to the outputs (for instance, learning is ideally graphed by a negative exponential function of error = e^{-t} for t time of training), and besides there is much noise to eliminate. If we postulate a strict segregation between brain modules or functions, we are bound to be left puzzled by how cognitive processing makes up a single, unified, mind.

In fact, not even a segregation into cerebral “functional areas” is now wholly sanctioned, given the plasticity and redundancy that are believed to characterize the brain (e.g., Andrewes, 2001, Ch. 10). In particular, the now well-established findings respecting synesthesia belie any strictly modular-functional segregating view: we all taste with our noses, too, and we all can (potentially) listen to colors, or see sounds, and whatnot (see, e.g., Robertson & Sagiv, 2005). An evolutionary view also belies the dissociative approach (e.g., Reber, 1992a, b): if consciousness is a late acquisition in evolution, as we believe it to be, then it must have emerged from more ancient cerebral properties in a long, gradual process that suggests that rather than dissociating, these two modes of cognition are transitional with respect to each other.

Given all this, why do we go on looking for dissociations? Basically, because since the first talk of dissociation with Freud and Breuer (Breuer & Freud, 1895), a scientific paradigm was painstakingly established (see Augusto, 2010, 2016). The dissociation paradigm provided us with a more or less settled terminology to talk about, and a more or less fixed methodology to approach, unconscious cognition (Augusto, 2016). Many reported findings lost their mysterious character once the phenomena were tackled in this perspective. But our “knowledge” of the many dissociations reported did not make us more clever about a model (or models) of the unified mind; we were left with the corners without being able to fill in the puzzle.

3.2. The dissociation logic and the dual-system/-process theories

Dissociation is a central concept in some branches of psychology. Notoriously, *dissociation of function* lies in the very foundations of (cognitive) neuropsychology: any textbook in this field will teach in its very first pages that dissociation occurs when one aspect of some function is impaired but another aspect of the same function is preserved. For instance, a subject might be unable to understand spoken words but be capable of understanding them in written form. If there is another subject who exhibits the converse pattern of this dissociation, then one talks of a double dissociation. From the viewpoint of (cognitive) neuropsychology, this entails that processing spoken and written words, i.e., listening and reading, are two independent aspects of the function of natural language processing.

In the field of unconscious cognition, one speaks of a dissociation when it is verified that subjects process or represent stimuli, but: do so unintentionally, are unable to consciously represent what it is they do, and/or cannot report verbally on their cognition. These criteria,[3] coupled with empirical dissociative methods and dichotomous thresholds of consciousness (see Augusto, 2016), have motivated the reporting of a large plethora of dissociations. For instance, subjects may be able to manage satisfactorily a complex system without being able to say how they do it, or a blindsight patient may correctly point to a stimulus they claim not to be able to identify visually. Often, the two notions of dissociation come together: for instance, if a patient with no cortical visual abilities performs accurately in visual tasks while claiming no awareness of visual stimuli, it is believed that this implicates extrastriate paths that process visual stimuli in a solely unconscious way.[4] In this case, one speaks of both impairment/preservation and conscious/unconscious dissociations.

This, and other commonalities, shows how the concept of *dissociation* in unconscious cognition is intertwined with the whole field of psychology. But whereas the concept has been object of critical scrutiny in (cognitive) neuropsychology (e.g., Dunn & Kirsner, 2003), in cognitive science and cognitive psychology its influence has been such so as to set up a foundational dichotomy: we talk here of the *dual-process* or *dual-system theories*, according to which any cognitive phenomenon is *either* a system-1 (i.e., an unconscious, or type-1, process) *or* a system-2 phenomenon (i.e., a conscious or type-2 process), *but not both* (see Fig. 1). This exclusive disjunction is known as the *dissociation logic*, and it lies at the basis of, or has motivated, both cognitive architectures (e.g., Carruthers, 2009; Sun, 2016) and psychological accounts of various

[3] These are the intentionality, metaknowledge, and reportability criteria, respectively (Augusto, 2016). See below for an elaboration.

[4] See below for jargon and details on blindsight.

cognitive phenomena—for instance, in social psychology (e.g., Chaiken & Trope, 1999; Sherman, Gawronski, & Trope, 2014), in the psychology of reasoning (e.g., Kahneman, 2003, 2011; Kahneman & Frederick, 2002; Stanovich & West, 2000), and in developmental psychology (e.g., Stanovich, West, & Toplak, 2011). Although dual-process/-system theories only rarely feature in perceptual research,[5] they nevertheless underlie dissociative theories of perception such as the dual visual stream hypothesis (see below), as well as research into subliminal perception (e.g., Merikle & Cheesman, 1987).

Even though there have been some proponents of an inclusive disjunction who postulate some "leakage," or cooperation, between the two systems, the prevailing view is that the relation between the two systems is of a competitive nature (e.g., Evans, 2003), which again suggests a dissociative nature of human information processing. This at the same time motivates, and is supported by, neurocognitive dualistic perspectives that see cortical areas, namely the prefrontal cortex, as carrying out higher-level, conscious cognition, and subcortical areas and the limbic system as responsible for lower-level, predominantly unconscious cognitive phenomena (e.g., Bechara, 2005; Somerville, Jones, & Casey, 2010; Spunt, 2015) (see Fig. 1). This contributed to a perspective that sees unconscious cognition as "lesser" or "weaker" with respect to the conscious mode or manner, though the features in Figure 1 point to unconscious cognition as an overall "stronger" form of cognition in terms of storage and computing complexity, robustness, etc. (see, e.g., Lin & Murray, 2015).

2.3. A tripartite framework in the dissociation paradigm

Three main dissociation criteria have been devised in the field of unconscious cognition (see Augusto, 2016). Roughly, they are believed to detect a mismatch between test performance (TP) and the claimed unperceived character of the input stimuli. For instance, in face of positive TP, subjects may be asked whether they had the *conscious*

[5] One reason for this is that in perceptual research involving unconscious perception the focus seems to be on determining the scope and limits of unconscious perceptive processing (see, e.g., Lin & He, 2009).

intention of learning or memorizing specific stimuli or aspects thereof; if not, then subjects are said to have learned or memorized unconsciously, even though they may be applying this knowledge intentionally and consciously (this is the *intentionality criterion*). Also, subjects might be asked how confident they are (the *conscious* aspect) with regard to TP in some task believed to involve unconscious processing, and this is contrasted with how well they did actually perform in the task: good TP in face of low confidence is accounted for by unconscious processing (the *meta-knowledge criterion*). Yet another scenario: if subjects are incapable of saying (the *conscious* aspect) what the stimuli or features thereof are that account for correct TP in a task, then it is believed that the stimuli were processed and/or represented at the unconscious level (the *reportability criterion*).

These criteria are typically appealed to in experimental settings, but these vary their interpretations of the TP: results can be significant because (a) they show a qualitative influence on the subject's behavior, (b) they are (well) above chance (i.e., > 50%), or (c) they account for provided input. In (a), for instance, the subjects show strong preference for stimuli that were presented but unperceived (e.g., in priming or subliminal perception tasks); also, subjects with a specific visual deficit can respond physiologically to the presentation of visual stimuli with emotional valence. With respect to (b), subjects' TP is quantified and it is verified to be (well) above chance. In (c), output in a task (e.g., correct answers of grammaticality of letter strings, or skillful control of a complex system) is congruent with provided input.

Three major dissociative frameworks in the field of unconscious cognition can be identified according to the main foci (a)-(c) on cognitive experience[6] (see Table 1): (1)

[6] In the strictest sense, a *cognitive experience* is information processing of some kind (e.g., visual, olfactory, reasoning, volitional). This processing can be conscious and/or unconscious for different reasons that range from the neurophysiological to the psycho-dynamic perspectives. We elaborate on this in Sections 4.3.1 and 4.3.3 below, but anticipate it now because we shall be speaking of conscious and unconscious experiences of some kind. Let us use visual experience, because we shall be focusing on it

the quality of the experience, (2) *numerical data*, and (3) *black-box processing*. Accordingly, we refer to them as the *qualitative*, the *quantitative*, and the *computational* frameworks, respectively.[7]

below. We can deduce that a subject undergoes an unconscious visual experience when, presented a visual stimulus, the subject cannot report directly on the stimulus, they have no conscious intention of perceiving the stimulus, and they can even answer negatively if asked if they saw the stimulus, *but* they "pass" indirect tests on the stimulus and/or they exhibit neurophysiological indicators suggesting that the stimulus—or properties thereof—was indeed perceived (see "Main specific criteria" in Table 1).

[7] Although we call (3) "the computational framework" of the dissociation paradigm, surprisingly little work of a truly computational nature has actually been done; some exceptions are, for instance, Boyer, Destrebecqz, & Cleeremans (2005); Cleeremans & Dienes (2008); Gureckis & Love (2005); Schneider & Chein (2003); Timmermans & Cleeremans (2001).

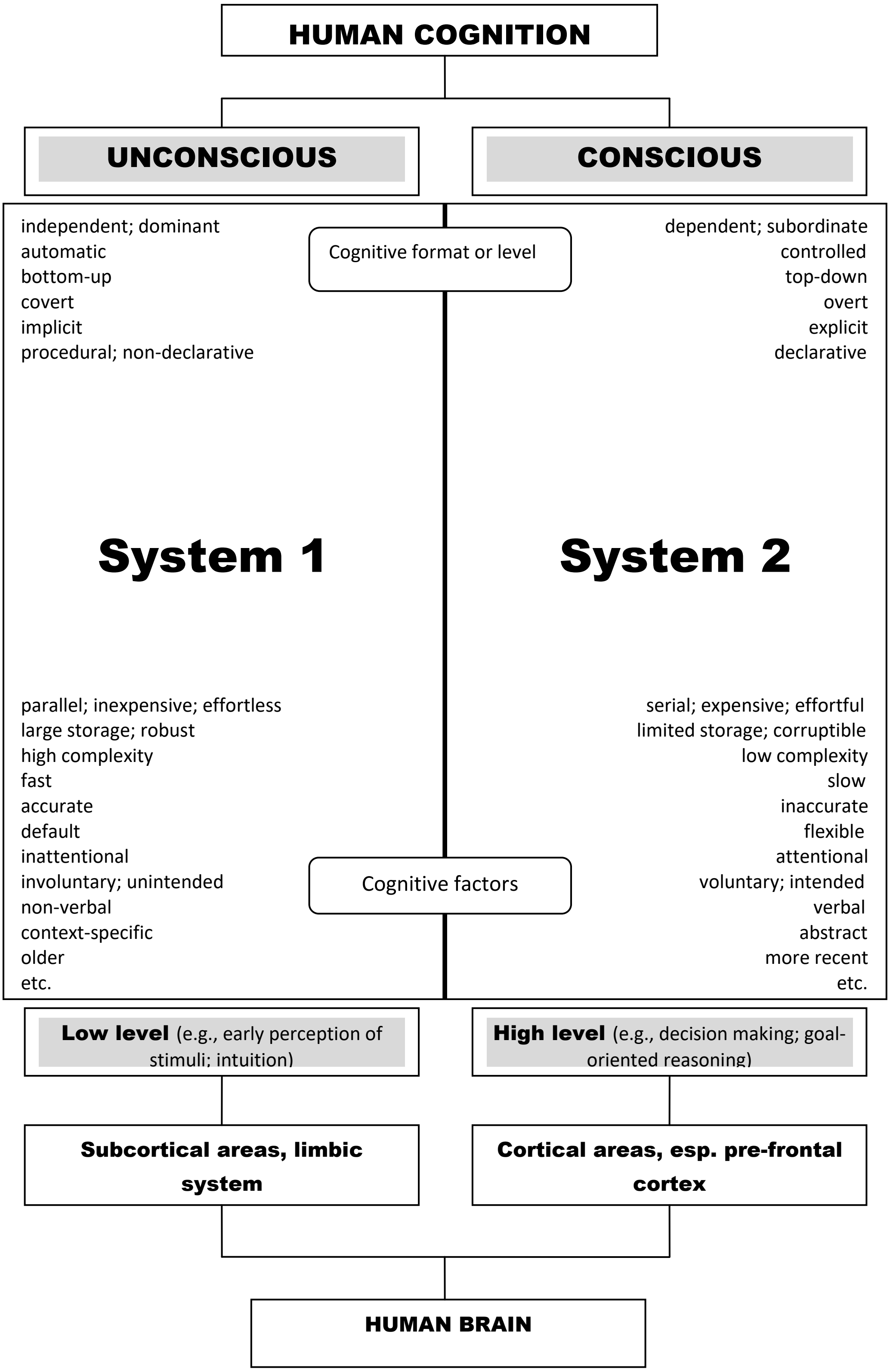

Figure 1: The dissociation paradigm and the dual-system/-process perspective.

With respect to (1), research actively falls on why conscious and unconscious cognition modes account for qualitatively dissociative cognitive experiences. For instance, a patient with prosopagnosia sees familiar faces with claimed neutrality (s/he recognizes none, that is) but, if asked to state preferences (an indirect test or measure), s/he will likely do so for those faces of friends or relatives. Moreover, neurophysiological measures may suggest that the patient distinguishes familiar from unfamiliar faces at a wholly unconscious level.

In (2), dissociation occurs when responses in a direct measure (i.e., a measure of the ability of a subject to detect or identify a stimulus) are at chance level but indirect measures indicate a value higher than zero. For instance, the subject's recognition of lexical items presented in a masked priming task is at chance level, but s/he does tend to use the presented items when asked to fill in (partial) gaps in sentences. A dissociation is also believed to be the case in this paradigm when quantitative data obtained in some experimental task exceed some purely statistical expectation.

According to (3), dissociation occurs when, given a certain output, it is believed that more input is available for processing than the subject has (had) conscious access to. An example of this type of dissociation comes from the simulated systems paradigm: asked to control a complex and dynamic system with a specific goal in view (e.g., maintaining the productivity level of a factory system), subjects often perform well while being unable to say how they do it, thus suggesting that input they cannot consciously access is nevertheless cognitively available.

These three dissociating frameworks are not exclusively disjunctive, actually sharing the main criteria and methods (see Table 1); as stated, they are rather a matter of focus. Together, these three frameworks have accounted for a large dissociation literature in which one easily gets lost (Augusto, 2016). However, if we distinguish the main dissociations according to whether they are connected to processes or representations, we realize that their number can be reduced to six. At the *processing level or format*, conscious dissociates from unconscious cognition in that the latter is (i) independent and dominant, (ii) automatic, and (iii) bottom-up, whereas the former is (i') dependent and subordinate, (ii') controlled, and (iii') top-down. At *the representational level or format*, unconscious cognition is believed to be (iv) implicit and (v) procedural or non-declarative, thus dissociating from the (iv') explicit and (v') declarative cognition of the conscious kind. There is a dissociation that is to be found at *both the representational and processing formats or levels*, which distinguishes cognitive phenomena as being either (vi) covert or (vi') overt. (See Augusto, 2016, for details.) If we now add the dissociative cognitive factors that account for these level/format dissociations, we have the corners of a puzzle (Fig. 1), namely the puzzle of a single, unified, mind.

Unconscious/Conscious Cognition Dissociation			
Frameworks	**Qualitative**	**Quantitative**	**Computational**
Focus	The quality of cognitive experience	Numerical data	Black-box processing
Motto	"Out of sight, but not out of mind"	"Behavior without awareness"	"We know more than we can tell"
General criterion	Contrast/lack of correlation between the subject's (self-)awareness and non-overt or non-introspectable indicators of cognitive processing: actual cognition contrasts or does not correlate with (self-)awareness	Contrast between (purely) statistical rates: values > 50 % (or even just > 0) obtained in tasks of unconscious cognition contrast with statistical expectancy or with (chance) values obtained in tasks of conscious cognition	Contrast between informational availability and accessibility: the output (TP) exceeds the conscious input but is commensurate with the purported unconscious input
Main specific criteria:			
- Mismatch* between intentions and performance	+	+	+
- Mismatch** between self-knowledge states (e.g., confidence, expectancies) and performance	+	+	+
- Mismatch¤ between reportability (e.g., detection, explanation) and performance	+	+	+
- Mismatch between purely statistical rates (e.g., statistical expectancy vs. performance rates)	–	+	±
Methodology:			
- Stimuli:			
neutral	–	+	+
emotional valence	+	–	–
- Neurophysiological measures (e.g., EEG)	+	–	–
- Reaction times (RTs)	±	+	±
- Forced responses	±	–	+
- First- (e.g., introspection) vs. third-person observation (e.g., brain imaging)	+	–	±
- Direct vs. indirect measures of cognitive processing	+	+	+
- Testing of subjective vs. objective thresholds	+	+	+
- Comparing purely statistical rates	–	+	±
Significant empirical settings	- Associative learning - Agnosias and other visual anomalies - Priming (esp. in social psychology) - Decision making - Social cognition - Subliminal perception	- Associative learning - Priming - Subliminal perception	- Artificial grammars - Dynamic systems control - Agnosias and other visual anomalies - Sequence learning

* This is the intentionality criterion (see Augusto, 2016)

** The meta-knowledge criterion (*ibid.*)

¤ The reportability criterion (*ibid*.)

Table 1: The dissociation paradigm: Three main frameworks.

(Grey areas indicate commonalities. + denotes significant presence; – denotes significant absence; ± denotes partial presence.)

4. An emerging paradigm

4.1. Transitions and the puzzle of the unified mind

But we do not know how to fill in the puzzle. Also because we are not sure that the corners (see Fig. 1) are veridical; in effect, there have been a few challenges to this neat picture (Augusto, 2013, 2016; see below). But mostly because the transitional character of cognition has yet to be approached within a coherent theoretical and methodological framework.

For instance, visual perception has figured prominently in the dissociation paradigm because, once you diagnose a patient with a particular visual anomaly, it is rather easy to contrast their performance in visual tasks with the performance of normal subjects: these identify the stimuli or discriminate properties thereof correctly, whereas the former do not, or do so in uncommon circumstances. Indeed, in some conditions—e.g., blindsight—certain tasks appear to reveal that the patients do process the stimuli, albeit in an unconscious way.

Blindsight is a visual anomaly that has been the object of much research (see Cowey, 2010). Neurophysiologically, the condition is characterized by cortical blindness that can affect an entire visual hemifield or even the entire visual field, but more often than not affects only parts thereof (scotomata, or blind spots). This contrasts with the behavioral aspects of the condition: typically, a patient with blindsight who is shown a figure or shape on a screen is unable to identify it, but, if forced to indicate its location, can do so well above chance. This is known as type 1 of the condition. This performance is accounted for by a neural model that dissociates vision into two streams, a conscious, cortical stream (the ventral stream), and an unconscious, perhaps partly subcortical stream (the dorsal stream) (see Milner & Goodale, 2008). This model, known as the *dual visual stream hypothesis,* accounts for unconscious vision when the striate cortex, or primary visual cortex (V1), has been damaged or removed, claiming that visual percepts in the dorsal stream are useful for spontaneous action only, whereas those processed by the ventral stream allow for discrimination and identification.

According to the model, the dorsal stream processes solely properties such as location, motion and direction of visual stimuli, but lacking in content and form, which are processed by the ventral stream (Sahraie et al., 2010). It explains how, for instance, there are saccades (largely involuntary eye movements) as a response to, say, moving stimuli in the absence of conscious discrimination (e.g., Danckert & Rossetti, 2005; Weiskrantz, 1996).

But this dissociative clarity is obscured once we are in possession of a few facts:

Some blindsight patients, when asked how they locate the stimulus on the screen, claim they definitely do not see it, but say that they "feel" it is there. This is known as type-2 blindsight, and it poses issues to do with the modality-specificity of visual experience and of perceptive experience in general (e.g., Brogaard, 2015; Foley, 2015).

It has been reported that patients can process information on the emotions of faces exhibited to their blind fields, a phenomenon now coined "affective blindsight" (e.g., Celeghin, de Gelder, & Tamietto, 2015). This indicates that there is no emotion-free perception and that cognitive modularity must be relativized: non-interdependent modules for stimuli perception and emotional processing are not plausible.

The dorsal stream appears to serve pervasive features of conscious visual experience, i.e. it is likely that, if the dorsal stream is damaged, then visual awareness in the ventral stream will be affected (e.g., Wu, 2014). This, and other aspects, point to a relative specialization of the two streams, with the ubiquity and extension of interactions suggesting that the two streams are in fact not independent (e.g., Himmelbach, Boehme, & Karnath, 2012; Schenk & McIntosh, 2010). In particular the attribution of the behavior exhibited in blinsight to the dorsal stream has been challenged in multiple ways (see Barton, 2011, for a review). Furthermore, not all patients with a damaged striate cortex exhibit behavior typical of blindsight (e.g., Weiskrantz, 1996).

All this indicates that in order to be able to fill in the puzzle of the unified mind we need to understand the transitional character of cognition, namely with respect to the conscious-unconscious spectrum. This is so not only because we lack the pieces to fill in the center of the puzzle, but also because the corners are blurred. For instance, type-2 blindsight suggests that it is simplistic to dissociate visual experience into conscious vs. unconscious, because maybe something like synesthesia (see above) is at play, too. Rather than looking for a dissociation, we appear to be required to look for phenomenological and neurophysiological indicators in visual experience that mark the—possibly many and varied—transitions from a conscious visual perception to an unconscious "visual" experience, and this in turn might require that we be able to capture the transitions from a purely visual to a non-purely but maybe still largely visual experience.

As a matter of fact, if we critically analyze all the features at the corners of the puzzle, we find that all are blurred (see Augusto, 2016).

4.2. The crisis

No scientific revolution takes place overnight. Despite what the term "revolution" may suggest, overthrowing a paradigm is a gradual, sometimes rather inconspicuous, process, and this begins with the accumulation of intuitions, evidence, methods, etc. pointing to a new direction in the field. This is clearly the case in the field of unconscious cognition: theoretical, rather tentative, work on the "continuous" nature of the unconscious-conscious cognitive spectrum has been published (e.g., Augusto, 2013, 2014; Bar et al., 2001; Cleeremans, 2006, 2014; Gelbard-Sagiv et al., 2016; Moutoussis & Zeki, 2002; Pascual-Leone, Grafman, & Hallett, 1994; Scott & Dienes, 2010), and the dual-system/-process theories have been challenged here and there (e.g., Keren &

Schul, 2009; van Bavel, Xiao, & Cunningham, 2012). What comes out of this work[8] is that it does not share a common theoretical or methodological framework, being rather of disparate nature and objectives. As is typical of an emerging paradigm.[9] As is also typical of a resisting paradigm, evidence is here and there offered against the new emerging ideas, but this is (increasingly) confronted with evidence coming from the new theoretical quarters (e.g., Overgaard et al., 2006 vs. Sergent & Dehaene, 2004), with the odd conciliating view meant to appease the revolting waters (e.g., Windey & Cleeremans, 2015). After all, there appears to be evidence for both sides.

4.3. New paradigm, new models

We now need a unifying theoretical and methodological framework that not only captures the transitional character of the conscious-unconscious continuum, but also accommodates what from the dissociation paradigm will be proved useful and relevant. With regard to this latter aspect, we predict that the largely absolute dissociations that this paradigm provided us with will not be removed *tout court*, but will rather be relativized in view of the results in the research on transitions between conscious and unconscious cognition. That is to say that expressions such as “unconscious cognition is automatic, whereas conscious cognition is control-based” will be reformulated into something like “unconscious cognition appears to be largely automatic, but in certain (*specifiable*) cases it might or does implicate control” and “conscious cognition is

[8] Which does not include the larger literature on studies in anesthesia, given that, in these, cognitive aspects are more often than not ignored in the transition from unconsciousness to awareness or responsiveness.

[9] As a matter of fact, the first steps away from dissociation were actually taken by Freud in his reformulation of the first theory of the unconscious (in Freud, 1915): In Freud (1923), the conscious is a part of the unconscious, namely a component of this that has been modified by contact with reality. More specifically, in Freud’s (1923) second model of the mind, the id is essentially conscious, the super-ego is partly conscious, and the ego is partly unconscious, so there is no strict dissociation conscious vs. unconscious.

characterized by control, though in certain (*specifiable*) cases automatisms can be verified."

We predict that various models will compete for prominence in the new paradigm. We also predict that one or both of the following *pairs* (rather than *distinctions*) will feature in some of these new models: the *representation-process* and the *analog-digital* pairs. It is also possible that dynamic aspects will, in cooperation with these, be incorporated in the new cognitive models of the mind.

4.3.1. Processes and representations

Although the *representation-process* pair is not new to cognitive science and psychology (e.g., Gazzaniga, Ivry, & Mangun, 2002; Thagard, 2005, 2012), it will require further work to be of use to research into the transitions between conscious and unconscious cognition. We have carried out preliminary work into this subject matter: summing up Augusto (2016), a cognitive representation is information in a knowledge form, whereas a cognitive process is an operation on information in knowledge-form or in any other form; summarizing Augusto (2014), a representation calls for specific processes, and a process is adequate for some specific representations, which means that representations X come with processes Y much like a pair (X, Y).

Given this, the first questions that we have to find answers for are: *what can be operated upon*, and *what can be represented*. The obvious common answer for both questions is *information*, but not all information that can be operated upon is representable. For instance, photons hitting the retina can be processed into ultimately a visual image; however, we are not capable of representing the individual photons, but only the final image or "versions" (maybe intermediate forms) thereof. Yet another example: we cannot represent acoustic waves before they hit our cochlea, but processing of what can be eventually represented as sound begins right there. The reason is that photons, acoustic waves, and light waves are not information proper, but rather potential information carriers as far as human information processing is concerned. The conclusion follows: cognitive operations can be carried out on stimuli that cannot yet be represented, and we can only represent information that has already been operated upon.

Note that the unconscious-conscious continuum begins right here: we *cannot* become conscious of photons or of acoustic waves, but only of visual images or sounds, blurred or degraded as they might be, just as we *cannot* become conscious of light waves, but only of colors, etc. Given the likely large amount of information that we operate on without being capable of representing consciously—especially (but not only) at early processing stages—, it is justified to believe that processes are largely unconscious cognitive phenomena. With respect now to representations, we do not in fact represent consciously a stimulus as *light*, or *sound*, or *color*, but as *this light* (e.g., sunlight), *this sound* (e.g., a noise), or *this color* (e.g., light red). Nevertheless, at some point in the processing we must represent those stimuli as yet unspecified light, sound, or color. Thus, not all representations reach consciousness. A remarkable illustration is provided by prosopagnosia, a visual agnosia in which one can be looking at a familiar face (including one's own) without recognizing it, though one is consciously representing *a* face. On the other hand, we can be conscious of some processes; for instance, we can be conscious of carrying out the process of searching for a word in our memory.

This means that for a pair (X, Y) we can be or become conscious of both X and Y, but there are pairs (X*, Y) in which we are, or can become, conscious of the process but not of the representation, or (X, Y*) in which the reverse may occur, or also pairs (X*, Y*) in which neither the representation nor the process reach consciousness. An example of the latter is the pair (X*, Y*) = (photon, reception at retina); an example of the first is the pair (X, Y) = (word, search in memory). The pairs (X*, Y) and (X, Y*) are transitional in a special sense of the term that we need yet to clarify.

But the most interesting cases of transitions from unconscious to conscious (or the reverse) cognition is when we go from X* to X, or from Y* to Y (or the reverse). For this end, again the pair (X, Y) is adequate because in fact this is a pair (X_n, Y_n), and we can isolate the *n* of interest. This is so because one single representation can undergo several operations, and one operation can be carried out on two or more representations. An example of the former is (word, (search in memory, attention)), i.e. (X, (Y_1, Y_2)), and an illustration of the latter is ((memory 1, memory 2), association), i.e. ((X_1, X_2), Y). By varying the *n* we have a suitable means to approach the above transitions. For instance, let X denote "word," Y_1 denotes "search in memory," and Y_2 stands for "attention." Let us denote "no attention" by $\not{Y}_2$. Then we have the pairs (X, (Y_1, Y_2)) and (X*, (Y_1*, $\not{Y}_2$)). That is, the operation of (in)attention motivates the transition between the conscious or unconscious status of the pair (word, search in memory). Furthermore, we can refine our Xs and Ys; for instance, we can be interested in finding out how much (in)attention is required for a transition in the conscious-unconscious status of the pair (word, search in memory), or how much the pair—or a component thereof—is in itself capable of reaching consciousness.

Obviously, there is nothing new here for experimental psychology: for decades, experimental psychologists have been manipulating variables, in order to obtain descriptive/explanatory curves. But this experimental manipulation of variables is essentially absent in the dissociation paradigm. In this, stimuli are typically either degraded (as in priming) or perceptively stable, complex or simple, etc. Many ways to implement the above in an experimental setting come to mind, and we discuss briefly one. Interestingly enough, Shea & Frith (2016) discuss an abundance of reported findings in light of the representation-process pair, providing thus many cues for further experiments in this vein.

As is well known, the apparently simple process of indicating orally the name of colors is significantly disturbed if a subject is presented a conflicting word-color stimulus, for example, the word *blue* printed in a color other than blue. This is known as the Stroop effect, and it is measured against the presentation of colors in printed squares (Stroop, 1935). A common interpretation is that the reading of the printed word is automatically triggered, thus impacting on the subject's response latencies (e.g., Monahan, 2001;

Stirling, 1979; Tzelgov, Henik, & Leiser, 1990). We are here in the presence of the pair $((X_1,X_2), (Y_1,Y_2^*))$ = ((color, word),(seeing, reading)), in which the word representation is largely conscious but the reading process is believed to be triggered unconsciously, i.e. unintentionally and eluding attentional control (see, e.g., Moors & De Houwer, 2006). In order to test for transitions between unconsciousness and conscious cognition, we can start with a colored figure that is not a printed word and proceed to gradually give it the form of a color-incongruent word. In all trials, the subject is asked to just indicate the color of the figure/word, which (the color) should vary so as not to lead to habituation. By analyzing the succession of response latencies, we can determine the point at which or from which the subject became conscious of the word; in terms of a curve, this would be the point from which the derivative is, or tends to, zero, i.e. we have roughly a horizontal line. The experiment can easily be carried out with some sort of brain imaging, and the particular brain area(s) active at or from this point on can be identified. We thus have a neural-computational coupling.

Above all, we are interested in determining the properties of the word form whose representation triggered the automatic reading and delayed the oral naming of the color. For this end, we have a second pair of interest.

4.3.2. Analogicity and digitality

We propose yet another pair for the study of transitions from unconscious to conscious cognition (or the reverse): the *analog-digital* pair. This is obviously applicable only to a perspective of cognition as information processing,[10] as these two dimensions respect (mathematical, or computational) properties of the information processed and/or represented. We begin by cautioning that here, too, a lot of work will be required, in order to make this pair suitable for work in cognitive science and psychology, though it has already been—rather tentatively—introduced in textbooks (e.g., Friedenberg & Silverman, 2006); after all, its roots are in electronics, namely in electronic signal

[10] Some call this view *Computationalism*, but we will not linger—or quibble—on this.

processing, and the mathematical distinction continuous-discrete at its basis cannot be transposed to human cognition in a simplistic way.[11]

Nevertheless, we can envisage an analog cognitive event as being "finer-grained" than its digital counterpart in the sense that it comprises more "variations"—possibly "noise"—than the latter. In this specific sense, what we can actually represent is, say, an apple in a fruit basket, but we can be more or less aware of the many variations involving the apple and the fruit basket which we cannot actually identify or discriminate, but somehow know to be there. This is actually the case in peripheral vision (e.g., To et al., 2011).

One way to make this distinction more precise in a cognitive sense is to see a digital mental event as conceptual-based, and an analog event as a non- or less-conceptually based mental event (e.g., Carruthers, 2000)[12], but we beg to disagree, because concepts are not necessarily digital (i.e. larger-grained), and many-variable mental events are not necessarily analog (i.e. finer-grained). In particular, we do not think this to be transposable to a percept-belief distinction (vs., e.g., Carruthers, 2000), mainly because percepts are—or can be—"conceptually-ladden" and beliefs can be formed and held without clear-cut concepts (vs. Gabbay & Woods, 2003).

We should also beware of the equations "analog = sub-symbolic" and "digital = symbolic" (e.g., Friedenberg & Silverman, 2006). For instance, digital processes are believed to be rule-like and operating on symbols or symbolic structures (e.g., syntactical rules in natural language), whereas analog processes are supposed to be purely quantitative and operating on fine-grained constituents of representations that can be as "fine" as implicating a single neuron. These equations are at the core of a long-

[11] Maybe here human and artificial cognition do part.

[12] This is a tentative example, as we are not sure about the author's position. Below in this paragraph we cite Gabbay and Woods (2003) hesitatingly also for the same reason.

lasting dispute in cognitive science and AI between supporters of connectionist vs. cognitivist models (see the respective classical references: Rumelhart, McClelland, & the PDP Research Group, 1986; Fodor & Pylyshyn, 1988). In particular, the equations of symbolic processing with consciousness and sub-symbolic processing with unconscious cognition (e.g. Sun, 2016) must be avoided, as they clearly fit only the dissociation paradigm.

As said, much work needs to be done on the representation-operation and analog-digital pairs, but we can already start sketching a cognitive model in which these pairs will have a prominent role. First of all, we think that the analog-digital pair can be applied to both representations and processes, that is, representations can be either digital or analog (or somewhere in between), and processes can be either digital or analog (or somewhere in between).

More specifically, we hypothesize that the finer-graded (i.e. analog) a representation or process is, the less it will be capable of reaching consciousness. For instance, representing individual photons is too fine-grained a cognitive phenomenon, so fine-grained that it is equivalent to “noise.” In contrast, peripheral vision is not so fine-graded that it does not allow us to identify and discriminate stimuli, but it is just fine-graded enough so that we can do it only in a degraded manner; for instance, we consciously identify letters in a text around a word we are focusing on, but we cannot discriminate what the letters are.

On the other hand, we hypothesize that the larger-grained (i.e. digital) a representation or process is, the more capable of reaching consciousness it will be. For instance, we can be conscious of looking for a word in our memory, but the process seems to be quite large-grained: we know we have got it “somewhere” and we are trying to locate it there, namely by recalling other words that are typically associated to the particular word we are looking for. Words are indeed very large-grained cognitive phenomena: as the Stroop effect shows, it is basically impossible not to represent them once we know their meaning and we can see or hear them, consciously or, as is the case in priming, unconsciously.

4.3.3. Integrating dynamic and cognitive aspects or dimensions

So, a representation that is digital in essence can provide an X representation, whereas one that is analog can only provide an X* representation, and the same works for the Y and Y* processes. This is clearly too simplistic, because it does not answer the questions why, for instance, an X representation may not be capable of reaching consciousness, or a (partly) X* representation may reach some degree of consciousness.

As said, this has probably to do with the degree to which a representation or operation is analog or digital, but an appeal to what is currently known as "dynamic" factors might prove itself necessary, too. In effect, dynamic dimensions or aspects such as defense mechanisms may be at play in the degree to which an X representation or an Y process may fail to reach consciousness, or an initially X* representation or an essentially Y* operation may attain some degree of consciousness. After all, at some point a cognitive model can, or does, become a model of the mind, and Freud's models of the mind (Freud, 1915, 1923), to give but a prominent example from the field of dynamic psychology, are in fact dynamic models—and highly complex, at that—in the sense that "dynamic" has in contemporary cognitive science (e.g., Schöner, 2008). Here, too, the waters have started to revolt and work has been published attempting to bring together dynamic and (neuro)cognitive components with a view to a unified theory of the mind[13] (e.g., Arminjon, 2011; Berlin, 2011; Bucci, 2000)

Like Neisser, we think that "every psychological phenomenon is a cognitive phenomenon" (Neisser, 1967, p. 4); additionally, we think that every cognitive phenomenon is an information phenomenon. As we see it, the repression of a

[13] Actually, this is hardly surprising, given Freud's originally neurological basis for a model of the conscious-unconscious mind (see Freud, 1895).

representation like a sexual wish (because, say, it is too distressful for the subject) is just a pair (X*, Y*) = (sexual wish, repression), in which repression is an unconscious process (perhaps automatic, or dominant; see above) carried out on a representation that could reach consciousness, were it not for the cultural or moral circumstances in which the subjects find themselves in.

Given this essentially information-based character of so-called dynamic aspects, all we need now is to find ways that are scientifically sanctioned of approaching these aspects in a cognitive model of the mind. One such way is computational modeling, and there is in principle nothing that prevents us from integrating dynamic aspects like, say, repression in a computational model. Recall how such aspects as reward and punishment have been successfully integrated in computational models of learning (e.g., Sutton & Barton, 1998), and how like models integrating the effects of dopamine have also been conceived (e.g., Fellous & Suri, 2003).

In effect, because dynamic factors just are information-based factors, we can unproblematically manipulate the *n* in the X_n and Y_n without making a distinction between dynamic and cognitive aspects.[14] Take the pair (X*, Y*) = (wish, repression); let us now add the cognitive factor "attention". Depending on the type of attention (e.g., direct or indirect) we may end up with a pair (X, (Y_1, Y_2)) = (wish (repression, attention)), i.e. the subject becomes aware of repressing a wish once attention has been adequately directed to it. The transition (X, (Y_1*, Y_2)) = (wish (repression, attention)), in which the subject becomes aware of the wish but not of the repression process, is of interest, too. This is, after all, what psychoanalytical therapy has been practicing for decades, and there is no reason now not to be able to model this cognitive transition, computationally or otherwise.

[14] In our view, the remaining difference is as follows: dynamic factors or dimensions require a cognitive basis. This in the belief that three levels are required for an analysis of human mind and behavior: neural, cognitive, and mental, hierarchically from lowest to highest, or from micro- to macro-level, respectively.

5. Concluding remarks

Since Freud and Breuer first spoke of dissociation (Breuer & Freud, 1895), a scientific paradigm in the field of unconscious cognition was painstakingly established comprising now three main frameworks (see Table 1). This dissociation paradigm created a dual-system/-process model of the mind that maps unconscious vs. conscious cognition into dualistic brain models (see Fig. 1) and it is believed to account for dissociative phenomena in the fields of (neuro)cognitive psychology, social psychology, the psychology of reasoning, etc., i.e. basically in all psychological fields.

However, a critical analysis of the dissociations (e.g., Augusto, 2016) suggests that they can only cautiously be appealed to for the explanation of many psychological phenomena. Moreover, the need to look for transitions, rather than dissociations, with respect to the cognitive status of the psychological phenomena (i.e., conscious or unconscious) appears now necessary, in order to fill in the puzzle of a unified mind. In effect, we have reached a Kuhnian crisis in the field of unconscious cognition, and a new paradigm is tentatively but perceptibly emerging.

We expect this new paradigm to gain momentum in a short term. For this end, we predict that three aspects that were wholly ignored or spurned by the dissociation paradigm will concur:

1. The pair *representation-process*;
2. The pair *analog-digital*;
3. Aspects from *dynamic psychology*.

We went so far as to suggest a very sketchy model incorporating these aspects. Sketchy as it is, it seems to us to be more adequate than any present model to approach transitions in cognition with a view to models of the unified mind. In Section 2, we touched three desiderata for models of the unified mind. With respect to the bio-ecological motivation behind this sketchy model, we believe that consciousness evolved gradually (to a great extent or wholly because of environmental pressure) from more primitive unconscious processes and representations, so that transitional states must still be extant in the cognitive experience of humans and of other animals that possess some degree of consciousness. To concentrate exclusively in the poles of the spectrum will not provide us cues as to why the unified human mind integrates both kinds, conscious and unconscious, of processes and representations.

By concentrating on the pairs analog-digital and processes-representations to approach cognitive transitions we are being cognitively realistic in the sense explained above. But we are not being simplistic, as we anticipate that the scientific approach of these two pairs will confront us with respectful challenges.

Lastly, as far as eclecticism is concerned, we anticipate that models of the unified mind incorporating transitions between consciousness and unconsciousness will include dynamic aspects. Whether this will require a change of scientific status of these aspects, we do not yet know, but this eventual integration has been hovering over the field of cognitive psychology since the very beginnings of the "cognitive revolution." Like Neisser, one of the main propellers of this revolution, we believe that no cognitive approach can dispense with "variables" like fear, desire, guilt, etc. when addressing the problem of models of the unified mind.[15]

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[15] We quote from Neisser (1967, pp. 4-5): "[A]lthough cognitive psychology is concerned with all human activity rather than some fraction of it, the concern is from a particular point of view. Other viewpoints are equally legitimate and necessary. Dynamic psychology, which begins with motives rather than with sensory input, is a case in point. Instead of asking how a man's action and experiences result from what he saw, remembered, or believed, the dynamic psychologist asks how they follow from the subject's goals, needs, or instincts. Both questions can be asked about any activity, whether it be normal or abnormal, spontaneous or induced, overt or covert, waking or dreaming. Asked why I did a certain thing, I may answer in dynamic terms, "Because I wanted…," or, from the cognitive point of view, "Because it

In any case, much work is required in the three aspects above to make them fit for work in cognitive science, namely as far as the interconnections among them are concerned. This being achieved, we are expected to come up with a computational model of the mind that can actually account for cognitive phenomena by means of their computational correlates. Concurrently, much further research into the human brain has to be carried out, in order to come up with mappings that can work as neural models of the transitions between unconscious and conscious cognition. The objective is a neural-computational model of human cognition.

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seemed to me…" (…) Many cognitive phenomena are incomprehensible unless one takes some account of what the subject is trying to do."

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