Distributed remembering through active structuring of activities and environments

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Abstract. In this paper, we consider a few actual cases of mnemonic strategies among older subjects (older than 65). The cases are taken from an ethnographic study, examining how elderly adults cope with cognitive decline. We believe that these cases illustrate that the process of remembering in many cases involve a complex distributed web of processes involving both internal or intracranial and external sources. Our cases illustrate that the nature of distributed remembering is shaped by and subordinated to the dynamic characteristics of the on-going activity and to our minds suggest that research on memory and distributed cognition should focus on the *process* of remembering through detailed descriptions and analysis of naturally occurring situations.

Introduction

Theories of distributed cognition (e.g. Hutchins, 1995a) and extended mind (Clark & Chalmers, 1998) claim that cognitive processes do not entirely occur in the brain, or are not entirely within the individual, but extend into the world. The thesis that cognition or mind is extended has been widely debated in recent years (for a collection of some of the central papers in this discussion see Menary, 2010). Much of this discussion focuses on memory. The discussion on memory, starting with Neisser's anthology *Memory Observed* (1982), was a forerunner that bolstered the emergence of the notion of distributed cognition (Salomon, 1993).

The idea that cognitive processes are not only in the head is central to the socio-cultural tradition (Leontiev, 1978; Vygotsky, 1978) that views human cognitive abilities and activities as residing not only in the brain but in the relationship between brain, body, and world. Hutchins (1995a) emphasized parts of this tradition and introduced the study of "cognition in the wild". In this way one would be able to talk about how a cockpit remembers its speed, to take one example (Hutchins, 1995b).

From this historical perspective, *memory* is still the right pick for discussing distributed cognition. The point we wish to make in the present paper is that in studying memory, the *activity* of remembering is perhaps a more fruitful focus than the *products* of remembering. We also argue that agents are active in structuring their environments and activities as part of the tasks of achieving the goals for which the memories are used, and this also in cases where the memory artefact is external to the brain and body. (We use the words "external" and "internal" in this paper synonymous with "extracranial" and "intracranial").

The real world examples that we will present here come from an on-going project of remembering in everyday situations, with the main focus on elderly people with normal cognitive functioning. All cases presented here come from the first study in the project.

The field study (conducted by MK) was conducted during the summer of 2010. We used an ethnographic approach situated in the context of the home-healthcare service in a small Swedish town, with approximately 25 participants that had some assistance or recent contact with the home-healthcare service. The age of the participants ranged from 72 to 91 years; some of them were diagnosed with Alzheimer's disease or other forms of dementia. The study was exploratory with a general focus on understanding remembering practices. The field notes were collected when MK worked as a healthcare assistant. In addition, open interviews were conducted with five participants outside the context of the home-healthcare, with a focus on trying to understand the participant's everyday life outside the context of the home-healthcare service.

Below we present excerpts from three participants (A, C and D). Of these, only A (age 79) was interviewed and observed outside the context of the home-healthcare service and therefore studied more extensively. C and D were studied less extensively with occasional observations.

The level of cognitive functioning varied among the participants. Some had normal functioning for their age while others had clinical memory declines. This was the case for D who received assistance several times a day due to her memory problems. All of the three participants were women. More detailed information on each case is provided at the excerpts presented below. Some observations and results from this study have previously been presented in Kristiansson (2011) and Dahlbäck, Kristiansson, Skagerlund, & Stjernberg (2011).

The rest of the paper is structured as follows. First we review previous research on memory in elderly persons. Second, we review previous research on distributed cognition and distributed memory, and point to some problems we see in previous research because of its focus in the results of the memory process, and suggest that a focus on the process of remembering could be a fruitful way forward. In the third section we present and analyse examples from our ethnographic study to illustrate and further elaborate the points above. The final section summarises the main points made.

Distributed Cognition: the case of older adults

Older adults show a decline in several cognitive abilities that traditionally have been considered internal processes of the brain. They are often referred to as so called fluid abilities; as opposed to crystallized abilities (Baltes, 1997; Craik & Bialystok, 2008; Salthouse, 2011). Tests measuring fluid abilities often focus on novel problem solving, reasoning and executive functions. Tests on crystallized abilities, on the other hand, focus on cumulative abilities such as knowledge and verbal fluency. Episodic memory is one of the most noted declines (c.f. Nilsson, 2003). (In this study, as is often the case, prospective memory is included in episodic memory). But another common result is that older adults in real-life settings often manage demanding cognitive tasks at the same level as younger adults. As an example of this, Kvavilashvili & Fisher (2007) showed for instance that older and younger persons

were equally good at handling a prospective memory task such as making a phone call at a specific time, even though they were explicitly asked not to use any kind of external aids for retrieval. This suggests that memory performance in the lab and in natural situations might be different enough to suggest that generalizations from lab studies to real life situations should be made with caution.

Craik and Bialystok (2008) describe, from a lifespan perspective, the process of aging as something that can be understood in terms of internal changes of representational structures and control structures in relationship to an external context. Inspired by Vygotsky's (1978) theory of development they note that environmental support is more important in the older population. Older adults rely more on and are more shaped by environmental cues to guide thoughts and actions, and to complement self-initiated behaviour (Craik & Bialystok, 2008). They also note that there is a general trend of declining control structures (c.f. executive functions) in the older population while accumulated representational structures become more dominant.

This picture of the aging process is supported by the fact that some internal memory processes decline more than others, for instance recollection (as opposed to familiarity) and episodic memory (as opposed to semantic memory). These can be viewed as relying more on internal control structures than other memory processes, since they require formation of new information (Craik and Bialystok, 2008). Also McDaniel, Einstein, and Jacoby (2008) suggest that age-related differences in memory tasks are larger under conditions that require higher executive control. Based on this it seems likely that older adults primarily will actively distribute memory processes such as explicit and episodic memory that require more control processes (for an example of this, see the case of D below).

The idea that older adults compensate for declining internal memory abilities through external memory aids has to a large extent been investigated and confirmed through self-reporting questionnaires (c.f. Cavanaugh, Grady, & Perlmutter, 1983; Frias, Dixon, & Bäckman, 2003; Intons-Peterson & Fournier, 1986). But findings about external memory use across the lifespan are not all consistent, where factors such as cultural demands (Long, Cameron, Harju, Lutz and Means, 1999) or stress-related psycho-social environments (Park and Minear, 2004) can be predictors for the use of such aids.

Based on earlier theoretical discussions of compensatory behaviour (Bäckman & Dixon, 1992; Dixon & Bäckman, 1995), the memory compensation questionnaire (MCQ) was developed to measure five components: (a) external memory aids, (b) internal mnemonic strategies, (c) investment of time, (d) more effort in memory task and (e) reliance on social others (Dixon, Frias, & Bäckman, 2001).

In studies using MCQ, external memory aids are overall the most common reported resource (Dixon, Frias, & Bäckman, 2001; Dixon, Hopp, Cohen, Frias, & Bäckman, 2010). Women are, however, more likely than men to state that they rely on social

others (Dixon et al., 2001). In a sample from the Kungsholmen project[1], healthy older adults and older adults diagnosed with Alzheimer's disease (AD) showed similar patterns of self-reports for the variables across two measurement occasions (Dixon et al., 2003). This was true for all components, except for a lower use of external memory aids and an increase of reliance on social others in the AD group. This suggests that the use of external physical objects, despite being the most frequently used strategy, is not maintained spontaneously in an AD population, even if the ability to maintain such strategies can remain (c.f. Bourgeois et al., 2003). As suggested by findings from the MCQ the older population in general report that they are more likely than the younger population to distribute their memory processes actively, however, whether this is true remains to a large extent an open question.

Harris, Keil, Sutton, Barnier and McIlwain (2011) investigated the social component of adaptive behaviour in elderly more closely to see what factors that could influence collaborative performance in older couples performing a personal list recall task. They found the following factors inhibited performance: (a) incompatible reference to expertise to a past experience, (b) strategy disagreements where for instance a question is interpreted differently, (c) corrections, and interestingly (d) the occurrence of failed cues. For this last one, Harris et al. (2011) propose that the willingness to cue is itself an important contributor for successful collaborative remembering. They also found the following three factors facilitating recall: (a) the occurrence of cuing, (b) production of new information in response to cues and (c) repetitions. These findings give some clues to the complexity of what it is to have a successful socially distributed memory system.

Most previous neurocognitive research on cognitive aging and memory makes use of a distinction between internal or external memory aids to explain the adaptive cognitive changes in the aging population (c.f. Cavanaugh, Grady, & Perlmutter, 1983; Frias, Dixon, & Bäckman, 2003; Intons-Peterson & Fournier, 1986). A similar distinction between internal and external memory is used in the on-going debate in philosophy and cognitive science on external mind and distributed cognition, in most cases sparked off by Clark and Chalmers (1998) paper on extended mind.

Distributed cognition and distributed memory

It is no surprise that the discussions concerning extended cognition often have centred around memory. If memory serves to preserve earlier experiences (something we can find reason to doubt in certain cases; see Matthen, 2010 and Michaelian, 2011), devices that aid such preservation would appear to be clear cases of an extension of our cognitive systems. Such extensions have almost invariably been thought of as *external* to the *internal* workings of the single subject, where what is internal is usually thought of as located inside the subject's brain. This understanding

[1] The Kungsholmen project was a longitudinal study of the older population living in a part of central Stockholm, Sweden, conducted 1987-2000. For more information, see http://www.kungsholmenproject.se/

may fit well with some examples of extended cognition, but we find that focussing on the internal/external divide will be less useful in real-life settings.

One original example of extended cognition (Clark & Chalmers, 1998) involves Otto and his use of a notebook as a mnemonic device. Much of the debate has focused on to what extent the use of the notebook can be seen as an extension of Otto's own cognitive resources or if another theoretical interpretation is warranted here. Everyone agrees that Otto needs and uses his notebook to complete his cognitive tasks, but the claim that has led to controversies is whether Otto and his notebook are to be seen as *one* cognitive system, on a par with Inga, who accomplishes the same cognitive tasks by only using her head. In that case, Otto's mind would be extended, not just supplemented by external devices. We will not discuss this issue further here (see Dahlbäck et al, 2011 for some comments on this).

There are more or less clear cases of the use of internal memory, just as there are clear examples of the use of external aids to remember something. But in general, people make use of a number of different strategies, internal and external (Tribble, 2005 and 2011, presents and discuss how Elizabethan actors remembered their lines, when they normally were expected to play many parts and there was very little time for rehearsals).

Our research into old people, a group with declining memory capacity (and some cases of people suffering from diagnosed memory declines such as Alzheimer's disease), shows a wide variety of strategies for aiding or even reshaping a faltering memory process. Older people with declining abilities can often counteract this cognitive decline in various ways. Some strategies work better than others, and they differ in how active the subject has to be in maintaining the memory traces or making use of the extended system. (The example with D below can be seen as an illustration of this.)

It is also the case that some of the scaffolding used by a subject can be both internal and external at the same time, though in slightly different senses. It can be internal in the sense that it is found within the subject, it is external in the sense that it employs strategies that are externally anchored. Mnemonics are typical cases of this.

Consider a few mnemonics:

Every Good Boy Deserves a Favour. (Music)

My Very Educated Mother Just Served Us Nachos. (Eight planets, in order from the Sun)

Divorced, Beheaded, Died/ Divorced, Beheaded, Survived. (The wives of Henry VIII)

These three would be familiar to most English speakers, and all cultures present many examples of mnemonic devices. Some can be like the above, making use of easily remembered catchphrases, where content, rhythm or rhyme can be the property that makes the mnemonic easy to remember.

The subject stores the mnemonic device, and then uses this easily stored material to gain access to something that is harder to access. These mnemonic aids are internally stored, but externally constructed. Given that we know the mnemonic for the planets, we can come up with a correct list of the planets, in the right order. We are in general agreement with Sutton's assessment of mnemonics in Sutton (2010), where he sees room for a category which is neither fully internal nor fully external: "They are cognitive even though they are not, in a straightforwardly ancestral way, natural and biological; and they are extended even though they are not literally external" (p. 209).

Such mnemonic processes are typically not in accordance with the four criteria suggested by Clark and Chalmers (constant access, direct availability, automatic endorsement, and past endorsement). It is usually the case that the mnemonic device is constantly accessible, yet the target – the thing to be remembered – has to be constructed anew after some work. This can fail at times. So neither the first (constant access) nor the second criteria (direct availability) are fulfilled in such cases. Neither is the third criterion (automatic endorsement), though the fourth (past endorsement) normally is. These are therefore aspects of a fortified (for want of a better term) memory, and they are all still arguably biological, in the sense of being biologically anchored in the single subject.

We can go further in the external direction. Consider a mnemonic for the number of days in a given month, based on your knuckles and the spaces between them: start counting both knuckles and spaces between, with January on your index finger knuckle, and go back when reaching the knuckle of your little finger. In this case knuckles represent "31" and the spaces between represents "30" with the exception of February that is represented with a lower space between the fingers. Another one is the so-called "right-hand rule" in the formation of a thumbs up for remembering the direction of a current in a magnetic field, where the thumb represents the direction of the current and the fingers represents the direction of the field. These are external in one sense, since they are not intracranial, but still constantly available for the subject, and in another sense not external, since they are not external to the subject. A deeper analysis of cases like these is made by Hutchins (2005), where he discusses this in relation to conceptual blending, i.e. where partial structures from two input spaces are projected into a blended space which has an emergent structure of its own (Fauconnier, 1997). Hutchins shows that in many cases the blending is based in part on an existing material structure onto which an external structure is projected, as when a line of people is seen as a queue by projecting a sequential order on it. The queue is not something external, nor internal, but an emerging structure that is both internal and external at the same time. In our examples below we will try to show how this is also the case for the process of remembering.

We believe that examples like this suggest that it can be fruitful to study in detail the processes of remembering in everyday situations, the ways in which the agent in her surroundings, cultural and natural, manages to keep track of earlier experiences and events in order to navigate her surroundings and handle her future. A similar point

was made by Dixon (1999). A difference between us and Dixon is that in that paper Dixon is primarily concerned with social cognition, whereas the focus here is primarily on the use of the physical environment for memory tasks.

In what follows, we will present a few examples from an on-going project concerning memory use and memory construction in the elderly, showing how real agents, both normally aged and with explicit memory impairments, go about their tasks.

Examples from our empirical work on memory

Lave (1988) argued that cognition (in her case arithmetic) as observed in everyday practice is distributed over *person, activity and setting*, and concludes that cognitive processes are structured quite differently across situations. The proper unit of analysis should be "the whole person in action, acting with the settings of that activity" (p.17). From this perspective the distributed ability to remember is a function within an activity that is formed and constrained by the on-going changing nature of the task. Our analysis below is similar to Lave's, but focused on remembering instead of solving arithmetic tasks.

The example and discussion of C below illustrates Lave's point of how the activity can constrain the process of remembering. C in this excerpt has just recently received more assistance due to a physical problem. The excerpt presented below is actually the first time C receives this kind of assistance. (All excerpts in the paper are verbatim translations from Swedish from MK's original field notes).

> C uses a shopping list for the shopping session. She makes it clear that it is important for her that she remembers paracetamol as she has none at home and is in some pain. She constantly addresses the shopping list to remind herself where to go. In the end we [MK+C] cannot find paracetamol. I [MK] am not used to this supermarket, so I am of no help. She stops and asks a worker, who tells her that it is to be found after the check-out. She wants me to remind her if she forgets. After the check-out she has indeed forgotten so I remind her.

Having a shopping list is a physical instantiation of a plan elaborated at home to be executed in the supermarket. In the store the list works as a reminder of that very plan. On the instances when she looked at the list, it worked as a way to be in control of what to collect. She probably has some idea of what to buy without the list, but as an artefact it works as a way of being in control of the activity, facilitating the process of actually finding the wanted items, and making her stop worrying about the paracetamol. On the instances where she has no explicit internal idea of a specific item to buy, the list works as an external memory, but even in the cases where she remembers a specific item unaided, the list works as a way of being in control of the process of remembering. This is the dynamic interaction between C and her shopping list. For this particular activity during these particular circumstances, this is important because the most important goal of the activity for C is to buy paracetamol. Inside the supermarket, paracetamol is the most important item to remember, as she often repeats it and is also reminded every time she glances at the shopping list. At the check-out something happens. The list is set aside to deal with

packing and paying and after the check-out she usually does not check the shopping list, especially since she has explicitly asked her follower to remind her. The nature of her distributed memory has changed as a consequence of the changing characteristics of the activity.

In the case of C and the role of her artefact, her distributed memory is determined by the settings in which it is usually used and also determined by the practice of grocery shopping, where the artefact as a resource is usually used up till check-out. She solves this by shifting the nature of her remembering to a social other. This is not strange given that this was to some extent a predetermined interactive activity between healthcare assistant and receiver. This points to some central aspects of a distributed memory: (1) the proper unit of analysis can both be *the person with her shopping list*, and *properties of the activity and how that shapes the use of the distributed memory system*, where, (2) the shopping list has a distributed role that (at least in the case of C) changes to meet the expectations of the agent. The shopping list is in a sense the plan for the activity. Therefore, when we regard extended memory systems we need to view the interactive nature between agent + external structure and properties of the activity from two perspectives, the task of the agent when using the artefact, and the properties of the system comprising of the agent and the artefact (c.f. Norman, 1991).

We believe that humans are likely to figure out how to distribute cognition within routine activities because within these activities external support will over time be adapted to suit the variable characteristics of the activity and the variable personal expectancies of the activity. This idea is brought to its head when considering the process of aging. In the field of cognitive aging it is generally held that older adults compensate for declining internal faculties by a greater reliance on external memory aids. But here we argue that changes in internal faculties are but a tiny bit of the reasons for using physical objects and structures in activities to assist remembering.

In our view, it is more fruitful to look at other units of analysis, such as activities where agents make use of external and internal resources in order to reach an intended goal.

Changing the unit of analysis to activities allows us to combine our understanding of distributed memory with previous findings in the process of aging. As we get older, we come to rely more on cognitive activities based more on accumulated knowledge about the world. This predicts that accumulated knowledge of everyday activities should be immense as a function of age. If there is such a thing as expert distributers of cognition in everyday life, older adults would be likely candidates. Because humans can be pictured as "experts or near experts in dealing with their everyday environments" (Kirsh, 2009, p. 289) they will know how to handle situations. The terms *canny cognizer* (Clark, 2008), *cognitive congeniality* (Kirsh, 1996), *opportunistic assemblers*, and *cognitive bricoleurs* (Hutchins, 1995a) all suggest that human beings can make clever use of the external world.

In the model based on self-report protocols proposed by Hayes-Roth and Hayes-Roth (1979) it is suggested that planning in everyday life is often *opportunistic*. For instance, we often re-arrange plans as we go along, and may sometimes have the opportunity to do more errands than planned, or suddenly realize that we do not have enough time to the things planned. Hayes-Roth & Hayes-Roth (1979) assert that even though we are opportunistic, we are not necessarily always successful. Cognition is a process which is not necessarily optimally constructed (Hazlehurst, 1996). Clark (2005) mentions an important class of cases, namely those where humans *actively* create assistive structures. We argue that this active agent is an important consideration for distributed memory.

We also think that systems of distributed cognition or distributed memory are sometimes best revealed when such systems fail and when the system stops meeting the expectancies of the task, that is often when the agent is needed to uphold the product of an unstable system. Consider the case of D:

> D has memory problems and cannot always remember whether the home healthcare personnel has been on their visit to her, so she keeps the used time and day-specific plastic medicine envelope on her kitchen table after it has been used as a way of helping her to assure herself that they have been there that day. For this visit she comes running after me as I am about to throw away the plastic envelope in the bin.

First, because of D's problems with her unassisted memory, the lack of a successful distribution can have direct consequences for the success or failure of the activity. With information about date, time it should be taken, social security number, this envelope works as an external memory aid. It is crucial for her to be in control of her everyday life. The case of D also shows that in extreme cases such as these, agents must be continuously active when things are about to go wrong. D likely expects this situation to occur occasionally, especially when vacation employees are there during the summer: she has to teach them the characteristics of her distributed system of remembering. In this specific extract, despite relying on an external memory aid, the control of the process of remembering was regulated by D. The preservation of D:s external memory is preserved by both biological and external characteristics, simultaneously. Similar observations in a slightly different situation were made by Wu et al. (2008), who studied families from a distributed perspective where one family member had memory impairment. They viewed the family as the unit of analysis and how the non-impaired members of the family structured and assisted the life of the impaired. They report that the redundancy of the system partly relied on the impaired individual's habit of repeating questions for information already given. The case of D is similar in the sense that she is the one that takes the initiative to maintain the distributed memory system.

Distributed cognition needs to consider individuals coping with unfortunate events. In large complex systems this is often called *resilience* (Hollnagel, Woods, & Leveson, 2006), where resilience is defined as "the ability of a system [...] to react to and recover from disturbances at an early stage, with minimal effect on the dynamic stability" (Hollnagel, Woods, & Leveson, 2006, p.16). So if we should talk about distributed memory systems we believe we should also consider resilience.

But everyday life does not necessarily contain complex systems in similar ways; resilience here is likely to be based on the individual person's activities. In the previous case, D's ways of coping with social others have effects on the distributed system. The activity to remember if the service has been there for her medicine is namely also the (unaided) ability to *remember to remind* the service to not throw away the envelope; without the ability to do this, the system risks breaking down. In everyday life humans encounter setbacks: their actions can break down in various ways.A distributed theory must account for the setbacks to cognition and how such cases are handled, on the fly and in advance. The next excerpt can be seen as a clearer example of a resilient distributed system of remembering. This time the setback is handled in advance:

> A has an appointment at the podiatrist. She has a note from the podiatrist which she has posted on her fridge. She has turned the note around and written the date again, though bigger this time. She also has inscribed it into her calendar, located on the kitchen table. This calendar is always located on the kitchen table. For some unknown reason, the dates have gotten mixed up, and the wrong date had been transferred to her calendar.

A has the date and time written in three places. From a preservative memory perspective the most reliable source is the note that is turned towards the fridge. But the most useful artefact for A is her calendar; that is why it is always located on the kitchen table, next to her phone. The kitchen table (or equivalent) is in fact a highly interesting area for considering distributed remembering in home environments. Information spaces in the kitchen environment has also been investigated by de Léon (2003) where he studied people cooking in their home environments. He noted the importance of the visible. For instance how the arrangement of structures can support cognitive processing (p.48). He also discussed in his analysis of a spice shelf that procedural means and artefact properties can be arranged in ways, in some cases actively by agents, so that they resist entropy (p.100). This is also true in the case of A.

Even though the calendar is the quintessential artefact for remembering appointments for A, the fact that she has not tossed the original note into the bin and that she has written the date and time bigger on the other side of the note makes it an efficient artefact for anomaly detection. So together these artefacts serve something that can be viewed as a distributed prospective memory, but they also serve as a distributed source memory, adding resilience to the function for remembering the appointment. Sutton (2009) discusses how remembering processes in real-life contexts are not easily categorized into traditional memory systems. To have information in several places has a physical advantage, especially as in the case of A, when she was having bodily pains. The fact that it works as a successful source memory can be something that A is unaware of. She simply acts on these sources of information in a similar way that Sutton (2009) describes how an amnesic person can habitually act in a familiar environment.

Two of the cornerstones of resilience in complex systems are the abilities to know what to expect and to know what to do (Hollnagel, Pariès, Woods, & Wreathall,

2011). We see that this also applies to distributed memory systems in everyday life; if an agent knows what to expect and has the means to meet that expectation, the likelihood for a distributed memory to be resilient increases.

This suggests that the process of remembering through an external world is also a constructive matter similar to internal memory processes. We select, abstract, interpret and integrate information through structuring the external world.

Michaelian (2012) correctly notes that the use of exograms often serves a preservative function: they are a faithful storage, unstructured storage, "just in case" storage, storage without forgetting. We would add to this, and argue that the nature of the coordination between artefacts, people and routines decides this preservative function. Even though the use of an external aid is evoked to preserve information, this does not mean that the activities with that structure or artefact make us remember. In fact, information in the external world can just as well make us forget, or be highly unfaithful to the exograms. The case of A above shows that A at least has a hunch of this and decides to keep whatever information that is inherent in the task.

When A above chose not to throw away the note it can be argued that this is an act or decision that sprang from her in order to improve her memory process. But in some cases, we structure the activity in a way that reduces or completely eliminates the need to remember in the strict sense of the word.

Consider this next case where we possibly see a generation specific practice but where we also see that cultural practices can add to an activity in such way that a distributed memory is unnecessary, once again A:

> A shows how to clean spoons discoloured by tea with the help of baking powder. A stands by the sink while the daughter and I are sitting by the kitchen table. [...] The daughter notices that A uses the wet spoon in the powder container: "you can't do that, it will ferment". A answers quickly, and suggests that it will not ferment and will not be used for baking: "yes I can, because it is old baking powder". When A returns the container to the cupboard the daughter remarks that she shouldn't place it next the active baking powder. A rebels against her daughter's suggestion and places it next to the active container. She stops for a moment and lifts it a couple of times and says that she will anyway pay attention to and remember by the weight that it is the right one. The daughter remarks that at some point the containers will be of the same weight and they will be indistinguishable. A adds that she anyway always tests if the powder is active before baking.

The last strategy proposed by A is not a memory strategy per se. But the strategy the daughter suggests is a physical structuring, ensuring that the remembering function of future activities involving baking powder is offloaded into the environment. The strategy of A was likely not developed as a consequence of aging but as a consequence of cultural practice (see also David Sutton, 2009, on the kitchen as a workspace and a cultural artifact). But the strategy of A nevertheless assists in the activity of baking in such way that it decreases the cognitive complexity of the

activity. As suggested by Vygotsky (1978) and Leontiev (1978), using the environment to assist our cognitive abilities is something we learn.

The examples above show two things: First, the memory process can be distributed, but the structuring of this process is shaped and constrained by the on-going activity. Second, the ability to remember is based on the individual agent's ability to do this in a successful way, so this is also something that is dependent on the individual's abilities. These abilities can be related to cultural matters, and how the culture in question forms the individual's ability to distribute memories in a successful manner. The individual may be powerless without the distributed system that upholds the memory work, but upholding the system is in many ways an active task for the individual.

Conclusions

Instances of distributed cognition spring from the human ability to handle an external world in a cognitively efficient way. To be able to handle the world is in itself an ability proper, and therefore part of what we call cognitive processing efficiency. One aspect of such efficiency is the ability to resiliently cope with changed circumstances. Resilience can thus be seen as a property of distributed memory systems.

Through examples from our material we have tried to show that by studying the interactive nature of external memory in naturally occurring situations, we can see how the nature of the distributed cognition is a function of the characteristics of the task and of the agents' abilities. In this perspective, the changes observed in memory in elderly people is not only or primarily seen as a compensatory process where what was once internal now becomes external, but instead a shift in balance and shift in methods between the internal and external contributions to the process of remembering.

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