

# Scaffolded Memory and Metacognitive Feelings

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**Abstract** Recent debates on mental extension and distributed cognition have taught us that environmental resources play an important and often indispensable role in supporting cognitive capacities. In order to clarify how interactions between the mind – particularly memory– and the world take place, this paper presents the “selection problem” and the “endorsement problem” as structural problems arising from such interactions in cases of mental scaffolding. On the one hand, the selection problem arises each time an agent is confronted with a cognitive problem, since she has to choose whether to solve it internally or externally. How does she choose? On the other hand, when confronted with the internally or externally retrieved solution to a cognitive task, the subject has to decide whether to endorse the information. How does the subject decide whether to endorse it or not? The last section proposes a solution to each problem in terms of metamemory and metacognitive feelings. Metamemory evaluates memory each time the subject is confronted with a memory task and elicits either a positive or negative metacognitive feeling that guides the decision.

## 1 Scaffolded Memory

I have a terrible memory. I often forget having an appointment, as well as important dates, such as my girlfriend’s birthday or submission deadlines. I also forget important words that I used to know in my native language, Spanish, and in my second language, French. I even forget names of people, authors, and artists that I used to like in the past.

Fortunately, there are many external ways to deal with my memory failures. Google calendar works very well. I use it to record my appointments and important dates, and it reminds me of each one, either by an email or by an automatic alarm. Electronic synonym and bilingual dictionaries support my semantic memory, and I use Wikipedia to retrieve names that I used to know. Like many people, I resort to all these external supports in order to cope with my impoverished memory and thus enhance it.

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According to “distributed cognition” theorists, these everyday examples illustrate very well the fact that environmental resources play an important and often indispensable role in supporting cognitive capacities. Sterelny, for example, remarks that the mind routinely uses external tools and the environment as scaffolding to support its cognitive processes: “human cognitive capacities both depend on and have been transformed by environmental resources. Often these resources have been preserved, built or modified precisely because they enhance cognitive capacity” (Sterelny 2010: 472). This idea derives from the theory of niche construction, according to which humans and non-human animals engineer their environments and construct cognitive tools to enhance the adaptive fit between the agent and the world. Mental scaffolding comprises many different behaviors: from ants’ scent trails between nest and food source to humans’ information storage in electronic devices. This is the scaffolded mind hypothesis (Sterelny 2010).<sup>1</sup>

*Sometimes*, however, the relation between the mind and the world is more intimate; environmental scaffolding turns out to be constitutive of the cognitive process itself instead of remaining a merely instrumental means. According to Andy Clark and David Chalmers’ Parity Principle (Clark and Chalmers 1998; henceforth C&C), “if, as we confront some task, a part of the world functions as a process which, were it to go on in the head, we would have no hesitation in accepting as part of the cognitive process, then that part of the world is (for that time) part of the cognitive process” (C&C 1998, 8). Occasionally, when a subject makes systematic use of external resources, her mental processes cross the boundaries of brain and body, to extend into the environment (see Adams and Aizawa 2008 for a criticism of this move). This is the so-called “Extended Mind Hypothesis” (henceforth “EM”; C&C 1998; Clark 2008).

Mental extension seems to be rather rare, whereas cognitive scaffolding seems to be a widespread phenomenon. In their famous paper, C&C (1998) proposed three criteria for mental extension: availability, constancy or systematic use, and endorsement. Recently, Sterelny (2010) has proposed adding another criterion to the list: “individualization and entrenchment”. Let us present these criteria:

1. **Availability criterion:** The resource is ready to hand, and the subject can easily consult it.
2. **Constancy criterion:** The resource should be reliably used throughout the subject’s life, or at least for a considerable time.
3. **Endorsement criterion:** This has two aspects. On the one hand, the subject should automatically endorse the information upon retrieval. And, on the other

<sup>1</sup> John Sutton et al. (2010: 536) have pointed out that Sterelny’s account of the scaffolded mind offers the “same kind” of perspective as what they call the second wave of extended cognition based on the *complementary principle*: “in extended cognitive systems, external states and processes need not mimic or replicate the formats, dynamics, or functions of inner states and processes. Rather, different components of the overall (enduring or temporary) system can play quite different roles and have different properties while coupling in collective and complementary contributions to flexible thinking and acting” (Sutton 2010: 194). However, Sterelny’s (2004, 2010) avoidance of the term “mental extension” to name his approach, and his insistence that using this term has no explanatory gain, points to a key difference between both views.

hand, the information is stored in the resources because it has been endorsed or accepted in the past.

4. **Individualization & entrenchment criterion:** The resource should be shaped by the agent to fit to her individual features, needs, and purposes, so that it becomes entrenched as a cognitive resource.

It is difficult to find external resources that fulfill these criteria. In their famous paper “The extended mind”, C&C (1998) described the case of Otto, a fictional character suffering from Alzheimer’s disease who systematically makes use of a notebook as a form of external memory. According to Sterelny, Otto also fulfills the individualization and entrenchment criterion (Sterelny 2010, 476). I agree that if we found actual cases analogous Otto’s in everyday life, we should count them as cases of mental extension. However, few (if any) of the external resources that normal subjects routinely use to enhance their cognitive capacities fulfill these criteria.

Mental scaffolding (Sterelny 2010), in contrast, is cheap. It can be understood as a “multidimensional” phenomenon that ranges from mere “monocausal” exploitation of an external resource to highly “interactive coupling between disparate internal and external resources” (Sutton et al. 2010: 531–535; see Wilson and Clark 2009). Since normal subjects rely on many heterogeneous external resources to support their memory without sticking to just one of them, they instantiate cases of mental scaffolding rather than mental extension. As Sterelny notes: “[in presenting the EM] Clark underplays the importance of nonexclusive use of epistemic artefacts. Many of our most important cognitive tools are common-use tools, not parts of coupled systems” (Sterelny 2004: 245). Subjects use notebooks to record information, write notes on their hands or arms, post-its and blackboards; they set alarms on their cell phones and in electronic calendars, tie strings around their fingers, and also ask other people to remind them of particular information. All these resources are used or recruited to enhance memory occasionally, but *stricto sensu* none of them constitutes memory, because they do not fulfill the mental extension criteria. This is the reason why extended mind cases “are limiting special cases of a scaffolded minds” (Sterelny 2010: 473).<sup>2</sup> I’m mainly interested in the ways normal subjects routinely use mnemonic aids and external resources to support their memory. Therefore, I mainly focus on cases of memory scaffolding, and discuss memory extension very tangentially.

The “selection problem” and the “endorsement problem” are structural problems of the interaction between the mind and the world in cases of mental scaffolding. On the one hand, the selection problem arises each time an agent is confronted with a cognitive problem and the answer does not automatically pop up to her mind,<sup>3</sup> since she has to choose whether to solve it internally or externally. For example, when

<sup>2</sup> Wilson and Clark (2009) have developed a multidimensional model of EM to allow for casual, one-off use of external resources to count as cases of mind extension. However, I agree with Sterelny (2010) that there is no explanatory gain in treating the environment as part of the body or the mind in these cases. Most external mnemonic tools do not constitute *stricto sensu* parts of my mind, but they function as prosthetic support of my deficient inner memory (see Adams and Aizawa 2008: x, 12, 145).

<sup>3</sup> The cases that I will be considering are cases of memory retrieval when the answer does not pop up automatically. It seems that only in these cases does the subject have to choose between an internal and an external resource.

asked about the telephone number of a friend, the subject can try to retrieve it internally from her memory, or externally from her directory. How does she choose between these options? On the other hand, when confronted with the internally or externally retrieved solution to a cognitive task, the subject has to decide whether to endorse the information. When a subject, for instance, retrieves from her memory “Sydney is the capital of Australia”, she has to decide whether to endorse it or not. Supposing that she rightly decides not to endorse it, how does the subject decide?

These problems do not seem to arise in cases of mental extension, presumably because of the way the EM has been described. Otto, the Alzheimer's patient imagined by C&C (1998), does not have to select which memory resource to use because he only has one resource at hand: his notebook. Nor does he have to decide whether to endorse a piece of information that he retrieves from his notebook, because according to C&C's definition he endorses all the information contained in the notebook.<sup>4</sup> Something similar would be the case if subjects were brain-bound and only used their brain and internal resources to solve cognitive problems. If this were the case, subjects would not have to decide which resource to use, and they would also prefer internally retrieved solutions.

I will propose a solution to each of these problems in terms of metamemory and metacognitive feelings. “Metacognition” has been used indistinctly to refer to both theory of mind (or the mindreading capacity) and self-control. I use the term to refer *only* to the experience-based kind of self-control that has been conceptualized by cognitive psychologists such as Lynne Reder (1987, 1988, 1996) and Asher Koriat (1993; 2000; 2008), and by philosophers such as Joëlle Proust (2007, 2009a, b, 2012, forthcoming), Jérôme Dokic (2012), and myself (Arango-Muñoz 2011, forthcoming).

## 2 Two Structural Problems of the Interaction Between the Inner and the Outer

The fact that environmental resources play an important role in supporting cognitive capacities presupposes certain interactions between the mind and the world. In order to clarify how such interactions take place, I will describe the “selection problem” and the “endorsement problem” as structural problems of such interactions. Even though the interactions seem intuitive or obvious, it is not obvious how exactly they take place. The issue becomes even more salient once we leave aside imaginary cases (e.g., Otto's case proposed by C&C 1998), to focus on real life cases where subjects have more than one resource at hand to deal with cognitive tasks. Normal subjects routinely rely on internal as well as on external resources to solve cognitive problems. How do these interactions occur? How do subjects choose whether to consult their

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<sup>4</sup> One of the editors suggested that Otto would face the same problems as Inga (i.e., the selection and endorsement problems), if he relied on external resources other than his notebook, such as a cell phone. This seems right to me, but it should be noticed that in those cases Otto's mind would not extend to the other resources unless he resorts to them as often as to his notebook. Of course, if Otto uses other external resources, he would confront the selection and endorsement problems. It should be noticed, however, that those cases are cases of mental scaffolding, not of mental extension.

mind or the world to search for a piece of information? I will call this the “selection problem”, following Kourken Michaelian’s suggestion (Michaelian 2012a).

The selection problem was first conceived in cognitive psychology as a problem concerning which inner mental strategy to use when the subject faces a cognitive problem (Lovett and Anderson 1996; Lovett and Schunn 1999; Payne et al. 1988; Reder 1987), for example, choosing between remembering or mentally calculating the result of a multiplication. An *extended* version of the problem arises when we accept, following distributed cognition theories, that the available resources to solve the problem can be external to the subject’s mind, brain, or body. Here is the extended version of the selection problem:

*Extended Selection Problem*<sup>5</sup> Since normal subjects routinely use external as well as internal resources, each time that they are confronted with a cognitive problem, they have to choose whether to solve it internally or externally. How do subjects choose which resource to resort to?

In the following cases subjects have to make such metacognitive decisions:

- When confronted with the problem of determining whether a given shape will fit a slot, as in the computer game Tetris, subjects have to choose whether to make mental rotation or to push the button to flip the figure (Kirsh and Maglio 1992).
- When confronted with an arithmetic task, the subject has to choose whether to calculate mentally or use a calculator (Walsh and Anderson 2009).
- When confronted with a general knowledge question, the subject has to choose whether to remember the answer or to use external means such as a dictionary or the Internet to retrieve the answer (Reder 1987, 1988, 1996; Paynter et al. 2009; Sparrow et al. 2011).

As a matter of fact, most of the cited studies point to the fact that subjects are well tuned or calibrated to such interactions between the internal and the external; they normally make relatively good decisions concerning which resource to resort to. For example, they only try to *internally* retrieve the information from their inner memory if it is likely that they will be able to recall it (Reder 1987, 1988, 1996; Koriat 1993, 2000; Kalnikaitė and Whittaker 2007; see also Sparrow et al. 2011). Sometimes, the decision can be made based on the intrinsic difficulty of the task. For example, when confronted with a memory task, subjects normally try to solve it internally if it is an easy one (“how many colors does the French flag have?”), while resorting to the external resources if it is a difficult one (“what is the exact date of birth of Ludwig Wittgenstein?”). In intermediate cases, however, when the task is neither too easy nor too difficult, subjects have to assess the trade-off between using an internal strategy and an external one. An internal strategy is normally quicker but has cognitive costs, since it requires working memory and attention; moreover, it is less accurate. An external strategy, on the other hand, is more accurate, but has sensory-motor costs and is normally less efficient; i.e. it takes longer (Kalnikaitė and Whittaker 2007). The fact that subjects seem to be relatively good at assessing such trade-offs suggests that

<sup>5</sup> I call it the “extended selection problem” to distinguish it from the classic “selection problem”, which only considers internal resources. But by calling it “extended” I do not mean that this is a problem for EM cases in particular. As I said above, this problem does not arise for EM.

they do not blindly choose whether to use an internal or external resource (see Walsh and Anderson 2009). But how, then, do they make these decisions?<sup>6</sup>

The second issue concerning the interaction between the inner and the outer is the endorsement problem. After having retrieved a piece of information, the subject has to decide whether to endorse it or not. How does the subject decide whether to endorse the information or not? Taking into account the scaffolded mind picture according to which the subject retrieves information from her inner memory as well as from the external environment, the problem can be divided into two parts: (a) the endorsement of internally retrieved information, and (b) the endorsement of externally retrieved information. Even if both parts essentially point to the same problem, they merit separate treatments because each of them involves different variables, as will be shown below in the proposed solutions.

- (a) **The endorsement of internally retrieved information:** When confronted with an internally retrieved solution to a cognitive task, the subject has to decide whether to endorse the information to form a belief. For example, after retrieving “Brasilia” from her memory as the answer to the question “what is the capital of Brazil?” the subject has to decide whether to endorse this solution. How does the subject decide whether to endorse a piece of information? This decision becomes relevant once we acknowledge the imperfect character of internal informational sources. Once we recognize that the outputs of a cognitive process are not always accurate, it is worth considering again whether or not to endorse the outcome of a cognitive process. This is a modified version of Kourken Michaelian’s “endorsement problem” (Michaelian 2012a).<sup>7</sup>
- (b) **The endorsement of externally retrieved information:** When confronted with an externally retrieved piece of information, the subject has to choose whether to endorse it or not, and form a belief. For example, after finding some information about Simon Bolivar on a web page, the subject has to decide whether to endorse or accept this version of his life. A similar problem arises when an

<sup>6</sup> One of the editors, as well as Kevin Reuter, asked me to explain whether these decisions need to be conscious to qualify as metacognitive. This is a difficult question and would deserve further investigation. So far, there is no consensus on this issue. On the one hand, Koriat has claimed that these decisions are conscious (Koriat 1993, 2000). Reder and her colleagues, on the other hand, have claimed that such decisions, and the feelings associated with them, are unconscious because they can shape subjects’ behavior very quickly; so it is unlikely that subjects are aware of their decisions and the feelings associated with them (Reder and Schunn 1996; Spehn and Reder 2000; Paynter et al. 2009; see also De Sousa 2008). The issue becomes even less clear when one considers philosophy. On the one hand, Ned Block (1995) has famously championed the distinction between phenomenal and access consciousness, which allows for phenomenal conscious experiences that the subject is unaware of; so the subject might be phenomenally conscious of her decision even though she is not able to report them. On the other hand, Carruthers (2009, 2011) and Daniel Wegner (2002) have recently claimed that subjects are never conscious of their decisions or decision-making processes, and they have amassed some empirical data to support this view. It is hard to give a straightforward answer to this question, given the great complexity of discussions about consciousness. What is clear from the experimental data on metacognition is that subjects are not behaving randomly, and this fact suggests some form of control or decision-making; whether this control is conscious or not is still matter of debate.

<sup>7</sup> Michaelian’s version of the problem focuses on the epistemological justification aspect of belief formation: “How can beliefs produced by endorsing information received from imperfect sources be formed in a justification-conferring manner?” (Michaelian 2012a). My account, however, focuses on the subjective decision to endorse a piece of information independently of the epistemological justification of the resulting belief. However, I am in agreement with the epistemological considerations developed in that paper.

agent serves as external resource and provides the information (Sperber et al. 2010). Given that both the web page and the agent might be possible sources of error, it is worth assessing the accuracy of their answers before endorsing them (see Sterelny 2004). How does the subject decide whether to endorse a piece of external information?

The external version of the problem (b) has recently received some attention in its social version in the literature on testimony and social cognition: it is important to evaluate the information obtained from other agents (before endorsing it) because of “the risk of being accidentally or intentionally misinformed” (Sperber et al. 2010: 359; but see Michaelian 2012c; Gilbert et al. 1990; Gilbert et al. 1993 for the opposite view). The internal version (a), on the other hand, has been rather neglected (but see Michaelian 2012a) and even partially denied (Fletcher and Carruthers 2012; Sterelny 2004: 246). Some philosophers assume that the agent has no control over information retrieved internally; it is automatically endorsed (Bernecker 2010). However, the internal version of the problem becomes more salient when we leave aside imaginary cases of how memory works (e.g., Otto’s case discussed by C&C 1998), to focus on real life cases where subjects have to monitor and control the outputs of their inner memory. Cognitive psychology has shown that normal subjects do not endorse the content of all their memories: subjects retrieve a lot of information from their memories, some that they endorse, and some that they do not (Nelson and Narens 1990; Johnson 1997, 2006; Koriat and Goldsmith 1996; Hertwig et al. 2008).

The relevance of the selection and endorsement problems is that they reveal two important functional stages of memory retrieval and memory scaffolding. At the selection stage, subjects’ use of external resources will only be successful if they know when to resort to an internal or external resource: searching for too long in their inner memories would be inefficient if an external resource is available and can provide the same information much quicker. Correspondingly, incurring the sensory-motor costs of consulting external resources when the information could be retrieved from memory much more easily would be unpractical. At the endorsement stage, the internally or externally retrieved outputs should be evaluated before using such information as a premise for action or reasoning to ensure the success of such activities. Endorsing the information uncritically could entail failures of action or reasoning.

These problems do not arise in cases of mental extension, presumably because of the way the EM has been formulated. On the one hand, Otto, the Alzheimer’s patient imagined by C&C (1998), does not have to select which memory resource to use because he only has one resource at hand: his notebook (see footnote 4). Similarly, the problems do not arise if subjects systematically rely on problem-solving routines that are automatically enacted and determine behavior (see Clark 2008: 74–75), such as always using an iPhone to look for information (Chalmers 2008: x). On the other hand, according to C&C’s (1998; Clark 2008) criteria for EM, the information retrieved from extended memory is necessarily endorsed (see Michaelian 2012b for a criticism of the endorsement criterion). Otto, for example, automatically endorses all information that he retrieves from his notebook.

### 3 Metamemory and Metacognitive Feelings

In the previous section we saw that memory scaffolding introduces two challenges: the selection and endorsement problems arise because of the number of resources that are used to support memory and the epistemic instability of internal as well as external resources. In other words, by enhancing memory, mental scaffolding produces (more) mental and epistemic uncertainty.<sup>8</sup> My solution to the selection and endorsement problems appeals to metacognition as an experience-based control system (see §1). It draws on the psychological literature on metamemory and metacognitive feelings to explain cases of memory scaffolding. The decisions about when to resort to an internal or external resource are mediated by metamemory and are often (but not always) guided by metacognitive feelings. The same considerations apply to decisions about when to endorse an internally or externally produced output.

Metamemory is just one facet or dimension of metacognition. Metacognition is a complex capacity to monitor and control cognitive processes through metacognitive feelings and/or higher-order beliefs. At the subpersonal level, it is a cognitive mechanism that monitors and control the performance of different cognitive processes (Nelson and Narens 1990) based on heuristics and cues. This mechanism elicits metacognitive feelings as outputs that, at the personal level, interact with subjects' beliefs and other mental states. Metacognitive feelings are phenomenal experiences that point towards mental dispositions of the subject such as knowledge,<sup>9</sup> ignorance, or uncertainty. The following are some instances of metacognitive feelings: the feeling of knowing (Reder 1987, 1996; Koriat 1993, 2000), the feeling of confidence (Koriat 2008; Brewer and Sampaio 2012), the feeling of error (Arango-Muñoz et al. in preparation), the feeling of forgetting (Halamish et al. 2011), and the tip-of-the-tongue phenomenon (Schwartz 2002).<sup>10</sup> These feelings tell the subject something about her own mind, and motivate her to perform mental actions, such as retrieving information from her memory, or endorsing retrieved information. I will elaborate on these feelings and the experiments used to test them below.

In the context of the debates around distributed cognition, David Kirsh (2004) has also suggested a solution to the “selection problem” in terms of metacognition: “Metacognition works, in part, by controlling the interaction of person and world. It is not just a mental control mechanism regulating Cartesian mental performance. It is a component in the dynamic coupling of agent and environment” (Kirsh 2004). According to this view, metacognition is the capacity to manage and coordinate

<sup>8</sup> Mental and epistemic uncertainty differ from the feeling of uncertainty. A subject may be epistemically uncertain about the truth of a proposition (e.g., she may not know whether she is justified in believing p) without having a feeling of uncertainty. In contrast, she can feel uncertain even though she is justified in believing a given proposition.

<sup>9</sup> I use “knowledge” in the psychological sense, that is, to refer simply to the possession of a piece of information in the memory store, independently of this piece of information being true, justified or even endorsed.

<sup>10</sup> Some theorists, however, do not accept this view of metacognition as a mental mechanism that elicits metacognitive feelings. Most of these theorists hold that metacognition is a capacity that produces second-order thoughts about the self, and therefore they associate metacognition with mindreading (e.g., Carruthers 2009, 2011; for a criticism of the identification of mindreading and metacognition, see Proust 2007, 2012, forthcoming). As I said at the outset, I am mainly interested in the experience-based control account of metacognition, which is why I favor this view here. I defend the view in Arango-Muñoz (forthcoming).



internal and external resources (see also Clark 2008: 70–75). I take these enlightening remarks as the starting point to develop a more detailed account of how metacognition guides decision-making and how it regulates the use of external memory devices.

Many models of human problem solving suggest the existence of a strategy selection phase and a rapid strategy selection mechanism (Lovett and Anderson 1996; Lovett and Schunn 1999; Payne et al. 1988; Reder 1987). In the case of memory, metacognition evaluates memory each time the subject is confronted with a memory problem and elicits a feeling of knowing<sup>11</sup> if the answer can be retrieved internally (Reder 1987, 1988, 1996; Koriat 2000; Paynter et al. 2009; Kalnikaitė and Whittaker 2007). In this way, metacognition guides the decision concerning whether to *select* an internal or external resource by means of metacognitive feelings.

According to the leading theories of metacognition, this mechanism monitors the performance of different cognitive processes based on cues and heuristics, producing metacognitive feelings as outputs. For example, in the case of metamemory, it diagnoses good performance *if* the stimulus is a perceptually fluent one (Whittlesea 1993; Whittlesea and Williams 2001). This diagnosis is conveyed by a feeling of familiarity, which in turn is interpreted by the subject as pointing to the possibility of internally recalling a given item. Similarly, metacognition diagnoses the possibility of retrieving a piece of information by a feeling of knowing *if* the stimulus is a frequent one (Reder 1996; Paynter et al. 2009). Among the cues that determine confidence in the outputs of memory are ease of retrieval (i.e. the amount of effort invested) and speed of retrieval (Kelley and Lindsay 1993; Robinson et al. 1997; Thompson et al. 2011). Subjects tend to be confident of information that is easily or quickly retrieved. Metacognition evaluates mental activity by reference to cues and heuristics (Koriat 1993, 2000), as well as by reference to salient concepts and theories, as some framing effects suggest (Finn 2008; Koriat et al. 2004).<sup>12</sup>

### 3.1 Solving the Selection Problem

When a subject is confronted with a memory task, she has to choose whether to solve it internally or externally. How does the subject decide which resource to resort to? When confronted with a memory task, metamemory evaluates whether the information

<sup>11</sup> I endorse here Reder's (1987, 1988, 1996) definition of the feeling of knowing: It is an experience a subject undergoes when she faces a question and is about to recall some information, but before the actual recall. For example, the experience that a subject undergoes when asked: "What is the capital of Spain?" Assuming that the subject has a feeling of knowing, the functional role of this experience is to indicate to the subject that she will be able to recall the appropriate information to answer the question and thus motivates her to recall it ("Madrid") (Reder 1987, 1988, 1996). There is, nevertheless, some ambiguity in the literature about the use of this concept. Many researchers use it to mean the kind of feeling that a subject undergoes when, after failing to retrieve an item from memory, she still feels that it is stored in her memory (e.g., Hart 1965; Nelson and Narens 1990; Pannu and Kaszniak 2005). The latter experience is known as the tip of the tongue phenomenon (Schwartz 2002; Schwartz and Metcalfe 2010).

<sup>12</sup> The idea that concepts and theories are involved in metacognition is an old one: subjects use their conceptual capacities and their folk theories to evaluate their performance. However, until recently researchers were not entirely aware of the fact that the way you frame the questions in metacognitive tasks can change the results. Asking "are you sure you remember everything?" and "are you sure you are not forgetting something?" produces different judgments; the latter form leads to more accurate judgments (Finn 2008; Koriat et al. 2004).

can be internally retrieved from a subject's internal memory store,<sup>13</sup> or the subject has to resort to an external strategy such as consulting a dictionary or the Internet. This evaluation generates a positive metacognitive feeling when the information is likely to be internally retrieved. This metacognitive feeling concerning memory retrieval has traditionally been called the feeling of knowing: it motivates the subject to try the internal mental action of internally recalling the information (Reder 1987, 1988, 1996; Koriat 1993, 2000). For example, when confronted with the question: "which countries compose South America?" The subject may immediately undergo a feeling of knowing suggesting that the information can be internally retrieved (see footnote 11). The lack of automatic answer retrieval<sup>14</sup> from inner memory together with the lack of a feeling of knowing would motivate the use of an external strategy. For example if you are asked "what is the telephone number of the current president?" (Nelson 1999: 634), you normally do not get an automatic answer or a feeling of knowing.

To illustrate what I have just said about the selection stage of metamemory, let me present Reder and Ritter's (1992) paradigm. In their experiment, subjects reported the feeling of knowing in a memory retrieval task. Subjects were shown a series of mathematical problems, some of which were repeated multiple times during the course of the experiment, and subjects had to rapidly choose (in less than 1 s) whether they could quickly retrieve from their memory the result of a problem (retrieval trials) or needed to calculate the result on scrap paper (calculate trials). Their behavioral results show that, when solving arithmetic problems, subjects retrieve answers to problems that are easy and familiar from memory, while they calculate answers to problems that are difficult and unfamiliar. The decision whether to remember seemed to be driven by the feeling of knowing, which predicted subjects' capacity to retrieve an answer internally.<sup>15</sup> In other words, subjects estimate whether they know the answer much faster than they are able to retrieve the answer from memory and then act according to such estimation. Moreover, subjects' performance shows that their feeling of knowing was a reliable signal of their knowledge of the answer (Reder and Ritter 1992; Reder 1987, 1988, 1996; Paynter et al. 2009).

A study by Kalnikaitė and Whittaker (2007) confirms these findings. In their study, subjects listened to stories and were instructed to support their memories using one of three prosthetic memory devices: pen and paper, Dictaphone, and ChittyChatty (a notepad equipped with audio recorder, so that subject can use her notes to retrieve audio) to answer some questions after a delay. They found that, in general, subjects were less likely to consult prosthetic memory devices when they were confident that they could resort to their inner memory to answer the questions. Interestingly, they also found that the use of a prosthetic memory device was determined by the properties of the device, such as accuracy and efficiency. The Dictaphone, for example, turned out to be an accurate but very inefficient device (i.e., it takes a lot of time and effort to retrieve information from it); pen and paper, in contrast, turned out to be efficient but inaccurate after a long retention interval. The ChittyChatty was

<sup>13</sup> For the sake of simplicity, this is an oversimplification of how memory works. To get a more realistic view on memory see Loftus et al. 1996; Schacter and Addis 2007; Michaelian 2011, 2012b.

<sup>14</sup> This occurs when the answer pops up into the mind without the need for any retrieval attempt or further effort.

<sup>15</sup> Paynter et al. (2009) estimate that the production of the feeling takes place in the 300–500 ms time window, whereas the retrieval of an item from memory takes longer.

both accurate and efficient, but not as efficient as inner memory. All in all, this study demonstrates that subjects prefer using efficient (even if sometimes inaccurate) memory devices to using accurate but inefficient ones.

The process of solving a cognitive problem does not stop when the subject chooses the means to solve it. After starting either an internal or external strategy to solve a problem, metamemory continues to monitor the unfolding process. On the one hand, it evaluates whether the chosen strategy is actually leading to the intended outcome. On the other hand, it also takes into account the timing; it considers whether the time required for the strategy is reasonably short. This evaluation generates either a positive or a negative metacognitive feeling concerning the process of remembering. The metacognitive feeling produced in each case motivates the subject to keep using an internal strategy or switch to an external strategy when the chosen strategy is not producing the expected results during execution (see Walsh and Anderson 2009; Thompson 2009; Koriat 2000).

When recalling E. A. Poe's poem *Nevermore* from inner memory, a positive feeling (e.g., the feeling of fluency) points to the fact that I'm doing it well and that I can keep going; retrieving information from internal memory is producing the intended results. I can also undergo the feeling of forgetting, which points to the fact that I might be forgetting a verse or a word and thus motivates me to resort to an external resource. A recent study by Halamish et al. (2011) suggests that this feeling is fairly reliable and that, when they are forgetting information, subjects are often aware of this. In their study, subjects studied a mixed list of 40 words that had some categories in common (e.g., animals or vegetables –although subjects did not know this), and later recalled words when cued with each category. Each category appeared in the top of the screen and subjects had to write down the studied words that fall into that category. Subjects then had to estimate the number of word that they could not recall from each category. Remarkably, subjects accurately estimated the number of words they forgot. Thus, this study demonstrates that subjects are able to accurately monitor their forgetting. The authors enumerate a number of possible interpretations of the phenomenon, but do not endorse any of them. I interpret these results, in the light of experience-based metacognition, as showing that the feeling of forgetting points to a retrieval failure and, eventually, motivates the subject to resort to an external strategy, such as looking in a book or consulting the Internet.

### 3.2 Solving the Endorsement Problem for Internally Retrieved Information

When a subject retrieves information internally or externally, she has to decide whether or not to endorse it. How does the subject make this decision? Someone might immediately object that one never decides this in the internal case, arguing that one simply endorses all the contents of inner memory automatically (e.g., Sterelny 2004; Bernecker 2010). Many studies on memory have shown the contrary: subjects do not automatically endorse all their memories; subjects retrieve a lot of information from their memory, some that they endorse, and some that they do not (Nelson and Narens 1990; Johnson 1997, 2006; Koriat and Goldsmith 1996; Hertwig et al. 2008; Michaelian 2012b). For example, a recent study by Mazzoni et al. (2010) of non-believed memories undermines this simplistic view. Non-believed memories are vivid autobiographical memories for events people no longer believe happened to them;

i.e., memories that they do not endorse. They found that approximately 20 % of their initial sample reported having at least one non-believed autobiographical memory. Participants' phenomenological reports "indicate that non-believed memories share most recollective qualities of believed memories, but are characterized by more negative emotional events" (Mazzoni et al. 2010). A conspicuous example of a non-believed autobiographical memory is Jean Piaget's report of his vivid memory of an attempted abduction—needless to say that it never happened (Piaget 1951).<sup>16</sup>

According to the model that I am proposing, metamemory evaluates the outputs of internal memory each time an item is retrieved from memory and elicits a metacognitive feeling that determines whether the output should be endorsed or not.<sup>17</sup> On the one hand, metacognition elicits a positive feeling (e.g., the feeling of confidence or the feeling of rightness) if the answer is satisfactory and can be endorsed. On the other hand, metacognition elicits a negative feeling (e.g., the feeling of uncertainty or the feeling of error) if the information is doubtful and should be revised or rejected (see de Sousa 2008; Hookway 2008). In cases of rejection, the feeling of error or uncertainty motivates the subject to resort to external resources. In this way, metacognition and metacognitive feelings inform the decision whether to *endorse* an internal output or resort to an external resource.

Many experiments evaluating the relationship between confidence and accuracy in semantic memory settings have found a strong correlation between them (e.g., Schneider and Laurion 1993; Perfect 2004; Luna and Martín-Luengo 2012). For example, in an experiment by Brewer and Sampaio (2012), participants were asked deceptive and nondeceptive questions involving geographical information. In both experiments, as predicted by the metamemory approach to memory confidence, there was a negative correlation for deceptive items; i.e., subjects showed little confidence for deceptive items. And there was a positive confidence/accuracy correlation for nondeceptive items; i.e., subjects tend to be confident for non-deceptive items. So, this suggests that subjects have some awareness of the correctness of their answers in the domain of semantic memory (but not in all domains).<sup>18</sup>

The negative feeling concerning memory retrieval and reasoning is the feeling of error. Think for example of the "negative emotional events" reported by subjects in the study by Mazzoni et al. (2010). The subject has a feeling that something has gone wrong with the cognitive process of remembering and therefore the output should not be endorsed. This kind of feeling concerning memory or reasoning processes has

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<sup>16</sup> The reader may feel uncomfortable with this case because I have been mainly discussing about semantic memory along the paper. I chose this example because it is more striking than the case of semantic memory. In Section 1, I gave a less picturesque example of a non-believed semantic memory: A subject retrieves from her memory "Sydney is the capital of Australia", but she decides not to endorse it.

<sup>17</sup> Since I have relied heavily on Michaelian 2012a in discussing the problems and their solutions, I want to explain how our views fit together. We agree on the overall function of memory and metamemory. The main difference between our approaches concerns the role of metacognitive feelings: whereas for me they are the output of metacognition and the intermediaries of metacognitive decisions, they are deemphasized in Michaelian's account, which focusses on heuristics and the resulting judgements. However, the two accounts may be compatible, as it seems likely that there is room for roles for both heuristics-based metacognitive judgements and metacognitive feelings in explaining how the selection and endorsement problems are solved.

<sup>18</sup> The correlation between confidence and memory accuracy seem to be disrupted in eyewitness memory reports (Krug 2007; Perfect 2004; Luna and Martín-Luengo 2012).

been little studied by psychologists. To address this desideratum in the metareasoning literature, Arango-Muñoz et al. (in preparation) have designed an experiment to test subjects' awareness of their errors. In the "number bisection task", the subject has to estimate whether the number in the middle is the arithmetic mean of the two other numbers (e.g., 2 4 8) by a Yes/No answer. Subjects were instructed to press the Yes/No buttons as fast as possible (in less than 2s) and then report whether they have a feeling of error as fast as possible (in less than 2s) using again the Yes/No buttons. Each bisection problem was presented only once during the experiment, and no feedback about the correction of their answers was given to the subjects. The fast timing manipulation was done to prevent the subjects of recalculating the problems and thus to ensure that the reports were based on sheer feelings and not analytical thought. Interestingly, the feeling of error reports were strongly correlated with actual arithmetic errors; in other words, subjects reported having a feeling of error mainly when they had actually committed an error. Additionally, the experimenters tested subjects' confidence in their answers when they did not report feelings of error. Surprisingly, in these cases subjects reported less confidence for wrong answers than for right ones, suggesting that in cases where subjects did not have a conscious feeling they still had an implicit awareness of their errors.

### 3.3 Solving the Endorsement Problem for Externally Retrieved Information

As I said in Section 2, when I introduced the problem, there are at least two versions of the endorsement problem for externally retrieved information: a social version and non-social one. Given the various external sources of information on which a subject can rely to scaffold her memory and the various degrees of reliability of those sources, how does a subject decide whether to endorse information retrieved from external sources?

There are some sources which are known to be reliable, in which case subjects can retrieve information and endorse it without much deliberation to support their memory: "Informational resources in shared space are sometimes reliable *because* they are shared. Such resources are the joint product of many agents and are typically used at unpredictable times and places" (Sterelny 2010: 474). For example, subjects uncritically endorse road signals and maps to remember their way to a location (supposing they have already gone there).

There are also some cases of uncritical or automatic endorsement in social contexts. Sometimes, subjects seem to uncritically rely on information provided by familiar people even at the risk of being misinformed: people are "susceptible to memory distortion when someone they know provides the misleading information" (French et al. 2008, 271; see also Gilbert et al. 1990; Gilbert et al. 1993).

However, when the source is unfamiliar or unknown, a subject needs to be more cautious about the endorsement. There are criteria that she may use to determine whether a piece of externally retrieved information should be endorsed, such as coherence (the fact that it is in accordance with some of her beliefs [Mercier and Sperber 2011, 60]), consensus (the fact that most of the people endorse it [Koriat 20089]), intelligibility (the fact that it is easy to understand [Kahneman 2011]), and relevance (the fact that it increases the likelihood of attaining her goals [Sperber and Wilson 1995]).

An important criterion for endorsement, in cases where the source is unfamiliar or unknown, seems to be the cognitive fluency of the information. According to Reber and Schwarz, fluent information elicits a positive feeling that they call “the feeling of truth”,<sup>19</sup> that is, a subjective appreciation of the likelihood of the information being correct (Reber and Schwarz 1999; Reber and Unkelbach 2010). Various findings in cognitive psychology have shown that subjects rely on this feeling, which is produced by the fluency of the processing of a stimulus (see Oppenheimer 2008 for a review). Some stimuli are easier to process than others and therefore more fluent; others are harder and less fluent. There are three determinants of processing fluency: repetition, structure and perceptual features (see §3). “When people hear or see a statement repeatedly, they believe that this statement is more likely to be true than new statements which they have never encountered before” (Reber and Unkelbach 2010). Hence, this feeling seems to be one important determinant of the endorsement of externally retrieved information from unknown or unfamiliar sources.

#### 4 Final Remarks

A long time ago, at the dawn of the literacy tradition, Plato condemned writing as a harmful tool for memory. This invention would produce lead to forgetfulness for its users because they would rely on the external characters instead of exercising their inner memory (Plato 2011, *Phaedrus* 274–7). Thirty years ago Walter Ong (1982, pp. 79–81) pointed out that the same denunciation was often put forward against computers. More recently, the same charge has been put forward against Google and the Internet (Carr 2008).

Skeptics are right to say that technologies for mental scaffolding not only enhance our mind but also bring challenges with them. The extended selection problem and the endorsement problem are the immediate challenges that subjects have to face when they use external resources to scaffold their memory. On the one hand, each time an agent is confronted with a memory problem, she has to choose whether to solve it internally or externally. How does she decide? On the other hand, when confronted with the internally or externally retrieved answer, the subject has to decide whether to endorse the information to form a belief. How does the subject decide whether to endorse a given piece of information?

The trend of pessimism with respect to technology, however, seems unjustified. According to the experimental data and the account that I have developed here, humans so far seem to be able to deal with these problems intelligently. On the selection side, subjects are quite good at adapting their memory to the constraints of the world and the cognitive tools they use. Sparrow et al. (2011) have recently studied the effects of Google on memory. Their first finding was that people had a strong disposition to consult the Internet when they did not know the answer to a question. Second, they found that subjects had better recall for studied information when they

<sup>19</sup> Joëlle Proust has pointed out to me that it is debatable whether it is appropriate to call this experience “the feeling of truth” because it suggests that the feeling unveils the truth conditions of the proposition, and this seems too demanding for a feeling. I agree that the name may not be appropriate; the classic concept of “confidence” works better here.

believed that the information could not be externally retrieved afterwards. In other words, when they knew that they could find the information somewhere “outside”, they did not bother to store the information in their internal memory. So, according to these findings, there is not only strategic retrieval, but also strategic internal storage of information (see Friedman and Castel 2011). Finally, they found that, when subjects saved information in external devices, they better recalled the place where it was stored than they did the information itself. We have designed the Internet and Google to enhance our memory; but we are not only creating technology that serves our cognitive purposes, we are also adapting our minds to that technology.

On the endorsement side, many web pages go to great lengths to ensure the reliability of the information that they provide, so that subjects can confidently endorse the information. This “epistemic vigilance” –to use Sperber’s et al. (2010) term– with respect to uploaded information is often even exaggerated. An example of this endeavor is provided by Philip Roth’s anecdote about Wikipedia’s refusal to correct an imprecision concerning the origin of Roth’s novel *The Human Stain*. The Wikipedia Administrator answered to Roth’s petition to delete a misstatement: “I understand your point that the author is the greatest authority on their own work, but we require secondary sources” (Roth 2012).

To sum up: Decisions about when to resort to an internal or external resource are mediated by metamemory and are often guided by metacognitive feelings. The same applies to decisions about when to endorse an internally or externally produced output. Each time a subject is confronted with a cognitive task, their metacognitive capacity evaluates whether the information can be internally retrieved or the subject has to resort to an external resource. Positive metacognitive feelings (e.g., the feeling of knowing and the feeling of fluency) motivate the execution of the action by internal means, whereas negative metacognitive feelings motivate looking for external strategies (e.g., the feeling of forgetting and the feeling of error). In a nutshell, a subject can only adaptively rely on external resources to supplement her internal memory if she has some awareness of when to consult them and when to endorse their contents. This kind of awareness is provided by metacognition and metacognitive feelings.

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