Memory for future actions

Maria A. Brandimonte
IUSOB, Naples, Italy

Abstract

Memory for intentions (*or prospective memory*) refers to the processes and skills required to support the fulfillment of an intention to perform a specific action in the future. Everyday examples of prospective memory include remembering to buy bread on the way home from work, remembering to give friends a message upon next encountering them, and remembering to take medication. Real-world prospective memory tasks often require that we remember to perform an action while we are busily absorbed by another task. The mechanisms and characteristics of such a complex cognitive function have been extensively investigated in the last decade. The present chapter is aimed at discussing some theoretical issues and related empirical findings that may have an impact on applications in real-world contexts.

Memory: A mental time travel

A couple of years ago, Tulving wrote: "With one singular exception, time's arrow is straight. Unidirectionality of time is one of the most fundamental laws. It has relentlessly governed all happenings in the universe - cosmic, geological, physical, biological, psychological - …galaxies and stars are born and they die, living creatures are young before they grow old, causes always precede effects, there is no return to yesterday…Time's flow is irreversible" (Tulving, 2002, 1). The singular exception is represented by the human ability to travel in their mental time. The rememberer can travel back into his/her past and forward into his/her future, hence violating the law of the irreversibility of the flow of time (Tulving, 2002).

There are many important psychological consequences of humans' time perspective. One of the most relevant to the organization of human memory is that, according to temporal distance, people form different mental representations depending on whether the information pertains to the near past or to the distant past, to the near future or to the distant future. Individuals form abstract, high-level temporal construals of distant past and distant future events. High-level construals include general, decontextualized features that convey the essence of information about time (Trope & Liberman, 2003, 403). On the other hand, people form low-level construals for near past and near future events (Trope & Liberman, 2003). Low-level construals include more concrete, contextual, and incidental details. Both high-level and low-level construals are formed for past events as well as for future events.

In terms of memory processes, high-level and low-level construals formed for past events go under the rubric of *retrospective memory*, whereas high-level and low-level construals formed for future events go under the rubric of *prospective memory*. The primary focus of this chapter is on prospective memory, that is, on the mechanisms and characteristics of memory for actions that have to be performed in the future.

Memory, action, and temporal construal

In the past two decades, a new conceptual framework has been developed within which cognitive processes are seen to be deeply rooted in the body's interactions with the world (Koriat & Pearlman-Avnion, 2003, 435; for a review, see Wilson, 2002). This view - which has been stimulated by the notions of "embodied cognition" and "situated cognition"- brings action to the forefront of cognitive theory (Koriat & Pearlman-Avnion, 2003, 435). By their nature, memory processes are intimately tied to action (Zimmer et al., 2001). Therefore, any memory theory should take into account the question of when and how memory functioning influences the individual's interaction with the world.

An increasingly relevant area of research within which the relationship between memory and action has been studied refers to the realization of intentions (Brandimonte, Einstein, McDaniel, 1996). Everybody knows how important it is that we remember to timely and successfully execute previously formed intentions. In our daily lives, we are required to form and initiate several intentions. However, often we cannot execute the action at the moment that the intention is formed because we are busily absorbed by another task and are then forced to delay execution until some later time. As a consequence, memory processes are of paramount importance for successfully executing the task. The process of storing and retrieving such intentions is known as *prospective memory* (Brandimonte, Einstein, & McDaniel, 1996) and in the last years it has received increasing attention. Everyday examples of prospective memory include remembering to buy bread on the way home from work, remembering to give friends a message upon next encountering them, and remembering to take medication.

It is commonly accepted that there are many different forms of intentions and that each type of intention has its own characteristics and processing requirements (see Brandimonte, Einstein & McDaniel, 1996). However, there are also some properties that are common to all PM tasks (see Burgess, Quayle & Frith, 2001; Ellis, 1996). First, any PM task involves a retention interval between the formation of the intention and the time to realize it. This period may last minutes, hours or days. A second feature is that a PM task involves both an ongoing and a background task. In a typical laboratory PM task, the participant is required to perform an ongoing task (e.g., memorizing a list of words, generating associations among words etc.) while at the same time he/she has to remember to do an action at the appropriate moment (background task, e.g., pressing a particular key on the computer keyboard on the appearance of a particular item or at a particular time). That is, the paradigm takes the form of a dual-task, with a primary, ongoing task which serves as a covering task for the prospective, background task. According to the type of retrieval context - i.e., on appearance of a specific event or at a particular time - researchers refer to these as to event-based and time-based tasks, respectively (Einstein & McDaniel, 1990). Finally, another central feature of prospective memory tasks is that the rememberer must recollect the intended action at the appropriate instance without an

agent stimulating retrieval (e.g., Craik, 1986; Einstein, Holland, McDaniel, & Guynn, 1992; McDaniel & Einstein, 2000).

Memory for intentional actions to be realized in the future reflects a very special and unique human ability: That of travelling forward in time, mentally anticipating the properties and characteristics an action may have. Typically, the further the action to be performed, the more general and abstract its representation. Therefore, the individual's time perspective will influence the way the intention will be maintained during the retention interval, monitored and eventually updated as the appropriate time for execution approaches. In general, future time perspective issues have a great relevance for everyday life activities because, for example, many prospective memory failures are among the most common causes of human errors (both in terms of omission and commission errors). Consistent with this idea, Gollwitzer and Brandstaetter (1997; see also Gollwitzer, 1999) showed that forming so-called "implementation intentions" (i. e., a concrete plan as to how, when, and where to perform an activity) enhances the likelihood of actually undertaking the activity, as compared to forming more abstract intentions to perform the same actions. It is out of doubt that humans perform actions to reach goals, that is to create or modify some event according to their intentions. Therefore, intentional actions presuppose some kind of conscious or unconscious anticipation of the intended goal event, some knowledge about the goal and how it can be achieved (Hommel, 2003). Some authors introduced the concept of *episodic future thinking* which refers to "a projection of the self into the future to pre-experience an event " (Atance & O'Neill, 2001, 533). The concept of *episodic future thinking* is strictly tied to the concept of autonoetic consciousness, which Tulving (2002, p. 2) defined as "a special kind of consciousness that allows us to be aware of subjective time in which events happened" and that extends from the personal past through the present to the personal future. The combination of autonoetic consciousness and episodic memory allows people to travel in their mental time, re-experiencing the past or pre-experiencing the future (Atance & O'Neill, 2001). In terms of PM efficacy, episodic future thinking might be relevant to how we develop and implement strategies for remembering to perform an action in the future. Indeed, the more specific the plan for the future action (i.e., the when, where, and how of responses leading to goal attainment) the more likely the completion of the task (Gollwitzer, 1999). Extrapolating from this reasoning, a general prediction in the realm of PM research, susceptible of empirical investigation, is that the better the ability of pre-experiencing the future event (hence unfolding the plan) the more likely the realization of the intention. However, an important constraint to this general hypothesis derives from temporal construal theories. As already mentioned,
individuals represent distant future events at a more abstract level than they represent near future events. In addition, when planning future actions, people tend to consider time constraints only when these events are in the near future. This bias toward present and near-future time plays a role in generating inefficient behavior with respect to completing tasks with distant deadlines. As I'll discuss later in the chapter, this kind of individuals' time perspective may have important practical consequences in everyday life.

Prospective memory in real-world settings

Prospective memory failures are particularly relevant in everyday life. Winograd (1988) noted that if retrospective memory fails, the person's memory is seen as unreliable, but if prospective memory fails, the person is seen as unreliable. In natural settings, people tend to perform a variety of errors. Some may be due to prospective memory failures, while others can be attributable to different types of failures such as loss of the content of an intention, inappropriate output monitoring, or absent-mindedness.

Any prospective memory task implies a delay between the time the intention is formed and the moment to realize it. In everyday life situations, delay is a critical aspect of *prospective memory*. The fulfillment of an intention is often delayed because we are absorbed by another task and can execute the action only at some designated moment in the future. Sometimes, we postpone an action because it is inappropriate in the current situation, other times we do so because the current task is too demanding to respond immediately (see Einstein et al., 2003). On other occasions, we may even forget to do something and forget that we have forgotten! As Reason (1990) argued, prospective memory failures are among the most common causes of human errors. However, with few exceptions, the study of the types of prospective memory errors (as compared to other types of human errors, see Reason, 1990) that occur in such situations as work settings, individual decision-making, and medication adherence has been largely neglected. As a consequence, methods and techniques to improve prospective memory skills have not been developed until recently (e.g. Camp, Foss, Stevens, & O'Hanlon, 1996; Chasten, Park, & Schwarz, 2001; Einstein et al., 2003). In the present section, I will concentrate on a practical issue that in the near future might represent an important challenge for applications of prospective memory theory; namely, the differential value of external memory aids in the neuropsychological therapy of memory-impaired patients and in economic agents' behaviour. To anticipate, whereas external memory aids have proven extremely useful in helping memory impaired people to compensate for their deficits, welfare-improving memory aids are purchased only by agents who have (or believe themselves as having) poor prospective memory, hence linking the value of external memory aids to the level of self-PM confidence (Holman & Zaidi, in preparation).

The role of memory aids in the therapy of memory-impaired patients

In a recent article, Thöne-Otto and Walther (2003) examined the usefulness of external memory aids as tools for improving memory in brain-injured patients and proposed a new electronic memory aid aimed at compensating for both lack of self-initiated retrieval and for problems during action execution or evaluation of outcome.

Successful compensation for prospective memory deficits is a relevant predictor of living independently after brain injury. In the last decade, neuropsychologists have tried to use memory aids for the therapy of memory impaired patients. A number of tools have been developed, ranging from simple, portable paging systems which can be fastened to the patient's belt (NeuroPage by Hersh and Treadgold, 1994), to

Voice Organizers (Van den Broek, Downes, Johnson, Dayus, and Hilton, 2000), to Standard Mobile Phones (Wade and Troy, 2001), to Palmtop (Kim, Burke, Dowds, Boone, and Park, 2000) and Pocket computers (Wright et al., 2001).

Commercially available memory aids have the advantage of being available to everybody, but they can only support mildly impaired patients. In addition, many commercially available electronic aids are usually too difficult to handle. Therefore, a number of modifications were proposed (see Thöne-Otto and Walther, 2003 for a review). In particular, a system (MEMOS, Thöne-Otto, Schulze, Irmsher, & von Cramon, 2001) has been recently presented (which is currently under construction) especially suitable for patients with more severe deficits. This new memory aid seems particularly promising in that it presents many advantages as compared to existing tools. Thöne-Otto and Walther (2003, 8) describe it as follows: "It consists of an internet server that allows the management of several clients, such as patients, therapists, and significant others.. In addition there is an application server managing the execution of incoming and outgoing tasks. Appointments can be entered via different computers, which may be organized at a central service interface or in the patient's home. In addition, appointments can be entered via speech input directly into the mobile device. Relevant patient data are stored in a database. From the application server, information is sent to the patient's personal memory assistant, PMA, a mobile memory device similar to a mobile phone. Interactive contact is possible between the application server and the PMA at any time. Thus the patient can be contacted directly in case of missing confirmation of relevant intentions (such as important medication)…Patients are asked whether the task can be fulfilled or if it needs to be postponed. In the case of postponement, the system automatically looks for other appointments that may conflict with the postponed one".

Apparently, MEMOS presents such advantages as easier encoding, patients are interactively guided through the steps of an action and each step has to be confirmed, execution has also to be confirmed, postponement is possible and the system automatically looks for other appointments that may conflict with the postponed one (Thöne-Otto and Walther, 2003).

To summarize, external memory aids are of great value in compensating for prospective memory deficits shown by brain-injured patients. However, the question remains open as to the role of external memory aids in helping normal people to fulfill their intentions.

Prospective memory overconfidence and external memory aids in normal populations

The need to view ourselves favorably seems to be fundamental in motivating our
behavior, hence influencing many decisions in everyday life. Typically, humans tend to acquire overconfident beliefs on their skills, abilities, intelligence etc. (Holman & Zaidi, in prep; Koszegi, 2000). For example, in retrospective memory research, it is well known that

eyewitnesses overestimate their memory for the physical details of a criminal suspect (Loftus, 1979). The concept of *personal metaknowledge* is typically used to refer to the individual's beliefs about his/her abilities, personal utility (ego utility, Koszegi, 2000), obstacles to successful performance, as well a to the belief system people hold about prospective memory (Dobbs & Reeves, 1996). Metaknowledge about prospective memory may have fundamental consequences on the quality of life. For example, task importance (e.g., Brandimonte et al., in preparation, Kliegel et al., 2001) and personal beliefs about one's own prospective memory abilities may determine if and when this knowledge is put into play (Dobbs & Reeves, 1996, 203). Yet, so far, we know very little about prospective memory metaknowledge. For example, it is clear that there are important individual differences in this kind of metamemory. Children typically overestimate their abilities to remember to perform an action in the future (Beal, 1988) and do not see the need for setting plans (Kreutzer, Leonard, & Flavell, 1975). The findings from self-ratings similarly indicate that elderly give themselves higher ratings on PM that do young adults (Martin, 1986), i.e., older people tend to overestimate their PM. Thus, overconfidence seems an important determinant of PM failures. However, until recently, there has been no formalized model of PM that has taken into account PM overconfidence.

Most recently, Holman and Zaidi (in prep.) developed a baseline model of PM to be applied to decision-making problems. The model focus on long-term, episodic, step PM tasks. A step PM task has a wide time period for action execution (e.g., meeting John sometime today, see Ellis, 1988, 1996), with an exogenous imposed deadline. The individual will perform the action within the appropriate period if a) the intention is retrieved and b) if the expected utility of doing the task in that period is higher than the subjectively perceived expected utility deriving from procastinating the action and relying on future memory. When PM overconfidence, defined as either overestimating the base likelihood of recall in the future or underestimating the effect of temporary forgetting on subsequent recall, is introduced into the model, it reduces welfare in that it not only leads to less than optimal rates of task execution, but also to the prediction that the probability of task execution can vary inversely with the length of deadline (Holman & Zaidi, in prep.). Thus, PM overconfidence explains inefficient behavior with respect to completing tasks with longer deadlines. When an agent is overconfident with respect to PM, he/she will inefficiently procastinate PM tasks, overoptimistically relying on his/her own ability to retrieve intentions. After all, people find it difficult to imagine not remembering what they are aware of in the present and therefore they are overoptimistic about their ability to later retrieve an information that is currently held in consciousness. One key result in the model is that PM overconfidence increases the likelihood that extending the deadline will be detrimental to the agent.

In an extension of the model, Holman and Zaidi (in prep.) incorporate memory aids into the model and demostrate that only people with poor memory will purchase welfare-improving memory aids. Indeed, if memory aids are sufficiently costly, they will only be employed by agents who believe themselves as having a poor prospective memory.

These individuals may eventually perform better on PM than on retrospective memory tasks (see Wilkins & Baddeley, 1978), but only because they are more likely to purchase and employ PM aids. However, even individuals sophisticated about their PM limitations (i.e., who are not overconfident), who correctly realize the value of memory aids, may still not implement them. The reason is that most PM aids (calendars, palm pilots, other reminders) involve immediate costs and future benefits, and if individuals are present-biased (in the sense that each day they would rather put tasks off until tomorrow), and naively unaware of this tendency, then every day they may plan on implementing a memory aid but never actually get around to doing so (Holman, personal communication, May 24th 2004).

Concluding remarks

Taken together, the above considerations highlight some important issues that, so far, have played a marginal role in PM theories and their applications. A first issue pertains to the psychological consequences of humans' time perspective. A second, related issue refers to the practical consequences of forming temporal representations of future actions in order to implement strategies according to temporal distance. One such practical consequences refers to the use of external memory aids to enhance prospective remembering. The degree of efficacy provided by external memory aids seems to depend on the existence of memory deficits and on the individuals' expectations for future recall of intentions.

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