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# Remembering Intentions: Testing a New Method of Investigation

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SUMMARY

The paper examines some of the methodological difficulties associated with the investigation of remembering intentions in a laboratory and reports the development of a new and easily administered naturalistic task. The task requires participants to act as a narrator and read aloud a story that they are informed will help the experimenter to obtain necessary test material for another study. Remembering intentions ('prospective memory') is examined by presenting a plausible cover story requiring to make a correct substitution for a 'target' word which appears on several occasions during the story. This method seems to capture adequately the nature of prospective remembering and preclude the occurrence of ceiling, floor and practice effects in performance. By distinguishing late responses from on-time or successful prospective memory responses it also stresses the importance of taking into account the speed with which one recovers from his or her prospective memory failures. Finally, this task enables us to collect reliable and consistent quantitative measures of remembering intentions and to investigate a variety of methodologically and theoretically important problems. The results of Experiments 1a and 1b (Study 1) suggest that both the type of prospective memory task (main versus extra) and subjects' awareness of the phenomenon under investigation are important influences on performance. On the other hand, no effects of (1) a short 5-minute delay between prospective memory instruction and onset of background activity and (2) information about the frequency of target word were revealed (Study 2). The design of a popular experimental paradigm (Einstein and McDaniel, 1990) is examined in the light of these findings. © 1998 John Wiley & Sons, Ltd.

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One of the recent distinctions drawn in memory psychology is a distinction between retrospective and prospective memory (Meacham and Leiman, 1982; see also Brandimonte, Einstein and McDaniel, 1996). The former refers to the remembering of past information (e.g. remembering *a friend's telephone number* when making a call), and the latter to the timely execution of an intended action at some point in the future (e.g. remembering *to call a friend* at some particular time tomorrow). Remembering plays an essential role in carrying out one's future intentions (cf. Ellis, 1988; for a different viewpoint, see Crowder, 1996). Indeed, if a person fails to remember on time that he or she had previously decided to do something at this particular moment, then his or her intention remains unrealized, and this may often have quite unpleasant or sometimes even tragic consequences (Meacham, 1982).

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According to some diary and questionnaire studies prospective memory failures tend to occur in everyday life as often as (Crovitz and Daniel, 1984), or even more frequently than, retrospective memory ones (see Mateer, Sohlberg and Crinean, 1987; Terry, 1988). Surprisingly, however, it is retrospective memory that has been intensively studied for more than a hundred years whereas the experimental investigation of prospective memory started only from the mid-1970s. Although a number of prospective memory studies has been gradually increasing over the past twenty years there is still 'less advancement than one might have expected, both in terms of the development of experimental paradigms and in the extent and sophistication of the conceptual analyses' (Dobbs and Reeves, 1996, p. 199). This criticism can partly be accounted for by the difficulties that are associated with the experimental investigation of remembering intentions (see Kvavilashvili, 1992; Maylor, 1996).

It is impossible to investigate prospective remembering in a laboratory setting with the methods developed for studying remembering past information in a form of word lists, digits, short stories, etc. Indeed, all that subjects have to do in a typical retrospective memory experiment is to retain as much information as possible, they need not worry as to *when* it is necessary to start remembering this information. At an appropriate moment they are explicitly cued by the experimenter to do so. In the case of prospective memory, however, the remembered information is usually minimal. What is really important is not to miss the appropriate moment for carrying out an intended action in an absence of any external prompt (Einstein and McDaniel, 1996; Levy and Loftus, 1984; Maylor, 1996; McDaniel, 1995). This self-cued or self-initiating aspect of prospective remembering (see Craik, 1986; Wilkins, 1986; Winograd, 1988) is regarded as the critical feature, distinguishing it from retrospective memory, and calling for the development of new laboratory methods that would be suitable for studying remembering intentions *per se*.

Another important feature of prospective remembering in everyday life is that once an intention has been formed it is no longer necessary to think about it 'obsessively' (see Freud, 1901/1960). Instead, a person switches to another activity that is often totally unrelated to the to-be-remembered intention. However, at an appropriate moment it usually pops to one's mind, often without any obvious external cue. In order to simulate this situation in a laboratory, experiments need to engage subjects busily in what they think is the main experimental task (termed background or cover task by various researchers) and, additionally, to ask them to perform a certain action (i.e. prospective memory task) either at some future point(s) in the course of the main experimental task (Cockburn and Smith, 1988; Maylor, 1993; McDaniel and Einstein, 1993; Harris and Wilkins, 1982) or after its completion (Kvavilashvili, 1987; Loftus, 1971; West, 1988, Exp. 2).

One of the most successful and frequently used paradigms for studying prospective memory in a laboratory was introduced by Einstein and McDaniel (1990). A cover task is employed that requires subjects to process the verbal material presented on a computer screen (e.g. memorizing lists of words, answering general knowledge questions, etc.). A prospective memory task is embedded into this cover task by asking subjects *to press a designated key* each time they encounter a certain target word(s) in the course of processing this verbal material.[1] In order to obtain the quantitative

[1]Other researchers have employed cover tasks that require processing of auditory verbal (Mäntylä, 1993) or non-verbal visual material (Maylor, 1993).

 

measures of prospective remembering the target word appears several times throughout the cover task (from three to a maximum of eight times in various studies) (Brandimonte and Passolunghi, 1994; Einstein *et al.*, 1992, 1995; Ellis and Milne, 1996; McDaniel and Einstein, 1993).

These laboratory simulations of prospective remembering have undoubtedly enriched the field with interesting and novel results concerning the effects on prospective memory of such variables as age, external cues, familiarity, distinctiveness of target words, etc. However, the above paradigm appears to suffer from certain limitations that one needs to take into account and, if possible, to overcome in future research. One of these is that a majority of subjects tend to perform either at ceiling or at floor, that is, they tend either to always remember or always forget to carry out the prospective memory task. The actual number of subjects who display some variability in their performance (i.e. remember on some trials and forget on others) is as small as 10–15% in some studies (McDaniel and Einstein, 1993; see also Einstein and McDaniel, 1990). In everyday life, however, it is difficult to imagine a situation where people forget to perform a certain repeated action all the time. In fact, normal functioning would be completely disrupted even if people forgot to do things on 50% of relevant occasions (Morris, 1984).

Furthermore, in the Einstein and McDaniel paradigm subjects tend to respond to a target word either immediately or not at all. Delayed responses are relatively rare (see e.g. Einstein and McDaniel, 1990; Ellis and Milne, 1996). In everyday life, however, people display a more varied performance. It is reasonably common that when someone initially misses an appropriate response she then recovers from the failure in a few seconds or minutes, and late response may remedy the situation (e.g. someone may return home after locking the front door in order to retrieve an object which one intended to take to work) (cf. Ellis, 1996). It is therefore desirable to develop methods which will allow us to detect and obtain reliable measures of late responses together with complete failures or omissions.

Finally, there has been a lack of interest in important methodological issues that inevitably arise when one wants to simulate prospective memory in laboratory (see Kvavilashvili, 1992; Kvavilashvili and Ellis, 1996). For example, various authors have adopted different strategies to avoid the ceiling and/or practice effects that are likely to occur in subjects' prospective memory performance but often there is no clear understanding of how these particular strategies help to eliminate these effects, what are the most parsimonious strategies to adopt, etc. For example, it has been suggested that ceiling effects can be attenuated if (1) a prospective memory task is introduced to subjects not as the main experimental task but as something additional to it, and (2) subjects are unaware that their prospective memory performance is under study (Kvavilashvili, 1992). Although all laboratory studies of prospective memory appear to have implicitly adopted the former strategy by embedding some extra task in an ongoing cover activity it would be still worthwhile to investigate the effects of task manipulation (main versus extra) on prospective memory performance. Not only will such a study help us to better understand the procedures that are often employed when designing prospective memory experiments but it may also provide experimental support for the distinction drawn by Harris (1984) between single- and dual-activity prospective memory (see General Discussion).

It would also be interesting to manipulate subjects' awareness of whether their prospective memory is being assessed. In most of the published prospective memory

 

studies subjects are explicitly told that a secondary purpose of experiment is to study their prospective memory (Einstein and McDaniel, 1990; Einstein *et al*., 1995; Mäntylä, 1993; McDaniel and Einstein, 1993). Although, in some studies, subjects are simply requested to do something in response to certain targets without any explanation (Brandimonte and Passolunghi, 1994; Ellis and Milne, 1996; Maylor, 1993; Guynn, McDaniel and Einstein, in press), it is usually obvious that performance will be monitored. Bearing this situation in mind, it would be interesting to see to what extent, if at all, the concealment of the real purpose of the study increases prospective memory forgetting.

The aim of the present study is therefore twofold. First, I wanted to develop a new method which would overcome some of the above-mentioned limitations of the currently popular paradigm (Study 1) and, second, to study the effects of several methodologically and theoretically important variables on prospective memory performance with this newly developed method (Study 1 and Study 2).

## STUDY 1

The task that I tested in one of my pilot studies involved reading aloud a story for certain purposes as a cover task and remembering to make a correct substitution for one particular target word as a prospective memory task. Specifically, subjects were asked to read aloud a story, with the expectation that they would be tested for memory and comprehension thereafter. In addition, they were also asked to say the word 'detective' whenever they encountered the word 'prefect' which occurred for a total of sixteen times in the story.

The results of this pilot study showed that none of the subjects performed at floor. If anything, there was a tendency to perform at ceiling as most of the time subjects managed to remember their intention in time and read quite fluently 'detective' instead of 'prefect'. However, on some occasions they seemed to forget their intention to substitute the target word and that resulted in committing the following three types of errors. *Serious errors* or omissions occurred when subjects read 'prefect' instead of 'detective' and continued reading without remembering that they were supposed to make a substitution. *Intermediate errors* occurred when subjects initially read 'prefect' but then, becoming aware of their mistake, quickly added 'detective'. *Slight errors* occurred when subjects realized they were making a mistake in the very course of reading the target word and immediately corrected it; they read either 'pre-detective' or 'pref-detective'. It is obvious that both intermediate and slight errors constitute the late responses described in the Introduction.

The aim of Study 1 was to develop an optimal version of this task (i.e. one which would elicit sufficient prospective memory forgetting) by manipulating two of the variables specified in the introduction: type of prospective memory task (main versus extra) and awareness that one's prospective memory is under investigation (aware versus not aware).

In order to test the possible effects of these factors on prospective remembering Study 1 was conducted on three groups of subjects. By varying instructions the following experimental conditions were created. Subjects of Group 1 knew that their prospective remembering was under investigation, and the prospective memory task of substituting the words was the main experimental task itself. Subjects of Group 2

 

also knew that their prospective memory was studied, but the intention to substitute the words was not part of the main experimental instruction. Rather, it was induced by an extra request (this condition was therefore similar to the tasks typically employed in the Einstein & McDaniel paradigm). The same held for subjects of Group 3 (i.e. prospective memory task was introduced as an extra task) but, unlike those in Group 2, they did not know that their performance on prospective memory task was under the study.

Thus, any difference obtained between Groups 1 and 2 could be attributed to the operation of the first factor (i.e. whether the to-be-remembered intention is induced by the main experimental instruction or by some extra request), and any difference between Groups 2 and 3 to the operation of the second factor (i.e. subjects awareness/unawareness that their prospective memory is investigated). A working hypothesis was that subjects of Group 3 would display the highest forgetting rate whereas those in Group 1 would probably perform at ceiling. As to the subjects of Group 2 their prospective scores were expected to occupy an intermediate position between those of Groups 1 and 2.

In order to enhance the generalizability of results, the effects of instructions on prospective memory performance were studied in two subsets of subjects that differed in their native language and cultural background. In addition, some minor procedural changes were introduced in one of those subsets. Therefore, the method sections for the two subsets are described separately (Experiment 1a and 1b) and experiment is treated as an independent variable in the combined analyses.

## METHOD

### Experiment 1a

*Subjects*

Fifty-four Georgian speakers (students in various departments of Tbilisi State University, aged 17–28) were randomly assigned to one of the three groups. There were 18 subjects (six male and twelve female) in each group. Participation in the study was voluntary and subjects did not receive any payment. Subjects were tested individually. On average, each experimental session lasted about 20 minutes.

*Materials and procedure*

Subjects of all three groups had to read aloud a Georgian translation of Edgar Poe's detective story 'The purloined letter'. For purposes of experiment a shortened version of this story was prepared. It comprised ten typed pages. The target word 'prefect' occurred twice on every page. Instructions given to all three groups of subjects were presented orally by the experimenter.

Instructions given to the subjects of Group 1 were as follows:

> You are taking part in a memory experiment and you will be administered a simple memory test. In particular, you must read aloud this text that is a shortened version of Edgar Allan Poe's story 'The purloined letter' (there are ten typed pages). One of the main characters in this story is a prefect of the Paris police and whenever you encounter the word 'prefect' you must read instead of it the word 'detective'.

 

Instructions given to subjects of Group 2:

> My colleagues and I are conducting a large-scale investigation on text comprehension in 8, 9, and 10 graders. Specifically, we are interested in a variety of factors that may have impact on the comprehension of a vague text. For example, what happens when subjects read the text themselves or when they listen to someone reading the same text? Furthermore, we also want to know how the peculiarities or a reader's voice may affect the comprehension of the text. To this end, we have to record dozens of people reading this text in order to enable the experts to select few records that, in their opinion, promote the best comprehension of text in subjects. I want therefore to ask you to act as a narrator. Here is a text that you must read. It is a shortened version of Edgar Poe's story 'The purloined letter' (there are ten typed pages). Try to read it with average speed, neither very quickly nor very slowly. While reading you may, of course, make some mistakes but don't get too anxious or worried about them since they will not distort the contents of the story. In short, you must read this story as you would perhaps read a fairy tale to a child at home. As you see, you must actually help us to obtain the material for our further experiments. However, we are also conducting another study in memory and we decided to profit by the chance that you are here and administer you a following simple memory test as well. Namely, one of the main characters in this story is a prefect of the Paris police, and whenever you encounter the word 'prefect' you must read instead of it the word 'detective'.

Instructions given to the subjects of Group 3 were similar to those given to Group 2 except for its final part where no mention was made about the memory task. However, instead of switching on the tape-recorder, the experimenter with a worried expression on her face said to the subject: 'You know, there was something I wanted to ask you'. Then, after a few seconds, as if remembering what it was she wanted to say, she turned to a subject with the following request:

> Oh yes, the thing is that one of the main characters in this story is a prefect of the Paris police. To our great surprise, however, we discovered in our pilot study that the word 'prefect' caused a great deal of miscomprehension, probably because this word has recently been used here in the meaning that is different from that given in the story. Unfortunately, we had no time to retype this story, so in order to avoid further complications it would be better if whenever you encounter the word 'prefect' you read instead of it the word 'detective' which is less likely to elicit unnecessary associations.[2]

After receiving one of the above-described instructions and after the experimenter had switched on the tape-recorder, a subject read all ten pages of the text aloud and, while reading, encountered the word 'prefect' twenty times (twice on every page). All subjects read the story in the presence of the experimenter who surreptitiously recorded the type of errors committed by subjects each time they encountered the target word. Careful recording of these errors was desirable as it eliminated the

[2]This apparently natural explanation given to the subjects of Group 3 referred to some political events that took place shortly before conducting Experiment 1a in May 1991. Namely, the freshly elected President Zviad Gamsakhurdia personally appointed the prefects as government officials in various regions of Georgia to replace the former local leaders of the Communist Party. The appropriateness of the policy was widely discussed in the mass media at that time.

 

necessity to replay the tapes after finishing the experiment. Thus, the experimenter needed to consult the tapes only in those rare cases when she was not entirely sure of the type of error committed by the subject on a particular occasion.

After reading the story, subjects of all three groups had to answer the following questions:

(1) Was it difficult to perform simultaneously two tasks like reading the story and substituting the word 'prefect' with the word 'detective'? (Subjects answered on a four-point scale where 1 = not difficult, 2 = slightly difficult, 3 = quite difficult, and 4 = very difficult).
(2) Did you constantly think about the task to substitute the words while reading or did you remember about it only when you encountered the word 'prefect'?
(3) How interesting was for you the story you were reading and did you have some text-unrelated thoughts during the reading, i.e. to what extent were you absorbed in reading? (Subjects answered these questions on the four-point scales where 1 = not interesting, not absorbed, and 4 = very interesting, very absorbed).
(4) How willing or motivated were you to substitute the 'detective' for the 'prefect' while reading the story? (Subjects answered on a four-point scale where 1 = not willing, and 4 = very willing.)

**Experiment 1b**

The aim of Experiment 1b was to replicate the results of Experiment 1a on a subject population with a different cultural background and language. Because the shortened version of the published Georgian translation of Edgar Allan Poe's detective story was used in Experiment 1a, it was possible to conduct an almost identical study on subjects whose native language was English using a shortened version of the original English text.

*Subjects*

Sixty native English speakers (undergraduates from various courses at the University of Wales College of Cardiff, UK, aged 18–30) were randomly assigned to one of the three experimental groups. There were 20 subjects in each group. They were paid £2.50 (approximately $4) for participating in the study.

*Materials and procedure*

The to-be-read story in Experiment 1b also consisted of ten typed pages and the target word 'prefect' occurred twice on every page. The only difference between Georgian and English versions of this story was that in the latter the target word was more evenly distributed throughout the text so that, on average, it occurred once in every 155 words (range 152–159).

The experimental procedure in Experiment 1b was almost identical to that of Experiment 1a except some minor changes to the instructions.[3] For example, in Experiment 1a instructions given to Group 1 differed noticeably in length and contents from those given to Groups 2 and 3. One can argue that the differences obtained between Groups 1 and 2, if any, could be attributed to these differences in

[3]In addition, due to experimenter error, the self-report measures obtained at the end of Experiment 1b were not available.

 

instructions rather than the operation of independent variable, i.e. whether prospective memory task was the main or extra task. In Experiment 1b instructions given to Group 1 were modified so as to diminish these differences. Specifically, after subjects were assigned to a prospective memory task they were also given standard instructions how to read the story which were identical to those given to Groups 2 and 3. Furthermore, instructions given to the subjects of Groups 1 and 2 in Experiment 1b specified that it was their ability to remember future intentions (and not memory in general) that was under investigation.

Finally, prospective memory instructions were slightly modified in Groups 3 to make it sound more plausible to British undergraduates. Thus, after the experimenter finished instructions about how to read the story she said:

> There was something I wanted to tell you ... Oh yes! I met my colleague this morning and she told me she had just tested some children with this text. It turned out to be quite difficult for them to understand the story, and especially one word was misleading, like 'the prefect'. The prefect of the Paris police is one of the main characters in the story, so it occurred to me that it would be better if you changed the word 'prefect' for 'detective' whenever you meet this word in the text.[4]

## RESULTS AND DISCUSSION

### Reading time and self-report measures

Since reading the story was a self-paced task, reading time (expressed in seconds) was initially entered as a dependent variable into a $2 \times 3$ ANOVA with type of *experiment* (Experiment 1a versus Experiment 1b) and *instruction* (Group 1 versus Group 2 versus Group 3) as-between subject variables. This analysis revealed a main effect of Experiment ($F(1,101) = 12.58$, $MSe = 17781.56$, $p < 0.001$) but no effect of Instruction ($F < 1$) or interaction between independent variables ($F = 1.78$). Overall, subjects of Experiment 1b took longer to read the story ($M_2 = 1122.81$) than those of Experiment 1a ($M_1 = 1031.12$), but there were no differences in this respect between the three groups of subjects ($M_1 = 1071.94$, $M_2 = 1063.29$ and $M_3 = 1095.66$ for Groups 1, 2 and 3, respectively). Moreover, post-experimental questioning of subjects in Experiment 1a showed that three experimental groups did not differ in rated difficulty of simultaneously performing the two tasks, and in levels of interest or absorption (see Table 1). Finally, and somewhat surprisingly, three groups did not also differ in their rated willingness to comply with the task of substituting the target word (largest $F = 1.24$). Taken together, these results indicate that obtained differences, if any, between subjects' prospective memory performance can be solely attributed to the operation of independent variable, i.e. the type of instruction received by subjects of Groups 1, 2 and 3.

It is also interesting to note that only four subjects out of 54 (7%) participating in Experiment 1a reported that they were constantly thinking about their intention while reading the text (two in Group 1 and two in Group 3); fourteen subjects (26%)

[4]It appears that this request seemed quite natural to British undergraduates as well, although for reasons that were different from those in Experiment 1a (cf. footnote 2). Indeed, subjects immediately agreed to comply with the request and quite a few even tried to explain the misleading character of the word 'prefect' by the existence of prefects in the British educational system.

 

Table 1. The mean ratings of task difficulty, interest, absorption and willingness to comply with a prospective memory task in three groups of subjects in Experiment 1a. All ratings were made on the four-point scales (see text for details)

| | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| Difficulty | **1.56** | **1.44** | **1.72** |
| | (0.51) | (0.51) | (0.57) |
| Interest | **2.50** | **2.50** | **2.67** |
| | (0.79) | (0.79) | (0.84) |
| Absorption | **2.82** | **2.69** | **2.81** |
| | (0.64) | (0.79) | (0.54) |
| Willingness | **3.29** | **2.87** | **3.03** |
| | (0.85) | (0.96) | (0.76) |

reported that they occasionally thought about their intention (eight in Group 1, two in Group 2 and four in Group 3), and thirty-six subjects (67%) reported remembering intention only when they encountered the target word (eight in Group 1, sixteen in Group 2 and twelve in Group 3).

## Prospective memory performance

*(a) Number of prospective memory errors*

In addition to serious errors or omissions, subjects of Experiments 1a and 1b committed both intermediate and slight errors. Omissions occurred when subjects completely forgot to make a substitution whereas in the case of slight and intermediate errors subjects recovered from their initial failure while reading or immediately after reading the target word. Since slight and intermediate errors differ only in the speed whereby subjects realize they have forgotten their intention they can be regarded as late responses and contrasted with omissions. However, it is obvious that both *omissions* and *late responses* are indicative of some sort of prospective memory forgetting – severe in the case of omissions and less severe (minor) in the case of late responses. Therefore, the number of times subjects committed any of these errors could be taken as an inverse index of their prospective remembering (for means see the bottom lines of the three panels of Table 2).

It is interesting to note that none of the 54 subjects of Experiment 1a forgot to substitute the target word on all twenty occasions; 13% of subjects (three in Group 1, three in Group 2 and one in Group 3) remembered on all twenty trials, 46% (twelve, eight and five subjects in Groups 1, 2 and 3, respectively) forgot their intention on one to three occasions ($M = 2.12$, $\mathrm{SD} = 0.73$), 22% (three, five and four subjects in Groups 1, 2 and 3, respectively) forgot on four to six occasions ($M = 5.25$, $\mathrm{SD} = 0.62$), and 19% (two and eight subjects in Groups 2 and 3, respectively) on seven or more occasions ($M = 9.00$, $\mathrm{SD} = 2.11$). Similar percentages were obtained also in Experiment 1b (see Table 3).

In order to see if there was any difference in prospective memory performance across the two experiments the total number of prospective memory failures (i.e. omissions + late responses) was entered into a 2 (Experiment 1a versus Experiment 1b) × 3 (Group 1 versus Groups 2 versus Group 3) between-subject ANOVA as a dependent variable. Although this analysis revealed a highly significant effect of instruction ($F(2,108) = 14.78$, $MSe = 7.39$, $p < 0.0005$) there was no reliable effects of

 

Table 2. The mean number of late responses and omissions committed by three groups of subjects in Experiment 1a (upper panel) and Experiment 1b (middle panel). The lower panel represents the means obtained as a result of pooling the data of Experiments 1a and 1b. Standard deviations in parentheses

| | Experiment 1a | | |
|---|---|---|---|
| | Group 1 | Group 2 | Group 3 |
| Late response | 1.39 | 1.55 | 3.06 |
| | (1.50) | (1.79) | (1.76) |
| Omission | 0.78 | 2.00 | 2.67 |
| | (0.94) | (1.94) | (3.09) |
| Total | **2.17** | **3.55** | **5.73** |
| | (1.72) | (2.99) | (3.48) |
| | Experiment 1b | | |
| | Group 1 | Group 2 | Group 3 |
| Late response | 0.80 | 1.20 | 1.90 |
| | (0.70) | (1.15) | (1.59) |
| Omission | 0.95 | 1.95 | 3.05 |
| | (1.47) | (1.64) | (3.44) |
| Total | **1.75** | **3.15** | **4.95** |
| | (1.41) | (1.87) | (3.87) |
| | Pooled Data | | |
| | Group 1 | Group 2 | Group 3 |
| Late response | 1.08 | 1.37 | 2.45 |
| | (1.17) | (1.48) | (1.75) |
| Omission | 0.87 | 1.97 | 2.87 |
| | (1.23) | (1.76) | (3.24) |
| Total | **1.95** | **3.34** | **5.32** |
| | (1.56) | (2.44) | (3.66) |

either experiment ($F(1,108) = 1.09$, $p > 0.05$) or interaction between the experiment and instruction ($F < 1$).

The main effect of instruction indicates that three groups of subjects reliably differed in the number of prospective memory failures, and the difference between the groups was in a predicted direction. As one can see from the bottom line of the lower panel of Table 2, minimal forgetting occurred in Group 1 ($M = 1.95$), and maximum forgetting in Group 3 ($M = 5.32$). Moreover, planned comparisons showed that there were reliable differences between Groups 1 and 2, on the one hand ($F(1,108) = 4.99$, $p < 0.05$), and Groups 2 and 3, on the other ($F(1,108) = 10.09$, $p < 0.01$). The difference obtained between the data of Groups 1 and 2 indicates that an intention is more likely to be forgotten when it is an extra task rather than the main experimental task itself. On the other hand, the difference established between the means of Groups 2 and 3 indicates that the probability of remembering to perform this extra task is lower when subjects are unaware that their prospective memory is under study.

After conducting this initial analysis on the total number of errors it was decided to carry out more detailed analyses separately on omissions and late responses as dependent variables. Since prospective memory performance in Experiment 1a did not reliably differ from that of Experiment 1b it seemed reasonable to conduct these

 

Table 3. Number of subjects who performed at ceiling (0 prospective memory failures), committed 1 to 3, 4 to 6 and 7 or more errors in three groups of subjects in Experiment 1a (upper panel) and Experiment 1b (middle panel). The lower panel represents the data pooled across the two experiments

| | Experiment 1a | | | | |
|---|---|---|---|---|---|
| | **0** | **1–3** | **4–6** | **7 +** | |
| Group 1 | 3 | 12 | 3 | 0 | 18 |
| Group 2 | 3 | 8 | 5 | 2 | 18 |
| Group 3 | 1 | 5 | 4 | 8 | 18 |
| | 7 (13%) | 25 (46%) | 12 (22%) | 10 (19%) | 54 (100%) |
| | Experiment 1b | | | | |
| | **0** | **1–3** | **4–6** | **7 +** | |
| Group 1 | 2 | 16 | 2 | 0 | 20 |
| Group 2 | 2 | 8 | 10 | 0 | 20 |
| Group 3 | 0 | 9 | 6 | 5 | 20 |
| | 4 (7%) | 33 (55%) | 18 (30%) | 5 (8%) | 60 (100%) |
| | Pooled data | | | | |
| | **0** | **1–3** | **4–6** | **7 +** | |
| Group 1 | 5 | 28 | 5 | 0 | 38 |
| Group 2 | 5 | 16 | 15 | 2 | 38 |
| Group 3 | 1 | 14 | 10 | 13 | 38 |
| | 11 (10%) | 58 (51%) | 30 (26%) | 15 (13%) | 114 (100%) |

analyses on the data pooled across the two experiments. One additional variable of interest, apart from the type of instruction given to subjects, was their performance on first ten versus last ten trials. This comparison would show if there were any practice effects in performance, i.e. if subjects committed fewer late and serious errors while reading the second half (i.e. last five pages) of the story.

First, the number of late responses was entered into a 3 (type of instruction) $\times$ 2 (part of story) ANOVA with the repeated measures on the second factor. There was a main effect of instruction ($F(2,111) = 8.75$, $MSe = 1.10$, $p < 0.0005$). However, planned comparisons revealed no difference between Groups 1 and 2 ($F < 1$) but a highly reliable difference between Groups 2 and 3 ($F(1,111) = 10.07$, $p < 0.005$); subjects in Group 3 produced significantly more late responses than those in Group 2 ($M_3 = 1.22$ and $M_2 = 0.68$, respectively). Finally, there was no effect of part of the story or interaction between independent variables (both $F$s $< 1$).

A similar analysis conducted on the number of omissions also yielded a highly significant effect of instruction ($F(2,111) = 7.76$, $MSe = 2.52$, $p < 0.001$). This time, however, planned comparisons revealed a reliable difference between the means of Groups 1 and 2 ($F(1,111) = 4.82$, $p < 0.05$) but not between those of Groups 2 and 3 ($F(1,111) = 3.01$, $p < 0.09$); the means for Groups 1, 2 and 3 were $M_1 = 0.42$, $M_2 = 0.99$, and $M_3 = 1.43$, respectively. Overall, the results obtained by these planned comparisons suggest that the performance of subjects in Group 2 is apparently psychologically more similar to that of Group 3 than Group 1. Thus, Group 2 committed significantly more serious errors than Group 1 but the statistically reliable difference between Groups 2 and 3 was only in the number of late responses.

 

Finally, there was also a highly significant effect of part of the story ($F(1,111) = 7.54$, $MSe = 1.23$, $p < 0.01$). Overall, subjects committed more serious errors in the second half of the story ($M_2 = 1.15$) than in the first half ($M_1 = 0.75$). The absence of practice effects when subjects had to remember intention for twenty times in succession (approximately once in every 50 seconds) is rather striking. However, an observation of subjects' behaviour together with informal remarks made by some of them at the end of experiment suggested that subjects might have become more interested and involved in reading the second half of the story, after an unexpected twist in the plot on page 6. One could therefore explain the increase in the amount of omissions by these heightened levels of interest and absorption (cf. Kvavilashvili, 1987; Exp. 2).

Interestingly, this conjecture was supported by the data obtained from 14 independent raters (aged 18–32) who read this story aloud and rated their levels of interest and absorption at the end of each page on seven-point scales where 1 = not interesting/absorbed and 7 = very interesting/absorbed. The mean ratings of both interest and absorption were reliably higher in the second than the first half of the story (Multivariate $F = 6.93$, $p < 0.005$) ($M_1 = 4.23$, SD = 0.69, $M_2 = 5.36$, SD = 0.91 for Interest ratings, and $M_1 = 3.94$, SD = 1.00, $M_2 = 4.99$, SD = 1.32 for Absorption ratings in the first and second halves of the story, respectively).

*(b) Likelihood of remembering*

In addition to conducting analyses on the number of prospective memory errors it was also interesting to explore the conditional probabilities of remembering intention on trial *n* given that in a previous trial *n*-1 the subject either remembered intention on time (hit), committed a serious error (omission) or a late response. Indeed, it was interesting to see if the likelihood of remembering intention on trial *n* depended on the type of response given on previous trial and/or type of instruction.[5] To answer this question a three-factor hierarchical log-linear analysis was conducted on the frequency data (collapsed across the two experiments and individual subjects) presented in Table 4 with the following factors: response on trial *n* (remembered, forgot); type of response on trial *n*-1 (hit, late, omission), and instruction (Group 1, Group 2, Group 3).

This analysis revealed that the best-fitting model had the main effects of instruction ($\chi^2 = 67.67$, df = 2, $P < 0.0001$) and type of response on trial *n*-1 ($\chi^2 = 37.21$, df = 2, $p < 0.0001$), explaining a total of 96.59% of variance in responses in trial *n* (see Table 5). Thus, the remembering of intention in trial *n* occurred in 90.86% of cases out of 722 in Group 1 and only in 72.44% of cases in Group 3, a result that corroborates the findings of previous analyses on the number of prospective memory errors. In addition, the hits in trial *n*-1 were followed by remembering in trial *n* in 84.73% of cases, and late responses in 79.01% of cases, whereas omissions were followed by remembering in only 62.38% of cases. In order to see if the likelihood of remembering was similar for the trials preceded by hits and late responses, an additional three-factor hierarchical analysis was conducted in which the type of response in trial *n*-1 had only two levels (hit, late). The best model in this case had only a strong effect of instruction ($\chi^2 = 50.82$, df = 2, $P < 0.0001$) explaining 94.79% of variance. The effect of type of response in trial *n*-1 was not significant ($\chi^2 = 1.00$, df = 1, $P = 0.32$),

[5]I am grateful to an anonymous reviewer for posing this question.

 

Table 4. A three-way contingency table with the following factors: response in trial *n* (remembered, forgot), type of response in trial *n*-1 (hit, late, omission) and instruction (Group 1, Group 2, Group 3). Percentages in parentheses. The table represents those 722 trials in each group of subjects (collapsed across the two experiments and individual subjects) which could be followed either by prospective memory success (hit) or failure (either omission or late response) in a subsequent trial *n*

| Instruction | Type of response in trial *n*-1 | Remembering in trial *n* | Forgetting in trial *n* |
|---|---|---|---|
| Group 1 | Hit | 597 (91.30) | 57 (8.70) |
| | Late | 31 (86.10) | 5 (13.90) |
| | Omission | 28 (87.50) | 4 (12.5) |
| Group 2 | Hit | 512 (84.90) | 91 (15.10) |
| | Late | 36 (80.00) | 9 (20.00) |
| | Omission | 52 (70.30) | 22 (29.70) |
| Group 3 | Hit | 411 (76.50) | 126 (23.50) |
| | Late | 61 (75.30) | 20 (24.70) |
| | Omission | 51 (49.00) | 53 (51.00) |

Table 5. The results of the three-factor hierarchical log-linear analyses with the following factors: response in trial *n* (remembered, forgot), type of response in trial *n*-1 (hit, late, omission) and instruction (Group 1, Group 2, Group 3). The upper panel of the table shows the results of analysis in which the type of response in trial *n*-1 included all three levels (hit, late, omission). The lower panel represents the results of analysis in which this variable had only two levels (hit, late)

| Levels of type of response in trial *n*-1 | Effects | $\chi^2$ | % variation |
|---|---|---|---|
| Hit versus late versus omission | Instruction | 67.67 | 62.32 |
| | Type of resp. | 37.21 | 34.27 |
| | Residual | 3.70 | 3.41 |
| | Total | 108.58 | 100.00 |
| Hit versus late | Instruction | 50.18 | 94.79 |
| | Type of resp. | 1.00 | 1.89 |
| | Residual | 1.76 | 3.32 |
| | Total | 52.94 | 100.00 |

indicating that probability of remembering in trial *n* preceded by late response does not differ from the one preceded by hit.

### Internal consistency

Finally, pooled data were used to evaluate internal consistency of this new prospective memory task. It was interesting to see how consistent the subjects were in substituting the target word while reading the ten pages, and if there were any differences in this respect between the three groups of subjects. The number of prospective memory failures in the first five pages (i.e. on first ten targets) was correlated with the performance on the last five pages and then adjusted using the Spearman–Brown formula to obtain reliability for the whole test in Groups 1, 2 and 3. The obtained split-half reliabilities (based on $N = 38$) were $r_1 = 0.32$, $p < 0.05$; $r_2 = 0.41$, $p < 0.01$; and $r_3 = 0.66$, $p < 0.001$, respectively (two-tailed). Thus, not only did subjects of

 

Group 3 display the highest levels of forgetting they also were more consistent in forgetting their intention.[6]

## STUDY 2

The results of Study 1 indicate that substituting a target word while reading aloud a text can be regarded as a simple and convenient laboratory task for studying prospective remembering. Thus, the highest forgetting rate displayed by the subjects of Group 3 provides clear support for the initial hypothesis that the best way to study remembering intentions in laboratory is to introduce a prospective memory task to subjects as an extra task, in addition to the main experimental one, and to ensure that subjects are unaware that their prospective remembering is under study. Therefore, in Study 2, I used only instructions given to Group 3 in Study 1.

The aim of Study 2 was to further explore some characteristics of this newly developed method by studying the effects of (1) time delay (no delay versus delay) between prospective memory instructions and onset of background activity (i.e. reading the story) and (2) information (no information versus information) provided to subjects about the frequency of the target word in the story.

When Einstein and McDaniel introduced their paradigm in 1990 they suggested (relying on the results of their pilot study) that it is necessary to introduce an interval of up to 15 minutes between prospective memory instructions and the onset of the cover task to eliminate ceiling effects and produce sufficient forgetting in prospective memory performance. In most of their published studies these 15 minutes have usually been filled with various tasks, mostly retrospective tests of memory. However, when Einstein and his colleagues specifically tested the delays of various length such as 15 minutes versus 30 minutes (Einstein *et al*., 1992) or 4 minutes versus 20 minutes (Guynn *et al*., in press) no reliable effects of delay were obtained.

On the other hand, Brandimonte and Passolunghi (1994), using the Einstein and McDaniel paradigm, were able to observe a prospective memory impairment with a short 3-minute delay between prospective memory instructions and the onset of the cover task. Brandimonte and Passolunghi tried to explain these discrepant results by suggesting that prospective memory forgetting may be occurring only during the first few minutes after encoding the intention 'whereas no effect of delay may be found later on' (p. 572). The aim of Study 2 was to see if the detrimental effect of a short delay observed by Brandimonte and Passolunghi could also be obtained with a word-substitution task developed in Study 1 of the present investigation.

Another feature of the Einstein and McDaniel paradigm is that subjects are never explicitly told how many target words they will encounter in the course of the cover task (Brandimonte and Passolunghi, 1994; Ellis and Milne, 1996; McDaniel and Einstein, 1993; see also Maylor, 1993). It is assumed that providing subjects with such information may increase their monitoring behaviour (i.e. conscious thinking about a prospective memory task) which may result in ceiling effects in their prospective memory performance. Therefore, in Study 2, I also wanted to check how crucial it is to conceal the frequency information from subjects.

[6]It should be noted, however, that $r_3$ was reliably higher than $r_1$ ($z = 1.92$, $p < 0.03$) but only marginally higher than $r_2$ ($z = 1.49$, $p < 0.07$). The difference between $r_1$ and $r_2$ was not statistically reliable ($z = 0.43$, $p > 0.05$; all tests one-tailed).

 

In order to study the effects of time delay and of information about target frequency, half of the subjects started to read the story immediately after receiving prospective memory instructions and the other half only after they completed a filler task which, on average, lasted about 5 minutes. Moreover, half of the subjects in each of these conditions did not receive any information about the frequency of occurrence of the target word, whereas the other half was warned that it would occur twice on every page.

### Subjects and design

Design was a 2 (no delay/delay) × 2 (no information/information) factorial. Sixty native-English speakers (undergraduates from various departments at the University of Wales College of Cardiff, UK, aged 18–36) were randomly assigned to the following experimental conditions: delay/no information, delay/information, and no delay/information. The no delay/no information condition consisted of the subjects from Group 3 of Experiment 1b (Study 1) as they had started to read the story immediately after receiving prospective memory instructions (no delay), and did not receive any information about the frequency of target occurrence (no information). There were twenty subjects in each of the four experimental conditions. Subjects were tested individually and were paid £2.50 (approximately $4) for their participation.

### Materials and procedures

These were identical to those used in Experiment 1b for Group 3 (no delay/no information) except that in conditions with information about target frequency the experimenter, immediately after introducing a prospective memory task, additionally informed a subject that she had been looking through the story and had discovered that the word 'prefect' occurred twice on every page. Moreover, in the conditions with a delay the experimenter, prior to switching on the tape-recorder, pretended to discover that she had run out of empty cassettes and therefore had to leave the room in order to fetch a new supply. She then suggested that while she was away, in order to save time, the subject could actually complete a task that the experimenter wanted him or her to do at the end of the experiment. This task was introduced to the subject as part of another study and involved rating 60 male faces (one face on every page of a booklet) for their distinctiveness on a seven-point scale. When the subject started to work on this task, the experimenter surreptitiously switched on a stopwatch, left the room and returned in exactly 3 minutes. None of the subjects had finished the task by that time. On average, it took 300 seconds (SD = 65.20), i.e. 5 minutes, to complete this task. As soon as the subject had finished the task, the experimenter switched on the tape-recorder and the subject started to read the story. When they finished reading, the experimenter gave them an unexpected comprehension test: subjects had to answer three questions which were crucial for understanding the plot of the story. By applying a special scoring system to subjects' responses it was possible to obtain comprehension scores for each subject (range 0–9).[7]

[7]Details of these questions and scoring system can be obtained from the author upon request.

 

Table 6. The mean number of prospective memory failures (late responses and serious errors or omissions) as a function of delay between prospective memory instructions and onset of background activity (no delay versus delay) and information provided to subjects about the frequency of the target word (no information versus information). Standard deviations in parentheses

| | No delay | | Delay | |
|---|---|---|---|---|
| | No information | Information | No information | Information |
| Late | 1.90 | 1.55 | 2.25 | 2.30 |
| | (1.59) | (1.23) | (1.55) | (2.16) |
| Serious | 3.05 | 1.50 | 3.10 | 3.05 |
| | (3.44) | (2.35) | (3.04) | (2.96) |
| Total | **4.95** | **3.05** | **5.35** | **5.35** |
| | (3.87) | (3.30) | (3.23) | (4.09) |

## RESULTS AND DISCUSSION

### Prospective memory performance

Initially, the number of prospective memory failures (see the bottom line of Table 6) was entered into a 2 (no delay/delay) × 2 (no information/information) ANOVA as a dependent variable. Although subjects in the no delay condition tended to commit fewer prospective memory errors ($M = 4.00$) than those in delay condition ($M = 5.35$), this effect did not reach an acceptable level of significance ($F(1,76) = 2.75$, $MSe = 13.28$, $p = 0.10$). Moreover, when a 2 (delay) × 2 (information) × 2 (part of story) mixed ANOVA with the repeated measures on the last factor was conducted separately for late responses and serious errors, no reliable effects of either delay or information were obtained. The only reliable effect revealed by these analyses was the main effect of part of the story for omissions as the dependent variable ($F(1,76) = 10.72$, $MSe = 1.23$, $p < 0.005$). The number of omissions tended to increase in the second part of the story ($M_1 = 1.05$ and $M_2 = 1.65$, respectively) and, in line with the results of Study 1, no such effect was observed for late responses.

### Correlations between reading time, comprehension and prospective memory errors

Since there were no main effects of delay and information it was possible to pool the data across all four groups of subjects ($N = 80$) when calculating correlations between the number of prospective memory failures, comprehension scores and the time it took subjects to read the story aloud. Correlations between reading time and comprehension scores, on the one hand, and reading time and prospective memory failures (either late responses or omissions) were not significant. There was, however, a weak but reliable negative correlation between the comprehension scores and a number of omissions ($r = -0.230$, $p < 0.05$, two-tailed). Subjects with higher comprehension scores tended to commit fewer serious errors than those with lower comprehension scores. Apparently, those who understood the gist of the story easily had more cognitive resources available for executing an additional task while reading the story.

 

## GENERAL DISCUSSION

A considerable amount of prospective memory failures that occurred in Group 3 in Experiments 1a and 1b of Study 1 clearly indicates that a simple and convenient laboratory method has been developed. Indeed, the method enables investigators to (1) obtain highly reliable and consistent measures of subjects' prospective memory performance within one relatively short experimental session that can be easily conducted both inside and outside the laboratory (e.g. subject's home); (2) avoid the practice, ceiling and floor effects in performance; and (3) monitor late responses together with complete omissions.

However, before discussing some of the characteristics of this method and the results that were obtained with it, it is first necessary to answer two important questions. The first refers to the face validity of the task. One may question whether an extra task of substituting the target word while reading the story aloud is really a memory task and not some modification of either dual-task or vigilance paradigms. Second, if it is a memory task then it is necessary to find out whether it captures adequately the phenomenon of prospective remembering as it usually occurs in people's everyday life.

It is interesting that subjects seemed to perceive this word-substitution task as a memory task as soon as they received prospective memory instructions. Thus, quite a few subjects in response to the experimenter's request to substitute 'detective' for the target 'prefect' replied spontaneously: 'OK, I'll do it if I remember'. If this task was perceived as a kind of sustained attention or vigilance task then instead of 'if I remember' subjects should have said 'if I notice this word'. Furthermore, if subjects in Experiment 1a were dealing with a classical dual-activity task then the mean ratings of perceived difficulty of substituting the words while reading the text aloud would have been much higher than those presented in Table 1.

These observations seem to speak in favour of the assumption that one is not dealing here with either dual-task or vigilance paradigms (cf. Brandimonte and Passolunghi, 1994; Maylor, 1996; Park *et al.*, 1997). Indeed, while in the former subjects attempt to conduct two different continuous tasks simultaneously that is often associated with a great deal of effort and subjective feeling of difficulty (see Einstein *et al.*, 1995, Exp. 3), in the latter subjects engage in only one continuous activity, that is, in a continuous watch for some target stimulus. Also, if they fail to respond to a particular target stimulus, that is not due to forgetting to do so but simply because they did not notice it in the first place. It is obvious that both of these tasks are quite different from a prospective memory task in which subjects are engaged in some continuous activity (e.g. reading a story aloud), and have to remember to stop themselves only intermittently in order to carry out some extra action (e.g. saying 'detective' instead of 'prefect').[8]

[8]It is also important to note that the failures to substitute the requested word with the target revealed in the present study were not so-called absent-minded errors or action slips (see Heckhausen and Beckman, 1990; Norman, 1981; Reason, 1979). The latter describe failures that occur during the execution or performance of the intended action and usually imply that a person carries out an unintended action instead of the intended one that has been remembered on time. Prospective memory errors, in contrast, take the form of a failure to retrieve an intended action at an appropriate moment (for further discussion see Cohen, 1989; Cockburn, 1996; Kvavilashvili and Ellis, 1996). Thus, if subjects did not read 'detective' when they saw the target word 'prefect' that means they did not retrieve an intended action at an appropriate moment. If, however, they remembered about the necessity to make a substitution but said the unintended 'defective' instead of the intended 'detective', then this would have been an example of absent-minded error or action slip. Incidentally, this particular action slip did indeed occur in Experiment 1b and Study 2 but only in a very few trials (on four and five occasions, respectively).

 

It is interesting that subjects' self-reports obtained at the end of Experiment 1a appear to be in agreement with an everyday observation that intention can be remembered even without constantly keeping it in mind during an intervening period (Freud, 1901/1960). Indeed, the majority of subjects (67%) reported that once they started to read the story they did not think about their intention to substitute the words. However, when an appropriate time arrived, i.e. when they noticed the target word, this intention suddenly occurred to them without any conscious effort on their part.

Furthermore, the word-substitution task appears to capture everyday prospective remembering also in that it enables us to reveal and reliably measure late responses in addition to serious errors. Thus, the majority of subjects tested within the Einstein and McDaniel paradigm have been reported to respond to a target word either immediately or not at all (omissions). Late responses are very rare and, if they do occur, they are counted as successful or on-time responses (see e.g. Einstein *et al*., 1992, 1995; Ellis and Milne, 1996). In the present study, however, late responses occur relatively often, especially in Group 3 (see Table 2), and they are distinguished from on-time responses (cf. Ellis, Kvavilashvili and Milne, 1997).

One crucial feature of the present method that may be responsible for eliciting increased number of late responses is that subjects are asked to remember to make a substitution rather than perform some extra action in response to a target word as is the case in the Einstein and McDaniel paradigm. One possible avenue for future research is therefore to investigate the effects of type of task (substitution versus additional action) on the number of prospective memory failures, particularly on late responses (cf. Ellis, 1996; Ellis and Milne, 1994). For example, subjects in the additional action condition could be asked to say 'detective' every time they have read 'prefect', instead of substituting the former for the latter.

Finally, the word-substitution task appears to imitate more closely people's prospective memory performance on repeated occasions in everyday life. Thus, unlike the Einstein and McDaniel paradigm, none of the subjects in the present study forgot on all twenty occasions, some performed at ceiling but the majority displayed a fair amount of variability in their performance (see Table 3).

It is important to note that the task of substituting a target word while reading aloud a story for certain purposes appears to be suitable for studying a wide range of problems. The present study, for example, investigated the effects of several variables that have both methodological and theoretical importance for future research on remembering intentions. Moreover, the results obtained with this method seem to have high generalizability: prospective memory performance did not reliably differ across the two experiments of Study 1 despite some differences in instructions and, more importantly, differences in languages and the cultural–political backgrounds of the participants.

The aim of Study 1 was to develop an optimal version of this new method by manipulating the type of prospective memory task (main versus extra) and subjects' awareness (aware versus not aware) that their prospective memory performance was under investigation. The significant difference that was obtained between the data of Groups 1 and 2 indicates that subjects are more likely to forget to perform some extra task than the one that constitutes the main experimental task. This finding seems to corroborate an everyday observation that intentions which constitute a sole purpose of a certain activity are less likely to be forgotten than intentions that are additionally incorporated into this activity. For example, if you go out in order to post a letter it is

 

less likely that you forget to do so even if there are a number of distractions on your way (like running into a friend in the street, seeing interesting shop windows, etc.). One could refer to this case as a single-activity prospective memory task because there is a single activity (going out) and a single goal (posting a letter). If, however, you decide to post the letter on your way to the library, then it is more likely that the letter remains unposted. One could call this dual-activity prospective memory task since there is one activity (going to the library) and two goals (returning the book and posting the letter).

These terms (i.e. single- and dual-activity tasks) were introduced by Harris (1984) more than a decade ago in his seminal review paper. Although the distinction between single- and dual-activity tasks seems to be quite important and has been widely cited by different authors it has never been subjected to empirical testing. The results of the present study (i.e. differences obtained between subjects' prospective memory performance in Groups 1 and 2), however, appear to speak in favour of this distinction. Indeed, subjects in Group 1 had to read the story aloud in order to make a correct substitution of the target word. Therefore, they were presented with a single-activity task as there was only one activity (reading the story aloud) and one goal (substituting the words). As to the subjects of Group 2, they had to read the story aloud in order to provide the necessary material for future experiments and, additionally, had to make a correct substitution every time they found a target word in the story. Therefore, they were presented with a dual-activity task since there was one activity (reading a story aloud) but two goals (acting as a narrator and substituting the words).

A significant difference that was obtained between the data of Groups 2 and 3 indicates, on the other hand, that subjects' awareness that their prospective memory is under investigation influences their performance. Thus, subjects who are unaware of the real purpose of the experiment tend to commit more prospective memory failures than those who know that their prospective memory is under study. However, the results of planned comparisons conducted on omissions and late responses indicate that type of task (main versus extra) and subjects' awareness have differential effects on prospective remembering in the word-substitution task: the former appears to affect serious errors and the latter late responses only. Since late responses are delayed but still successful responses one can conclude that subjects' awareness is a less influential factor than type of task. Thus, the subjects in Group 2 committed significantly more omissions than those in Group 1 but the difference between Groups 2 and 3 did not reach an accepted level of statistical significance.

In addition to the type of task and subjects' awareness, Study 2 of the present investigation also explored the effects of (1) a short 5-minute delay introduced between prospective memory instructions and onset of background activity and (2) additional information provided to the subjects on the frequency of the target word in the text (twice per page). Interestingly, these variables failed to produce reliable effects on subjects' prospective memory performance. Although negative, these findings have both theoretical as well as practical implications for prospective memory research.

First, the results of Studies 1 and 2 indicate that ceiling effects can be avoided even without any delay between prospective memory instructions and background activity (for similar results see also Brandimonte and Passolunghi, 1994, Exps. 3 and 4), thus casting some doubt on the idea suggested by Einstein and McDaniel (1990) that introducing an extended delay between prospective memory instructions and the cover task should be a crucial feature of laboratory methods of prospective remembering. Second, the results of Study 2 also show that introducing a short delay does not further

 

enhance the levels of prospective memory forgetting in a word-substitution task. This finding contradicts those obtained by Brandimonte and Passolunghi (1994) and, thus, does not seem to support their suggestion that prospective memory forgetting may be occurring only during the first few minutes after the encoding of intention. Clearly, however, further research is necessary to investigate the effects of short delays on prospective memory. Finally, the lack of any effect of knowledge about the target frequency indicates that even if subjects happen to learn accidentally about the target frequency when encoding their intention this knowledge is not going to have a major impact on their prospective memory performance.

An extra task of substituting a target word while reading aloud a story for other purposes (like acting as a narrator, for example) not only affords to investigate a variety of interesting problems (see Ellis *et al*., 1997; Ellis, Kvavilashvili and Milne, 1996), but it may also become a useful tool for testing prospective remembering in almost all age groups (except for those who cannot read) and, to some extent, in a clinical context as well. This task is very flexible and it can be modified in a variety of ways. In fact, the choice of a to-be-read text and a target word or words will be dependent entirely on an experimenter and the purposes of a given study. For example, testing time can be reduced substantially without seriously undermining the reliability of the test by cutting down the number of to-be-read pages from ten to five (see Ellis *et al*., 1996).

It is not anticipated that the method developed in the present study will replace the paradigms and methods successfully employed by other researchers (Einstein and McDaniel, 1990; Ellis and Milne, 1996; Cockburn and Smith, 1988; Mäntylä, 1993; Maylor, 1993; Park *et al*., 1997). What is needed at the present stage of prospective memory research is a set of well-developed methods and tasks which would enable the students of memory to choose the ones that are particularly suitable for studying their specific problems and issues. Therefore, testing and developing new prospective memory tasks should be beneficial for further development of prospective memory research, especially if these tasks yield converging results in future (see Ellis *et al*., 1996, 1997).

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## REFERENCES

Brandimonte, M., Einstein, G. O. and McDaniel, M. A. (Eds) (1996). *Prospective memory: Theory and applications*. Mahwah, NJ: LEA.

 

Brandimonte, M. A. and Passolunghi, M. C. (1994). The effect of cue familiarity, cue-distinctiveness, and retention interval on prospective remembering. *The Quarterly Journal of Experimental Psychology*, **47A**, 565–588.

Cockburn, J. (1996). Assessment and treatment of prospective memory deficits. In M. Brandimonte, G. O. Einstein and M. A. McDaniel (Eds), *Prospective memory: Theory and applications* (pp. 327–350). Mahwah, NJ: LEA.

Cockburn, J. and Smith, P. T. (1988). Effects of age and intelligence on everyday memory tasks. In M. M. Gruneberg, P. E. Morris and R. N. Sykes (Eds), *Practical aspects of memory: Current research and issues* Vol. 2 (pp. 132–136). Chichester: Wiley.

Cohen, G. (1989). *Memory in the real world*. Hove and London: LEA.

Craik, F. I. M. (1986). A functional account of age differences in memory. In F. Klix and H. Hagendorf (Eds), *Human memory and cognitive capabilities: Mechanisms and performances* (pp. 409–422). Amsterdam: Elsevier Science Publishers.

Crovitz, H. F. and Daniel, W. F. (1984). Measurements of everyday memory: toward the prevention of forgetting. *Bulletin of the Psychonomic Society*, **22**, 413–414.

Crowder, R. (1996). The trouble with prospective memory: A provocation. In M. Brandimonte, G. O. Einstein and McDaniel M. A. (Eds), *Prospective memory: Theory and applications* (pp. 143–148). Mahwah, NJ: LEA.

Dobbs, A. R. and Reeves, M. B. (1996). Prospective memory: More than memory. In M. Brandimonte, G. O. Einstein and M. A. McDaniel (Eds), *Prospective memory: Theory and applications* (pp. 199–225). Mahwah, NJ: LEA.

Einstein, G. O. and McDaniel, M. A. (1990). Normal aging and prospective memory. *Journal of Experimental Psychology: Learning, Memory and Cognition*, **16**, 717–726.

Einstein, G. O. and M. A. McDaniel (1996). Retrieval processes in prospective memory: Theoretical approaches and some new empirical findings. In M. Brandimonte, G. Einstein and M. McDaniel (Eds), *Prospective memory: Theory and applications* (pp. 115–142). Mahwah, NJ: LEA.

Einstein, G. O., Holland, L. J., McDaniel, M. A. and Guynn, M. J. (1992). Age-related deficits in prospective memory: The influence of task complexity. *Psychology and Aging*, **7**, 471–478.

Einstein, G. O., McDaniel, M. A., Richardson, S. L., Guynn, M. J. and Cunfer, A. R. (1995). Aging and prospective memory: Examining the influences of self-initiated retrieval. *Journal of Experimental Psychology: Learning, Memory and Cognition*, **21**, 996–1007.

Ellis, J. A. (1988). Memory for future intentions: Investigating pulses and steps. In M. M. Gruneberg, P. E. Morris and R. N. Sykes (Eds), *Practical aspects of memory: Current research and issues* Vol. 1 (pp. 371–376). Chichester: Wiley.

Ellis, J. A. (1996). Prospective memory and the realization of delayed intentions: A conceptual framework for research. In M. Brandimonte, G. Einstein and M. A. McDaniel (Eds), *Prospective memory: Theory and applications* (pp. 1–23). Mahwah, NJ: LEA.

Ellis, J. A., Kvavilashvili, L. and Milne, A. (1996, July). Individual differences in delayed intention performance. Paper presented at the 2nd International Conference on Memory, University of Padova, Italy.

Ellis, J. A., Kvavilashvili, L. and Milne, A. (1997). Experimental tests of prospective remembering: The influence of intention frequency and delay on performance. Manuscript submitted for publication.

Ellis, J. A. and Milne, A. B. (1996). Retrieval cue specificity and the realization of delayed intentions. *The Quarterly Journal of Experimental Psychology*, **49A**, 862–887.

Ellis, J. A. and Milne, A. (1994, August). Prospective memory actions and concurrent activity. Paper presented at the 3rd Practical Aspects of Memory Conference, University of Maryland, USA.

Freud, S. (1960). *The psychopathology of everyday life*. In J. Strachey (Ed.), The standard edition of the complete psychological works of Sigmund Freud (Vol. 6), London: The Hogarth Press. (Originally published in 1901.)

Guynn, M. J., McDaniel, M. A. and Einstein, G. O. (in press). Prospective memory: When reminders fail. *Memory & Cognition*.

Harris, J. E. (1984). Remembering to do things: A forgotten topic. In J. E. Harris &

 

P. E. Morris (Eds), *Everyday memory, actions and absent-mindedness* (pp. 71–92). London: Academic Press.
Harris, J. E. and Wilkins, A. J. (1982). Remembering to do things: A theoretical framework and an illustrative experiment. *Human Learning*, **1**, 123–136.
Heckhausen, H. and Beckman, J. (1990). Intentional action and action slips. *Psychological Review*, **97**, 36–48.
Kvavilashvili, L. (1987). Remembering intention as a distinct form of memory. *British Journal of Psychology*, **78**, 507–518.
Kvavilashvili, L. (1992). Remembering intentions: A critical review of existing experimental paradigms. *Applied Cognitive Psychology*, **6**, 507–524.
Kvavilashvili, L. and Ellis, J. A. (1996). Variety of intentions: Some distinctions and classifications. In M. Brandimonte, G. O. Einstein and M. A. McDaniel (Eds), *Prospective memory: Theory and applications* (pp. 23–52), Mahwah, NJ: LEA.
Levy, R. L. and Loftus, G. R. (1984). Compliance and memory. In J. E. Harris and P. E. Morris (Eds), *Everyday memory, actions and absent-mindedness* (pp. 93–112). London: Academic Press.
Loftus, E. (1971). Memory for intentions: The effect of presence of a cue and interpolated activity. *Psychonomic Science*, **23**, 315–316.
Mäntylä, T. (1993). Priming effects in prospective memory. *Memory*, **1**, 203–218.
Mateer, C. A., Sohlberg, M. M. and Crinean, J. (1987). Perceptions of memory functions in individuals with closed head injury. *Journal of Head Trauma Rehabilitation*, **2**, 74–84.
Maylor, E. (1993). Aging and forgetting in prospective and retrospective memory tasks. *Psychology and Aging*, **3**, 420–428.
Maylor, E. (1996). Does prospective memory decline with age? In M. Brandimonte, G. Einstein and M. A. McDaniel (Eds), *Prospective memory: Theory and applications* (pp. 173–198). Mahwah, NJ: LEA.
McDaniel, M. A. (1995). Prospective memory: Progress and processes. In D. L. Medin (Ed.), *The psychology of learning and motivation* Vol. 33 (pp. 191–221). San Diego: Academic Press.
McDaniel, M. A. and Einstein, G. O. (1993). The importance of cue familiarity and cue distinctiveness in prospective memory. *Memory*, **1**, 23–41.
Meacham, J. A. (1982). A note on remembering to execute planned actions. *Journal of Applied Developmental Psychology*, **3**, 121–133.
Meacham, J. A. and Leiman, B. (1982). Remembering to perform future actions. In U. Neisser (Ed.), *Memory observed* (pp. 327–336). San Francisco: W. H. Freeman.
Morris, P. E. (1984). The validity of subjective reports on memory. In J. E. Harris and P. E. Morris (Eds), *Everyday memory, actions and absent-mindedness*. London: Academic Press.
Norman, D. A. (1981). Categorization of action slips. *Psychological Review*, **88**, 1–15.
Park, D. C., Hertzog, C., Kidder, D. P., Morrell, R. W. and Mayhorn, C. B. (1997). Effect of age on event-based and time-based prospective memory. *Psychology and Aging*, **12**, 314–327.
Reason, J. T. (1979). Actions not as planned: The price of automatisation. In G. Underwood and R. Stevens (Eds), *Aspects of consciousness*, Vol. 1 (pp. 67–90). London: Academic Press.
Terry, W. S. (1988). Everyday forgetting: Data from a diary study. *Psychological Reports*, **62**, 299–303.
West, R. L. (1988). Prospective memory and aging. In M. M. Gruneberg, P. E. Morris and R. N. Sykes (Eds), *Practical aspects of memory: Current research and issues*, Vol. 2 (pp. 119–125). Chichester: Wiley.
Wilkins, A. J. (1986). Remembering to do things in the laboratory and everyday life. *Acta Neurologica Scandinavica*, **74** (supp. 109), 109–112.
Winograd, E. (1988). Some observations on prospective remembering. In M. M. Gruneberg, P. E. Morris and R. N. Sykes (Eds), *Practical aspects of memory: Current research and issues*, Vol. 1 (pp. 348–353). Chichester: Wiley.

 