Psychol Res (1997) 60: 192–199

ORIGINAL ARTICLE

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Interrupting intentions: Zeigarnik-like effects in prospective memory

Received: 2 May 1996 / Accepted: 4 November 1996

Abstract In two experiments, we examined the effects of task interruption on memory for intentions. Participants studied a series of anagrams, of which they solved one-half (Exp. 1) or two-thirds (Exp. 2), whereas the solution of the remaining items was interrupted by the experimenter. Furthermore, four anagrams (prospective cue items) differed from the remaining anagrams in that the third letter of each item was underlined. Participants were instructed to decide whether a subsequently presented (target) anagram contained the same or a different third letter as the underlined letter of the cue item. The results of both experiments showed Zeigarnik-like effects in prospective memory, so that cue items that were associated with interruption in the anagram task were better reminders than were items that were associated with completion. These findings suggest that interruption of an ongoing activity facilitates subsequent prospective memory performance, possibly by increasing the level of activation of the underlying intention representation that, in turn, increases the individual's sensitivity to identify the target event.

Introduction

Although few would deny the importance of both encoding and retrieval processes for successful episodic remembering, research on prospective memory has primarily focused on retrieval-related factors. For example, several studies have examined the types of memory aids people use in (everyday) prospective memory tasks (e.g., Harris, 1980; Harris & Wilkins, 1982; Intons-Peterson & Fournier, 1986; Maylor, 1990; Meacham & Colombo, 1980; Meacham & Singer, 1977), and more recent studies have examined the effectiveness of different types of reminders for triggering a planned action (e.g., Brandimonte & Passolunghi, 1994; Einstein & McDaniel, 1990; Ellis & Milne, 1992; Kvavilashvili, 1987; Mäntylä, 1993; McDaniel & Einstein, 1993).

In contrast, there is very little published research in which prospective remembering has been examined in relation to encoding-related factors. This lack of relevant research is somewhat surprising, considering that the spontaneous characteristic of prospective memory has been emphasized in the literature. For example, Einstein and McDaniel (1990; Einstein, Holland, McDaniel, & Guynn, 1992; McDaniel & Einstein, 1992) considered prospective memory as composed of processes that are both similar to and different from those of a standard retrospective memory task. Based on their componential analyses, McDaniel and Einstein (1992) stated that "the unique feature of a prospective memory task is that the memory must be spontaneously or automatically activated at the appropriate time; there is (usually) no request for remembering the designated time, as in retrospective memory tasks" (p. 100).

The point of departure of the present study was the notion that prospective memory is not only guided by externally- and/or internally-provided retrieval aids (referred to as the *cue-dependent component* of prospective memory), but that processes related to the formation of future intentions (referred to as the *trace-dependent component*) also contribute to optimal prospective remembering (see also Mäntylä, 1995). To illustrate this notion, assume that a person is making shopping plans and she or he has planned to buy tea and other items. Subsequently, whether the person remembers to buy tea may be cue-dependent, in that successful performance is determined by the properties of the cue event per se (e.g., distinctiveness, familiarity, and complexity). According to one view of prospective memory, target events that are in some sense salient are more efficient reminders of the planned action than are non-salient target events

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(McDaniel & Einstein, 1993). Thus, the person remembers to buy tea not because this intention is sustained in the memory, but because, for example, a distinctive package catches his or her attention, and thereby reminds the person that "something" should be purchased (cf., tying a string around one's finger, or a knot in a handkerchief). However, memory for intentions may also be trace-dependent in the sense that operations related to intention formation (and subsequent task monitoring) facilitate prospective remembering by modifying the underlying intention representation. Thus, the fact that the person made shopping plans changed the structure and/or activation level of the "grocery" representation that, in turn, increased his or her sensitivity to recognize the target item as a functional cue for the planned action.

Although there is very little published research examining the effects of encoding on prospective remembering (but see Goschke & Kuhl, 1993; Koriat, Benzur, & Nussbaum, 1990; Mäntylä, 1993), the basic idea underlying the trace-dependent notion outlined above is rather similar to that formulated by Lewin nearly 70 years ago. Apart from Freud (1901), Lewin (1926/1961) was presumably the first psychologist who considered "the influence of time on the effect of intention", (which was the subtitle of his classic paper "Intention, will, and need" (p. 1234). According to Lewin, a central question is "how does the act of intending bring about the subsequent action, particularly in those cases in which the consummatory action does not follow immediately the act of intending. (...) What are the further characteristics of this after-effect of the act of intending" (pp. 1234–1235). Lewin argued and this "after-effect of intention" is a force, or a "goal tension" that produces a "quasi-need" to carry out the planned action. Lewin stated that the clearest subjective experience of this force occurs in the resumption of interrupted tasks, "when after completing the interrupting activity, a general pressure – that 'there is something I should do – appears" (p. 1251).

Zeigarnik, Lewin's student in his Berlin laboratory, examined the memorial consequences of interrupting actions. Zeigarnik (1927; see also Ovsiankina, 1928) presented participants with a series of concrete tasks, such as threading beads or drawing a vase. Participants were allowed to complete one half of the tasks, whereas the remaining tasks, interspersed throughout the series, were interrupted by the experimenter before participants could complete them. Immediately after the completion of the series, participants were given a free recall test in which they were asked to recall the names of the tasks. The result of the study showed that the participants consistently recalled more of the interrupted than completed tasks (see van Bergen, 1968; Butterfield, 1964, for reviews).

Although Lewin (1926/1961) was one of the first psychologists who discussed prospective remembering in everyday life, it should be noted that the Zeigarnik effects deals with *retrospective* remembering. That is, participants are presented a series of tasks, of which some are completed and others interrupted, and following the study phase, participants are given explicit instructions to recall the names of the tasks. Thus, somewhat paradoxically, although Lewin was the first psychologist who studied memory for intentions, including the pioneering experimental work of his student, Birenbaum (1930), and although Lewin and his collaborators used the task-interruption paradigm in the context of retrospective memory, there are no reported studies in which the Zeigarnik effect has been used to examine the mechanisms of prospective remembering.

Following the reasoning outlined above, the main objective of this study was to examine Zeigarnik-like effects in prospective memory, the general idea being that task interruption may facilitate retrieval also in the absence of explicit agents that prompt the execution of planned actions. In other words, to the extent that task interruption facilitates prospective remembering, interrupted intentions (i.e., tasks that are associated with a prospective memory instruction) may produce better performance than completed intentions do. It should also be noted that out primary goal was to examine the Zeigarnik-effect in the context of prospective memory rather than testing the validity of Lewin's (1926/1961) "goal-tension" notion of the phenomenon. Thus, considering that research on prospective memory is at an early stage and that the mechanisms underlying the Zeigarnik-effect are not well understood (see van Bergen, 1968; Butterfield, 1964, for reviews), the orientation of this study was empirical, with the idea that once the phenomenon has been extended to the prospective temporal dimension of episodic remembering, it can serve as a point of departure for more detailed theoretical analyses.

To examine Zeigarnik-like effects in prospective memory, we presented participants with a series of anagrams, each item having a two-digit random number printed on the upper corner of the response sheet. Furthermore, four anagrams (cue items) differed from the remaining items in that the third letter of each item was underlined. Participants were instructed that, in addition to the anagram task, they should decide whether a subsequent (target) anagram contained the same or a different third letter as the underlined letter of the cue item. The identity of each target item was determined by the two-digit number printed on the response sheet of the underlined cue item. Participants solved half of the anagrams in Exp. 1, whereas the solutions of the remaining items were interrupted by the experimenter. In Exp. 2, we manipulated the ratio of interrupted to completed items, so that one group of subjects solved two-thirds of the anagrams, whereas another group solved only one-third and the solutions of the remaining two-thirds were interrupted by the experimenter. In both experiments, one-half of the prospective cue items were completed, and the solutions of the remaining cue items were interrupted.

Experiment 1

Method

Participants and materials. Twenty University of Padua undergraduates participated in the experiment. They were 20 to 29 years old and participated for course credit. None of the participants were familiar with the Zeigarnik effect.

The stimulus words used for the anagram task comprised 54 five-letter Italian nouns (e.g., *barca*, *gamba*, *latte* [boat, foot, milk]). To obtain a homogeneous set of anagrams, we first constructed a list of 120 randomly selected nouns, with the restriction that each item constituted a five-letter noun and had the mean frequency of occurrence between 200–300 per million. Furthermore, we attempted to exclude synonyms and words with multiple meanings, as well as items with distinctive orthography in the Italian language. The resulting set of 120 words was then used to construct the stimulus anagrams. We used four patterns of letter arrangements that Hunter (1963, see also Baddeley, 1963) found to be equally difficult, namely *31524*, *35142*, *52413*, and *42531*. Next, to minimize item-specific effects, a separate group of 12 undergraduates solved each item; based on their results, we then excluded extremely easy and difficult items, as well as anagrams with multiple and/or unexpected solutions. The remaining set of 80 items was then presented to another group of 12 undergraduates. Each participant was tested individually, and the experimenter recorded the solution times for each item. The final set comprised 70 anagrams (including 10 practice items and 6 recency items). These items were similar in the sense that the mean solution time was 10–15 for each anagram, and none of the items had multiple solutions. Each anagram was typed in block capitals on a 15 × 20-cm card, along with a two-digit random number printed on an upper corner of the card. Furthermore, 4 anagrams (cue items) differed from the remaining 50 study items in that the third letter of each anagram was underlined. For half of these items the underlined letter was a vowel (*aceto*, *ruota*), and for the remaining items a consonant (*gamba*, *barca*). The serial position of the cue items was random, with the restriction that the interval between each item was 10–15 items. Each target item (i.e., an item having the same number as the corresponding cue item) was presented within this interval, with 8 intervening items as the minimum cue-target interval (the positions of the cue items were 2, 13, 25, 40, and the corresponding target positions were 11, 23, 38, and 53). The position of the cue and target items was counterbalanced so that each pair occurred equally often in each list position.

Procedure. Each individually tested participant was first informed that the purpose of the experiment was to examine verbal problem-solving under divided attention. The experimenter explained the nature of the anagram task and clarified that each item had one unique solution and was a relatively common noun. The participants were instructed that they should solve each anagram as quickly as possible, and that the maximum solution time was limited but varied among items. The experimenter explained that two-digit random number was printed on the upper corner of each response card, and that some of the anagrams differed from the remaining items in that the third (middle) letter was underlined. The participants were instructed that when an underlined (cue) item was presented, they should memorize both the underlined letter and the number on the card. The experimenter gave the instruction that when a (target) item with the same number as the cue item was presented, they should decide whether that item had the same or a different third letter as the underlined letter of the cue item. When responding, the participants wrote a plus sign (+) on the response sheet if the anagram contained the same third letter as the cue item, and a minus sign (−) if it was different. Furthermore, the participants were instructed to write a circle (o) on the response sheet if they were not able to remember the letter (i.e., the content of the prospective memory task). After confirming that the participants had understood the instructions, they were given a practice list of 10 anagrams. The participants were allowed to work on the response sheet while attempting to solve the anagrams. They were instructed to give an oral response as quickly as possible when they found a correct solution. The experimenter recorded solution times for each item and made a general judgement of each participant's overall ability to solve verbal anagrams. The third practice item contained an underlined letter, and the corresponding target item was presented after two intervening items. None of the participants had problems in understanding the nature of the two tasks. The experimenter emphasized that both tasks were equally important. To obtain an equal number of completed and uncompleted items in the subsequent main task, the experimenter calibrated each participant's solving time on the basis of his or her performance on the practice items. Also, to reduce practice and item-specific effects, the experimenter monitored the participants' performance on each trial and attempted to interrupt them relatively late while they were solving to-be-interrupted items. The participants solved half of the anagrams, whereas the solution of the remaining items was interrupted by the experimenter (who told the correct solution for the interrupted anagram, cf. Baddeley, 1963). Two of the 4 prospective cue items were completed and the remaining 2 cue items were interrupted (but the prospective targets were always completed). Each cue item occurred equally often as a completed or interrupted item. Furthermore, half of the cue-target pairs had the same third letter (i.e., a plus sign was the correct response), and the remaining pairs had different letters (i.e., a minus sign was the correct response). After the anagram task, the participants were first given a free recall test in which they were asked to recall the correct solutions of the anagrams they studied earlier. The free-recall test was followed by a recognition test in which the study words (i.e., the correct solutions of the anagrams) were presented along with comparable distracters (which were selected from the original pool of stimulus words).

Results and discussion

Responses from the prospective and retrospective memory tasks were subjected to two main analyses. First, recall scores from the prospective memory task were analyzed as a function of item type. The primary measure of prospective memory performance was the total number of target items that participants marked with one of the three responses (±/o). The prospective memory data were analyzed both in terms of a strict (± response) and lenient scoring criterion (±/o response). Because both criteria showed virtually identical overall patterns and statistical effects, the reported means are based on the strict scoring criterion. Secondly, to examine Zeigarnik effects in retrospective memory performance, the free recall and recognition data were analyzed in terms of item type.

Before summarizing the main findings, we shall report the response-time data from the anagram task. As mentioned earlier, because the participants differed in their ability to solve anagrams, we used each individual's performance in the practice session as an index to calibrate the rate of presentation in the main task. Furthermore, we attempted to minimize the difference in response time between uncompleted and completed items by interrupting the participants relatively late (cf. Zeigarnik, 1972). The mean response times for completed and uncompleted items were 14.8 s (SD = 1.5 s) and 12.3 s (SD = 2.6), respectively; $p > .05$. In some cases, the experimenter failed to interrupt the solution of a given item before the participant found a correct solution. In these cases, the next to-be-completed item was treated as a to-be-interrupted item, so that the total number of interrupted and completed items remained equal. However, the level of interruption failures was less than 0.5% (i.e., 2–3 items), and none of the to-be-interrupted cue items were completed by the participants (and none of the participants failed to complete a to-be-completed cue item).

The principal results of the experiment are summarized in Table 1. What is readily apparent in these data is that a response was given more frequently following prospective memory instruction that was associated with interrupted items than with completed items, $F(1, 19) = 5.67$, $MSE = 176$, $p < .03$. A more lenient scoring criterion (i.e., the participants made a circle on the response sheet) showed a similar pattern of results, although this effect was only marginally significant ($p < .08$). With respect to error analyses, 18.7% of the minus-responses were incorrect (i.e., a plus instead of a minus), and the corresponding error rate for the plus-responses was 14.8%.

Concerning Zeigarnik-like effects in retrospective memory, the results summarized in Table 1 suggest that interrupted items were better recalled and recognized than completed items. ANOVAs confirmed this observation by yielding a significant effect of item type both for the free recall, $F(1, 19) = 20.68$, $MSE = .121$, $p < .01$, and recognition data, $F(1, 19) = 4.81$, $MSE = .027$, $p < .05$.

To summarize, the results of Exp. 1 indicated that memory for interrupted items is better than for completed ones, measured both in terms of prospective and retrospective memory performance. Thus, the free recall and recognition data replicated Zeigarnik's (1927) original findings and those of Baddeley (1963). With respect to prospective memory performance, the results suggest that cue items that were associated with interruption in the anagram task were remembered better than items that were associated with completion.

Relating the results of Exp. 1 to Lewin's (1926/1961) tension systems theory, a reasonable interpretation of the present findings is that task interruption increased the activation level of underlying intention representation ("goal tension") and thereby facilitated the individual's preparedness to remember a planned action. That is, prospective cue items that were associated with interruption were represented at a higher level of activation than completed items, and this sustained activation subsequently facilitated the identification of the prospective cue item.

Table 1 Prospective and retrospective memory performance as a function of item type and condition in Exp. 1

Type of task	Prospective Memory		Retrospective memory			
			Free recall		Recognition	
Type of item	*M*	*SD*	*M*	*SD*	*M*	*SD*
Completed	.58	.24	.39	.11	.64	.20
Interrupted	.74	.29	.51	.15	.71	.26

Although the present findings are consistent with this activation hypothesis, they do not necessarily exclude alternative explanations. For example, there is a possibility that , instead of increasing the level of activation, task interruption leads to a more elaborated and differentiated encoding of the prospective memory cue associated with the cue anagram. Consequently, elaborated encoding produces an intention representation that may be more resistant to interference at the time of retrieval and/or provides more differentiated retrieval access than task completion that is associated with less elaborated encoding. In Exp. 2, we attempted to contrast the activation notion of the task-interruption effect with this alternative account.

Experiment 2

To extend the generality of the findings of Exp. 1 we modified the design of Exp. 2 in several respects. First, the identity of the target item was defined by the same number in Exp. 1, because we attempted to avoid the possibility that participants remembered the prospective memory task but forgot the identification number. (None of the participants indicated this in subsequent interviews.) Although the participants were not informed that the same number was used for all target positions, there is a possibility that interruption affected memory for the retrospective rather than the prospective component of the task. That is, because the same number was used for all cue-target pairs, the requirements for self-initiated retrieval operations (Craik, 1983; Einstein & McDaniel, 1990; Mäntylä, 1994) were relatively low in Exp. 1. Although differences in the requirements for self-initiated processing were not excepted to have differential effects on memory for interrupted and completed items, we attempted to extend the generality of the findings of Exp. 1 by defining each cue-target pair by different random numbers.

Second, in contrast to Exp. 1, in which the proportion of interrupted and completed items was equal, we systematically varied set size in Exp. 2. The purpose of this manipulation was to test the hypothesis that interrupted items produced better performance than completed items in Exp. 1 did because task interruption increased *distinctiveness* (rather than level of activation) of the cue item (Hunt & McDaniel, 1993; Jacoby & Craik, 1979; Mäntylä, 1986). In other words, although the number of interrupted and completed items was equal in Exp. 1, the participants may have considered the interrupted anagrams as more salient than the completed items.

As a support for this notion, Patalano and Seifert (1994) reported a study in which they investigated the relative memorability of solved versus unsolved word problems. The participants were instructed to work on each word problem until they reached a solution or "got stuck" (i.e., an *impasse*). Problem memorability was then measured with a free-recall task. Patalano and Seifert found that when a majority of problems were solved (67%), unsolved problems were better recalled than solved. However, when they varied the ratio of solved to unsolved problems (by manipulating problem difficulty), no memory differences were found under conditions in which unsolved problems were as frequent as or more frequent than solved problems.

To examine the distinctiveness hypothesis in the context of nonverbal problem solving, the number of interrupted and completed anagrams was varied so that one group of participants completed two-thirds of the items and one-third was interrupted (referred to as the low-interruption condition), whereas another group of participants completed one-third of the anagrams and two-thirds were interrupted (the high-interruption condition). Following the reasoning outlined above, if cue distinctiveness produced Zeigarnik-like effects in Exp. 1, these effects should be reduced when the proportion of interrupted items was increased (and attenuated when the proportion of interrupted items was increased).

Method

Participants and design. Twenty-four University of Padua undergraduates participated in the experiment. They were 20 to 29 years old and participated for course credit. The design of the experiment was a 2 (Condition) × 2 (Item type) mixed factorial, with Condition (high-vs. low-interruption) as a between-subjects factor, and Item type (interrupted vs. completed) as a within-subjects factor.

Materials and procedure. The stimulus items comprised 75 anagrams, including the 70 items used in Exp. 1. The 5 additional items were selected from the original pool of words by using the same criteria as in Exp. 1. Ten items were presented in the practice session, and the remaining 65 in the main task. To reduce item-specific effects, we replaced the 8 prospective cue and target items used in Exp. 1 with another set of 8 items. However, these anagrams were selected by using the same criteria as in Exp. 1. The interval between each cue item was between 15–18 items, and each cue occurred equally often in each of the four list positions.

The procedure was virtually identical to that of Exp. 1, except that no prospective cue items were presented during the practice session, in which the participants solved a list of 10 anagrams. Again, the experimenter recorded the solution time for each item in order to calibrate the rate of presentation in the main task. Another difference between the two experiments was that here the identity of each prospective target item was determined by different two-digit random numbers. As in Exp. 1, the participants were instructed that when a target item with the same number as the cue item was presented, they should decide whether that item had the same or a different third letter as the underlined letter of the cue item. The participants wrote a plus sign on the response sheet if the anagram contained the same third letter as the cue item, a minus sign if it was different, and a circle if they could not remember the letter. Participants in the high- and low-interruption conditions solved one-third and two-thirds of the anagrams, respectively. For both conditions, the solution of the remaining items was interrupted by the experimenter. Different sets of interrupted and completed items were used for each participant, but each item occurred approximately equally often as a completed and an interrupted item. The experimenter gave the correct solution for each interrupted item. As in Exp. 1, 2 of the 4 prospective cue items were completed and the remaining 2 were interrupted. Each cue item occurred equally often as a completed or interrupted item. In the next phase of the experiment, the participants recalled the correct solutions of the anagrams they studied earlier. The free-recall test was followed by a recognition test in which 45 (with 10 primacy and recency items excluded) correct solutions of the anagrams were presented along with an equal number of comparable distracters.

Results and discussion

Each subject's responses were subjected to two main analyses. First, recall scores from the prospective memory task were analyzed as a function of item type and condition. As in Exp. 1, the primary measure of prospective memory performance was the total number of target items that participants marked with one of the three responses (±/○). The prospective memory data were analyzed by using both a strict and a lenient criterion and, as in Exp. 1, the reported data were based on the former scoring criterion. However, in contrast to Exp. 1, the lenient scoring criterion showed the same pattern of results as the strict scoring criterion ($p < .05$). With respect to error analyses of the prospective memory data, 15.4% of the minus-responses were incorrect (i.e., a plus instead of a minus), and the corresponding error rate for the plus-responses was 12.8%. Secondly, to examine Zeigarnik effects in retrospective memory performance, the free recall and recognition data were analyzed in terms of item type and condition.

The main findings of Exp. 2 are summarized in Table 2. As can be seen from the lower section of Table 2, the overall level of prospective memory performance was somewhat lower than that of Exp. 1, but again cue items that were associated with interrupted items in the anagram task produced better performance than items that were associated with completed items. It is noteworthy that interrupted items produced nearly twice as high prospective memory performance than completed items.

Furthermore, the manipulation of the ratio of completed to interrupted items appears to have small or

Table 2 Prospective and retrospective memory performance as a function of item type and condition in Exp. 2. High-interruption condition = 2/3 interrupted items and 1/3 completed items. Low-interruption condition = 1/3 interrupted items and 2/3 completed items

Type of task	Prospective Memory		Retrospective memory			
			Free recall		Recognition	
Condition	*M*	*SD*	*M*	*SD*	*M*	*SD*
High-interruption						
Completed	.23	.26	.16	.09	.58	.21
Interrupted	.42	.39	.19	.08	.64	.21
Low-interruption						
Completed	.32	.33	.15	.10	.52	.16
Interrupted	.59	.37	.24	.09	.79	.18
Total						
Completed	.27	.29	.15	.09	.55	.19
Interrupted	.50	.39	.21	.09	.71	.20

nonexistent effects on prospective memory performance. That is, the same pattern of results was observed whether the participants completed 67% or 33% of the anagrams, making the distinctiveness hypothesis less convincing. However, as can be seen from Table 2, the mean difference between the two item types was 0.27 when the interrupted items were less frequent (i.e., more distinctive) than the completed items and 0.19 in the opposite condition, which may indicate that distinctiveness also contributes to the Zeigarnik effect.

A 2(Condition) × 2(Item type) mixed ANOVA on the prospective memory data revealed a significant main effect of item type, $F(1, 22) = 7.18$, $MSE = .09$, $p < .01$, replicating the main findings of Exp. 1. However, the interaction between item type and set size was not reliable ($F < 1$), suggesting that the manipulation of the ratio of completed to interrupted did not affect the magnitude of the Zeigarnik effect.

Concerning retrospective memory performance, the overall patterns of recall and recognition performance were similar to those of Exp. 1. As can be seen from Table 2, Zeigarnik-like effects were observed both in free recall, $F(1, 22) = 5.80$, $MSE = .006$, $p < .03$, and recognition, $F(1, 22) = 6.72$, $MSE = .050$, $p < .02$. Furthermore, for both measures of retrospective memory, the effect of interruption was, at least numerically, larger when the interrupted items were less frequent than the completed items. However, subsequent analyses revealed that the interaction between item type and condition was nonsignificant both in recognition, $F(1, 22) = 2.28$, $MSE = .037$, $p < .15$, and recall, $F(1, 22) = 1,31$, $MSE = .011$, $p < .30$.

General discussion

The point of departure of the present study was the notion that prospective memory is not only guided by retrieval-related factors, but that processes related to the formation of future intentions may also contribute to optimal prospective remembering. To examine effects of encoding on subsequent prospective remembering, we used the task-interruption paradigm in the context of verbal problem solving. The primary prediction of the study was that prospective memory cues that were associated with task interruption would produce better performance than cues associated with task completion.

In general, the results from the two experiments were in agreement with this prediction. In both experiments, interrupted items were more efficient reminders of the to-be-performed action than were completed items. In other words, the identification of a prospective memory cue (the two-digit number) was better when encoding of that cue was associated with interruption rather than with completion of the ongoing foreground task. The second main finding of this study was that Zeigarnik-like effects were observed both in free recall and recognition (i.e., retrospective memory performance). Thus, consistent with Zeigarnik's (1927) original study and that of Baddeley (1963), the solutions of the interrupted items were better recalled and recognized than those of the completed items.

Although our findings both replicated and extended Zeigarnik's (1927) original study, the present results are no necessarily consistent with Lewin's (1926/1961) and Zeigarnik's explanation of the phenomenon, namely that interrupted items are remembered better than completed items due to a heightened level of activation. One complication for this sustained activation hypothesis is that both Baddeley's (1963) study and the present experiments also showed Zeigarnik-like effects in retrospective memory performance when the interrupted items were "completed" by the experimenter. Although the anagram task used here is rather different from that of Zeigarnik's original study, our findings and those of Baddeley are difficult to interpret in the light of Lewin's tension system theory, namely, that a task is considered as a system under tension only as along as it is unfinished, and completion of the task means tension release. Consequently, the effects of interruption should have been reduced because the task was "finished" by the experimenter. However, it should be mentioned that we also carried out a separate pilot study in which participants were not given feedback after interruption. The results of this pilot study showed effects of interruption that were comparable to those reported here.

In Exp. 2, we attempted to test the idea that interrupted items produced better memory performance than completed items, due to differences in item-specific distinctiveness (rather than in level of activation). Inconsistent with our distinctiveness hypothesis, the magnitude of the Zeigarnik effect was not affected by the manipulation of set size. However, considering Patalano and Seifert's (1994) findings mentioned earlier, and that the manipulation of set size reduced, at least numerically, the magnitude of the (retrospective) Zeigarnik-effect in the present study, additional research is needed before the role of distinctiveness can be evaluated. Concerning the distinctiveness notion in relation to prospective memory, it is interesting to note that if this assumption was supported by further research, then distinctiveness would be shown to be important both at the encoding and retrieval phases of a prospective memory task (cf. Brandimonte & Passolunghi, 1994; McDaniel & Einstein, 1993).

Although Zeigarnik-like effects were observed both in prospective and retrospective memory tasks, and the present findings are readily accommodated within Lewin's (1926/1961) tension system theory, they do not provide unequivocal support for the notion that task interruption increases the activation level of the intention representation. Furthermore, it should be emphasized that even if task interruption facilitated prospective remembering by increasing activation level of the underlying representation, encoding and subsequent task monitoring may have additional effects on prospective memory performance. Planning in most everyday situations is a dynamic and strategic activity that, in addition to activation of knowledge structures, includes different types of organizational and elaborative operations (e.g., integration and spatiotemporal sequencing). Thus, different planning activities (e.g., long-term vs. short-term planning, familiar vs. unfamiliar plans) may have differential effects both on the level and type of activation (e.g., a high level of activation of some central attributes of the plan), and, perhaps even more importantly, different planning operations may produce intention representations that vary in their structure and complexity.

For example, extensive planning (i.e., thinking and imaging about the specific elements of the plan, the actions to be performed, and their consequences for other relevant plans), may not only increase the activation of the intention representation but may also produce a more differentiated representation as compared to a situation in which planning is less elaborated. Consequently, a more differentiated (but equally active) intention representation may facilitate prospective remembering by increasing the number of potential cues that could trigger a planned action at the time of retrieval. Thus, instead of assuming that planning influences prospective remembering by merely increasing the level of activation of the intention representation, a more reasonable position is to assume that operations performed at the time of planning facilitate prospective remembering both by increasing the level of activation and by increasing the number of potential cues for activating the action. An important avenue for future research on prospective remembering would be to examine the effects of different types of planning activities, varying from a relatively automatic activation of the intention representation to complex encoding operations that produces a rich and detailed memory representation. Furthermore, these "trace-dependent" components of prospective memory may interact with the "cue-dependent" component, so that certain types of planning activities are optimal only in combination with specific retrieval conditions (see also Mäntylä, 1993).

The spontaneous characteristic of prospective retrieval is probably the most central difference between a retrospective and a prospective memory task. Although this aspect of prospective remembering was emphasized in the present study, it is not necessarily a unique feature of prospective remembering. Indeed, retrospective remembering may also be spontaneous and involuntary (Ebbinghaus, 1885/1913; Fulgosi & Guilford, 1968; Salaman, 1970; Yaniv & Meyer, 1987). For example, Ebbinghaus divided recollective experiences between voluntary and involuntary remembering: "Often, even after years, mental states once present in consciousness return to it with apparent spontaneity and without any act of the will; that is, they are reproduced involuntarily"(pp.1–2).

Acknowledgements This research was supported by a grant from the Swedish Council for Research in the Humanities and Social Sciences. The studies were conducted while the first author was a visiting researcher at the University of Padua, Padua, Italy. Portions of this research were presented at the Third Practical Aspects of Memory Conference, Maryland, August 1994.

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