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Abstract	Young and middle-aged participants were asked to describe actions they intended to perform during the two weeks following the interview without referring to any memory aids. At the end of this period, they were asked whether those intended actions had actually been performed or not. Results showed that though middle-aged participants were less likely to recall intended actions without memory aids, there was no significant age-related difference in forgetting to perform those actions. To understand why people forget to perform their intended actions, face-to-face interviews were conducted with the participants to examine several aspects of the actions (e.g., importance, forgetfulness) and the use of memory aids. Analyses suggest that young adults overestimate their own prospective memory skills in recalling intended actions properly in their daily contexts. Through regular social activities over years, people gradually obtain a dayschema, which helps them spontaneously recall intentions without salient cues. Time-based prospective memory in daily contexts seems to be based on hour-based prospective remembering, which may be functionally different from the well-known interval-based prospective remembering.
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Contributed Paper

Why Do People Forget to Do Intended Actions?

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Young and middle-aged participants were asked to describe actions they intended to perform during the two weeks following the interview without referring to any memory aids. At the end of this period, they were asked whether those intended actions had actually been performed or not. Results showed that though middle-aged participants were less likely to recall intended actions without memory aids, there was no significant age-related difference in forgetting to perform those actions. To understand why people forget to perform their intended actions, face-to-face interviews were conducted with the participants to examine several aspects of the actions (e.g., importance, forgetfulness) and the use of memory aids. Analyses suggest that young adults overestimate their own prospective memory skills in recalling intended actions properly in their daily contexts. Through regular social activities over years, people gradually obtain a day-schema, which helps them spontaneously recall intentions without salient cues. Time-based prospective memory in daily contexts seems to be based on hour-based prospective remembering, which may be functionally different from the well-known interval-based prospective remembering.

When we form a plan to do something at a particular time, we must later recall it at the appropriate time to execute it. Many investigators have focused on such *prospective memory*, which differs

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from *retrospective memory* or memory of past events. As Munsat (1966) once stated, when a person forgets something he or she learned in the past, other people attribute this failure to his or her memory, but when a person forgets to do something he or she had planned, other people attribute this failure to his or her character. Prospective memory is thus essential for successful social interaction.

Since Neisser (1978) proposed the necessity of ecologically valid memory research, numerous studies on prospective memory have been carried out (see Brandimonte, Einstein, & McDaniel, 1996). Observational studies have often been used to understand the features of the relationship between everyday prospective memory and aging (see Maylor, 1993b, 1996b, for reviews). Contrary to expectations, some of the studies using self-report measures demonstrated no ill-effects due to aging (Cohen & Faulkner, 1984; Dobbs & Rule, 1987) or even improvement with age (Martin, 1986).

The central issues on prospective memory research are largely discussed in the frameworks of event-based and time-based prospective remembering, which were originally proposed by Einstein and McDaniel (1990). In event-based and time-based prospective memory tasks, participants are generally instructed to engage busily in a background task, in which they are presented with words on a computer screen, and are asked to recall them after all the words have been presented. Participants in event-based prospective memory tasks are then generally instructed to press a pre-specified key on a keyboard whenever target words which were learned prior to the task appear, while participants in time-based prospective memory tasks are instructed to press a pre-specified key after a certain time has elapsed. This experimental framework generates controlled data which allow us to discuss the underlying mechanisms of prospective remembering.

Importantly, in the original study conducted by Einstein and McDaniel (1990), age is considered to be a critical factor in prospective

memory performance. A large number of studies on memory and aging have focused on age-related declines in working memory, short-term memory, long-term memory (e.g., Salthouse, 1991), encoding and retrieval processes (e.g., Craik & Jennings, 1992), as well as effortful processing (e.g., Hasher & Zacks, 1979). Some original studies of event-based prospective memory, however, showed few or no age-related differences in task performance (Einstein & McDaniel, 1990; Einstein, Holland, McDaniel, & Guynn, 1992). Several recent studies reveal that various factors can affect age-related differences in the performance of event-based prospective memory tasks (Einstein, Smith, McDaniel, & Shaw, 1997; Mäntylä, 1994; Maylor, 1993a, 1996a; Park, Hertzog, Kidder, Morrell, & Mayhorn, 1997). This is a significant difference from studies on time-based prospective memory, which basically show clear age-related losses in performance (Einstein, McDaniel, Richardson, Guynn, & Cunfer, 1995; Park et al., 1997).

These well-controlled laboratory studies have yielded valuable insights into the relationship between prospective memory and aging. However, in the case of time-based prospective memory in daily contexts, a focus on *hour-based* rather than the more traditional *interval-based* prospective remembering may be advantageous. Most studies on time-based prospective memory have most commonly considered time in an interval-based framework. In everyday contexts, however, rather than using interval-based plans like “call him again in 10 minutes,” people make plans on an hour-based schedule, such as “call him at 3:00” or “meet her at 7:30.” Although it is widely accepted that older adults show deficits in general memory performance, a serious age-related decline in everyday contexts is not conclusively supported by empirical evidence (Rendell Thomson, 1999). Rather, middle-aged adults working in constant activity cycles for a long period tend to show equivalent performance to young adults in these everyday contexts.

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In the present study, we selected people in two age groups, young university students and middle-aged office workers, to examine the question of whether or not there is an age-related difference in hour-based prospective memory. Due to middle-aged adults' greater dependence on memory aids, it is reasonable to predict that this group should show considerable deficits in remembering the contents of their plans when they are not allowed to refer to these aids. Nevertheless, middle-aged adults may not forget to do intended plans when they are embedded in social contexts.

In our pilot study, we asked young and middle-aged participants to describe actions they intended to perform during the upcoming week, without referring to any memory aids. Next, we handed them a sheet of paper and asked them to note down intended actions they had forgotten to mention in the first interview. (We called it the participants' FD sheet, for actions one "forgets to describe.") One week later, they were requested to hand in the FD sheet and to report whether or not they had actually performed each intended action. Results indicated that the total number of actions described on the FD sheet was greater in middle-aged adults than in young adults, despite the fact that the total number of intended actions in each age group was not significantly different. Surprisingly, the total number of actions participants "forgot to perform" (FP) was much greater in young than in middle-aged adults. An analysis of the use of memory aids indicated that young adults who referred to them "while planning" or "casually" often forgot to perform actions, whereas those who referred to them "regularly" never forgot. In the current experiment, described below, we replicate those results under more elaborate conditions and examine hour-based prospective memory in more detail.

Experiment

Method

Participants. A total of 80 adults participated in this experiment: 40 young adults and 40 middle-aged adults. The young adults consisted of 33 undergraduate students and 7 graduate students, with a mean age of 23.10 ($SD=5.43$). All of the students belonged to the Department of Psychology at Keio University or the Business School at the University of Tsukuba in Japan. The middle-aged adults were all office workers, with a mean age of 51.83 ($SD=7.15$). 22 of the middle-aged adults were graduates of good universities in Japan and 18 of the middle-aged adults attended evening classes at Keio University. All had worked regular schedules for many years. All participants were recruited through personal contacts. All of the participants were in good health and free of memory impairment.

Procedure

First interview Face-to-face interviews were conducted with each of the participants. First, we confirmed their health status and lack of memory impairment. After a brief explanation of the purpose of the study, participants were handed a booklet containing task instructions. Participants were asked to read these instructions silently first, and then listen to an explanation by the experimenter. They were then allowed to ask questions. The task asked participants to recall actions with time they intended to perform during two weeks following the interview without referring to memory aids such as daytimers, appointment books, or electronic diaries. Participants were requested to exclude habitual actions (e.g., greetings, having meals at home, reading newspapers), and detailed procedural actions (e.g., in the case of calling someone: picking up the receiver, lifting it, and putting it to the ear). They were given 15 minutes to complete the task. Next, participants received a sheet of paper (the FD

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sheet) to make notes of intentions recalled later, which should have been included in the first interview's descriptions. Participants were finally asked to keep the FD sheet until the second interview to be held two weeks later. However, we emphasized that they should not add any newly planned actions to the FD sheet.

Second interview The second interview was carried out in the same room as the first interview, two weeks later. Participants were first asked to return the FD sheet, and to recall and describe as many as possible of the actions they had described in the booklets from the first interview (retrospective remembering task). For this task, they were not allowed to refer to any memory aids, and were instructed to describe the actions without attempting to recall the order in which they were written in the first interview. Participants were then requested to answer the following questions: a) whether or not they had utilized any memory aids, b) if so, what kind of memory aids had been used, c) in what situations they had referred to those memory aids, and d) whether or not they had altered their regular pattern of utilizing memory aids during the two-week experimental period.

Next, participants were requested to answer the following questions for each action described in the booklet or on the FD sheet: a) whether or not they had executed the action, b) if they had not executed it, why it had not been executed (e.g., because they had forgotten to perform it (FP) or because the plan had been revised).

Then, to understand further the characteristics of FD (forgets to describe) and FP (forgets to perform) actions in detail, participants were asked whether each FD or FP had been an action intended for themselves or for others (i.e., promises). They were then asked to rate nine factors pertaining to each action on a five-point scale. These factors were: 1) personal importance (PER: "How important was the event to you personally?"); 2) public importance (PUB: "How

important was the event in a public sense?"); 3) social reward (REW: "How significant was the social reward?"); 4) positiveness (POS: "How positive was the event?"); 5) habitualness (HAB: "How usual was the event?"); 6) activeness (ACT: "How busy were you around the time of the event?"); 7) punctuality (PNC: "How important was the timing of the event?"); 8) forgetfulness (FGT: "How easy was the event to forget?"); and 9) monitoring (MON: "How often did you remember the event before its execution?"). Five-point scales for each factor were provided in which 1 stood for "definitely not" or equivalent expressions and 5 for "definitely" or equivalent expressions.

Results

Prospective remembering

The mean number of actions described in the first interview was 8.55 in the young adults and 8.13 in the middle-aged adults, and many of those actions were hour-based schedules. The data were subjected to a one-way ANOVA. There was no significant main effect ($F(1, 78)=0.30, p>.10$), indicating that there was no significant difference between the mean numbers of originally intended actions for young and middle-aged adults.

The mean proportion of actions which were intended for others to total actions was .61 in the young adults and .54 in the middle-aged adults. These data were also subjected to a one-way ANOVA. There was no significant main effect ($F(1, 78)=1.50, p>.10$). The proportion of actions intended for others was found to be almost equal in the two groups. The remaining analyses were conducted without regard to the direction of intention (i.e., for themselves or for others).

The total number of FD cases was 13 in the young adults and 38 in the middle-aged adults, whereas the total number of FP cases was 16 in the young adults and five in the middle-aged adults. Although the total number of FD and FP cases was low overall, there appears to be a difference in the forgetting patterns of the two

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groups.

The proportions of FD to total actions and FP to total actions were calculated for each participant, and were subjected to a 2×2 ANOVA that included the between-subject variable of age groups (young vs. middle-aged) and the within-subject variable of forgetting pattern (FD vs. FP).

The result showed a main effect of forgetting type, indicating that the number of FD cases was greater than that of FP cases ($F(1, 78) = 8.07, p < .01$). An interaction between age group and forgetting type was also significant ($F(1, 78) = 10.29, p < .01$). Post-hoc tests of simple main effect yielded the following two results: 1) the proportion of FD in middle-aged adults was greater than that of young adults ($F(1, 156) = 7.95, p < .01$), and 2) the proportion of FD was greater than that of FP, for middle-aged adults only ($F(1, 78) = 18.30, p < .001$).

Characteristics of FP and FD

Discriminant analysis was carried out to understand the predominant characteristics of FP in the young adults group. In this analysis, the predicted variables were whether or not each action had been executed, and the dependent variables were the actual values of ratings for the nine factors.

The results show that the significant variables are: 1) forgetfulness (FGT: $F(1, 273) = 41.56, p < .001$; FPs were rated more easier to forget), 2) punctuality (PNC: $F(1, 272) = 11.88, p < .001$; the timing of FPs were rated as less important), and 3) positiveness (POS: $F(1, 271) = 9.38, p < .01$; FPs were rated as less positive events).

A similar procedure of discriminant analysis was carried out to understand the predominant characteristics of FD in the middle-aged adults. In this case, the predicted variables were whether or not each action had been described or not.

The results show that the significant variable is only forgetfulness (FGT: $F(1, 308) = 11.95, p < .001$; FDs were rated more easier to

Table 1 Reference time of memory aids

	While planning	Casually	Regularly	Other
Young adults	26 (5)	14 (4)	6 (0)	2 (1)
Middle-aged adults	14 (1)	3 (0)	19 (3)	7 (0)

Note. The total number of participants with at least one FP are in parentheses.

forget).

Relationship between FP and use of memory aids

The number of participants who used memory aids was 39 for the young adults and 38 for the middle-aged adults. Almost all of the participants utilized daytimers or appointment books, and they did not alter their regular pattern of use during the two-week experimental period.

To examine the relationship between FP and the use of memory aids, four categories of reference time were formulated: "While planning" a newly intended action, "casually" e.g., in trains or coffee shops, "regularly" e.g., in the morning at the office or before going to bed at home, and "other." The reference times for all participants are shown in Table 1. Because some cases fell into more than one of these categories, the sum of the cases in each age group was not equal to the total number of participants.

As shown in Table 1, 26 of the young adults referred to memory aids "while planning" and only six of them referred to them "regularly." Most of the middle-aged adults referred "regularly" or "while planning." The number of participants with at least one FP is indicated in parentheses. One interesting fact is that the young adults who referred to memory aids "while planning" or "casually" performed some FPs in each category, whereas those who referred to memory aids "regularly" performed none.

Retrospective remembering

The proportion of actions which were also recalled in the retrospec-

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tive remembering task (in the second interview) to the total was .52 in the young adults and .51 in the middle-aged adults. A one-way ANOVA showed no significant main effect ($F(1, 78) = 0.01, p > .10$), indicating that there was no significant difference between age groups in the performance of retrospective remembering of their own intentions.

Discussion

The main goal of this study was to examine whether or not there is an age-related difference in hour-based prospective memory. The results of this study showed that middle-aged adults were more likely to forget to describe (FD) their intended actions when they were asked to recall without referring to memory aids. This suggests that middle-aged adults were more likely to depend on their memory aids in everyday contexts. More importantly, however, there was no significant age-related difference in the occurrence of forgetting to perform (FP) intended actions. This pattern of results was basically consistent with that of our pilot study.

These findings raise some important issues concerning hour-based prospective remembering. First, why are young adults more likely to forget to perform their plans? Young adults recalled intended actions relatively well (less FD) without referring to memory aids, but they may be poor at recalling them in a timely fashion. Why, then, might young adults fail to recall their intentions at the appropriate time? Our data point to overestimation of daily prospective remembering skills as a likely cause. Discriminant analysis indicated that FPs in young adults have the characteristics of high forgetfulness and low positiveness, i.e., that young adults forgot to perform intended actions mainly because they were not necessarily motivated to perform those actions. It is important to note that young adults considered those actions as intentions despite their lack of motivation to per-

form them. The overestimation of prospective remembering skills in young adults may be due to an ill-established day-schema.

Many adults know that memory aids usually work as effective tools for prospective remembering. However, memory aids per se have little potential to help them recall that something needs to be remembered. In everyday contexts, memory aids actually work as supportive tools for remembering contents, rather than the impending need to remember. Thus, we cannot depend on memory aids too much for the purposes of timely recollection. Researchers have already recognized the importance of the distinction between remembering to remember and remembering contents (Dobbs Rule, 1987; Dobbs & Reeves, 1996; Kvavilashvili, 1987; Einstein McDaniel, 1990; Einstein et al., 1992). The cognitive basis for remembering to remember remains unclear. A well-established day-schema may work to increase our sensitivity to our intent to remember, and thus increase a likelihood of successful self-reminding at the appropriate time (Hicks, Marsh, & Russel, 2000).

The middle-aged adults who participated in this study were office workers, and thus had the opportunity to establish day-schemata over a long period of constant working cycles. The well-established day-schemata helped them to enhance their sensitivity to holding intentions to remember without salient cues. If people are aware of the presence of an intention to remember, they then can proceed to try to recall contents by referring to memory aids. Thus, a well-established day-schema may work to decrease FP. This process appears to be an essential characteristic of daily hour-based prospective remembering, which is different from the interval-based prospective remembering of the laboratory studies.

In fact, in our daily contexts, the ability to recall intended actions spontaneously and in a timely fashion is critical for interacting with others smoothly, which may explain the common use of memory aids. In past studies of prospective memory, some researchers have

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pointed out that the superior prospective memory performance of older adults seems to be attributable to their greater likelihood of using external cues as compared to younger adults (see Moscovitch, 1982). Also, Maylor (1996 b) suggests that older adults may be better at using external cues than young adults. According to our interpretation, it may be their increased sensitivity that allows successful hour-based prospective remembering.

Another important finding in this study was that the young adults who referred to memory aids “while planning” or “casually” performed some FPs, whereas those who referred to memory aids “regularly” performed no FPs. This can be seen as further evidence to support the interpretation that some young adults have not yet acquired well-established day-schemata and skills for utilizing their memory aids effectively. Establishment of a day-schema requires accurate monitoring of prospective remembering, and use of memory aids appropriate to one’s current skill in prospective remembering.

In the retrospective remembering task, both young and middle-aged adults were able to recall about half of the actions described in the first interview. This result was not consistent with the general theory that memory for past events declines with aging (e.g., Salthouse, 1991; Craik & Jennings, 1992). The measure of retrospective remembering in this study was “daily activities that people intended to perform.” Independently of age group, past events that were once embedded in a day-schema appear to be better accessible to recall. Another interpretation is concerned with source monitoring deficits. In the retrospective remembering task, the participants had to discriminate between intentions which they possessed prior to the first interview and those which they formed after the first interview. If participants in both age groups have poor source monitoring discrimination abilities, each group may experience similar confusion between intentions formed prior to the interview, and those formed later. With the present retrospective memory measure, we

cannot draw any further conclusions about age-related differences in retrospective remembering ability.

Guynn, McDaniel, & Einstein (1998) showed that reminders that referred only to the contents of intention (target events) did not improve prospective memory relative to a no-reminder control. Reminders that referred only to the intent to act (presence of intention) did improve prospective memory. According the “activation” views, reminders increase the likelihood that the activation levels of prospective memory representations will be sufficient to support prospective remembering at the time that the target events are encountered (Einstein & McDaniel, 1996; Ellis, 1996; Guynn et al., 1998; Mäntylä, 1996; McDaniel, 1995). The associations between the target events and the intended activities are definitely crucial, but how and in what situations reminders affect prospective remembering remains unclear. An integrative theory of the activation view and our “increased sensitivity” view will be required for better understanding of daily hour-based prospective remembering.

Some other experimental paradigms have been presented to uncover the mechanisms of prospective remembering in practical situations (e.g., Einstein, McDaniel, Smith, & Shaw, 1998; Kvavilashvili, 1998). Einstein et al. (1998), who have extensive experience in examining the issue of confusion regarding whether or not an action has already been performed during daily activities (e.g. medication adherence), focused on habitual prospective memory and aging. Also, daily prospective remembering is discussed as an important issue in some articles (e.g., Gould, McDonald-Miszczak, & King, 1997; Marsh, Hicks, & Landau, 1998; Walbaum, 1997). For instance, Marsh et al. (1998) focused in detail on the various effects of reminders on daily prospective remembering. But as Winograd (1993) stated, prospective remembering tasks outside the laboratory have long retention intervals, during which subjects need not always be alert and vigilant for prospective remembering. Future prospective memory research

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should keep this in mind, especially with experimental controls. Furthermore, neuropsychological and neuroimaging approaches to know the underlying neural mechanisms for remembering intended actions are definitely useful to understand hour-based prospective remembering (Umeda, Nagumo, & Kato, 2006).

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