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Does believing in "use it or lose it" relate to self-rated memory control, strategy use and recall?

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Abstract

After an oral free recall task, participants were interviewed about their memory. Despite reporting similar levels of perceived personal control over memory, older and young adults differed in the means in which they believed memory could be controlled. Older adults cited health and wellness practices and exercising memory, consistent with a 'use it or lose it' belief system, more often than young adults who were more likely to mention metacognition and flexible strategy use as means of memory control. Young adults reported using more effective relational strategy use during study for a free recall test. Use of relational strategies predicted recall in both age groups, but did not materially affect age differences in performance. Metacognitive beliefs, including implicit theories about aging and memory decline, memory self-concept, and perceived control over memory functioning did not systematically correlate with strategy use or recall.

It is widely documented that older adults have more negative beliefs about their own memory, including memory self-efficacy and control over memory (Berry, 1999; Hertzog & Hultsch, 2000; Miller & Lachman, 1999). Lineweaver and Hertzog (1998) showed that adults of all ages believe that memory ability and control over memory functioning undergo major decline after age 40. The belief that memory control and memory ability decline with age could influence memory performance in several ways, including suppressing the use of effective encoding strategies (e.g., Hertzog, McGuire, & Lineweaver, 1998; Lachman & Andreoletti, 2006) and inducing stereotype threat and performance anxiety in assessment contexts (e.g., Hess, Auman, Colcombe & Rahhal, 2003).

Theories of control beliefs suggest that it is useful to separate beliefs about efficacy and effective control from implicit theories about the means by which control is achieved (e.g., Skinner, 1996; Skinner, Chapman, & Baltes, 1988). However, to our knowledge, there has been relatively little work on understanding implicit theories about memory control. Nor do we know much about people's implicit theories about why and how control over memory is lost as people age. Based on Dweck's conceptions of lay causal theories about cognition (Dweck, 2006; Dweck & Leggett, 1988), Elliott and Lachman (1989) suggested that older adults are more likely to hold entity theories about memory, believing that memory is relatively immutable, dependent on endowed ability rather than effort or skill. Data on causal attributions after memory task performance lends some credence to this view. Older adults are less likely to attribute memory performance to effort and strategies and more likely to nominate ability

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and other uncontrollable influences as causes of their performance (e.g., Devolder & Pressley, 1992; Hertzog, Lineweaver, & McGuire, 1999; Lachman, Steinberg, & Trotter, 1987). Attributions of memory performance as due to effort and skill predict strategic efforts to exert control over memory encoding and retrieval in performance contexts (e.g., Riggs, Lachman, & Wingfield, 1997). Conversely, dysfunctional beliefs about one's own ability to benefit from memory strategies predict failure to use effective strategies (e.g., Devolder & Pressley, 1992; Lachman, Weaver, Bandura, & Elliott, 1995). Although this past work has suggested that underlying causal theories may be operating, studies have not directly asked participants to describe the factors they consider to be important in order to control their memory. Thus, the primary goal of this study was to examine individuals' underlying causal theories about memory control based on participant responses in an in-depth semi-structured interview following a memory task.

A second goal of the present study was to investigate how causal theories about memory control and personal memory beliefs may relate to recall performance. One mechanism that has been examined in previous studies is retrospective reports of organizational strategy use for encoding word lists (e.g., Camp, Markley, & Kramer, 1983; Hertzog et al., 1998; Hultsch, 1969; Rankin, Karol, & Tuten, 1984; Sanders, Murphy, Schmitt, & Walsh, 1980; Verhaeghen & Marcoen, 1994; Zivian & Darjes, 1983). In word lists that have little or no intrinsic semantic association, strategies that identify new relationships among items or that group items into larger units (or chunks) enhance free recall (e.g., Hunt & McDaniel, 1993). Older adults are less likely to employ relational processing strategies to organize unrelated information during encoding (Devolder & Pressley, 1992; Guttentag, 1988; Hertzog et al., 1998), and are less likely to use of relational and item-specific processing in combination to maximize free recall (Luszcz, Roberts, & Mattiske, 1990; but see Bäckman & Larsson, 1992). Therefore, we were interested in examining whether the causal theories that one holds about memory predicted strategy use, or lack thereof.

To address our first goal, we conducted semi-structured oral interviews with young and older adults after they completed a free-recall memory task. Participants were asked about the ways in which they did or did not have control over memory, both in general and in the just-concluded free recall memory task. Interviews were audio-taped and coded for evidence of implicit beliefs about memory control, personal beliefs about memory control and memory self-efficacy, and use of strategies during the encoding phase of the free recall test. We evaluated whether there are age differences in the content of implicit theories about control and whether older adults' implicit theories predict (a) perceived memory ability (or memory self-concept) and perceived control over memory; (b) organizational strategy use; and (c) memory performance.

To address our second goal, we asked participants about the strategies that they use in general as well as those used in the free-recall memory task. These reports were coded for relational strategies, marginally effective strategies and strategies with little or no effectiveness We then evaluated whether control beliefs were associated with strategy use and memory performance (Lachman, Andreoletti, & Pearman, 2006; Hertzog, Dunlosky, & Robinson, 2009).

Method

Participants

The data were collected from 79 young (aged 17 to 31, M = 20.5, 46% female) and 80 older adults(aged 58 to 85, M = 72.0, 46% female) with similar levels of education (13.7 years for young, 14.2 years for older). Young adults self reported their health as "very good" (M = 1.56, SD = 0.59) on a 5-point Likert scale which was significantly better than older adults (M = 2.13, SD = 0.93), who rated their health as "*good*" on average. The young adult sample consisted of undergraduate students who received extra credit for participating in the study (80% of the

sample), and community-dwelling non-students who were compensated monetarily for their time (20% of the sample). Older adults were recruited from a participant pool, comprised of independently living community members from the Atlanta area who receive monetary compensation for their time. For analyses involving data from the oral interview, two young adults were not included due to poor audio recording quality.

Measures

Memory task—A list of 40 common, concrete English nouns were chosen from the Paivio, Yuille, and Madigan (1968) word concreteness, imagery, meaningfulness and frequency norms. Items on the word list were high in concreteness (M = 6.7, range 6.0 to 7.7), and in mean corpus frequency (M = 177.0, range 40 to 200). All nouns were printed in "all caps" and 24-point font in two columns, in a different random word arrangement for each participant. Participants were allowed a 4-minute study period followed by a 4-minute recall period in which they were asked to orally recall the words in any order, with no penalty for repeating words. The number of words recalled correctly (0 to 40) was used as the recall score.

Semi-structured interview—After the memory task, a semi-structured interview was conducted to elicit any beliefs individuals had concerning how they achieve control (or do not have control) over memory, including reasons for their perceived performance and about any potential role age may have played in their performance (for an abridged interview script, see Appendix A).

The first section of the interview included general questions about how participants remembered the words in the recall task, what they would do differently if they were to complete the task again, and how much control they feel they have over memory in general and within the test they just completed. If the participant indicated that a memory strategy had been applied during the recall test, those strategies were specifically probed in the following section.

If participants had not explicitly mentioned or only vaguely hinted at using a strategy initially (e.g., "I tried" or "I put some of the words together") participants were probed as to whether they had used a strategy. For each strategy, both spontaneously mentioned and prompted, participants were asked about their use of the strategy, its effectiveness in general, and for examples of how that strategy was used in the memory task. The same questions were asked for each prompted strategy until participants indicated that they had not used any other strategies.

Finally, participants were asked a series of questions about the types of information they remember well, the types of information that they forget, and the conditions under which they remember well or forget. Participants were also asked the role that age plays in remembering and forgetting in general and specifically for the task completed in the study.

Qualitative coding of memory control theories: Interview material was coded for implicit memory control theories, i.e. ideas about how control over memory can be achieved, including ideas about people in general as well as ideas referring to an individual's personal memory experience. A team of coders, headed by the second author, were trained to extract codeable segments regarding memory control theories from the interview transcripts. These segments were extracted irrespective of the section of the interview from which they were elicited. Based on a randomly selected set of transcripts from 5 young and 5 older adults, the team created a coding scheme to classify the nature of these responses. This scheme was then used and modified on the basis of a second set of 10 randomly selected transcripts. The final control theory scheme was then used to classify all extracted interview segments for the presence or absence of means for achieving control in Table 1. Coders were blind to participants' recall

performance, questionnaire responses, and age. Coders achieved 76% agreement in assigning specific segments to control categories; discrepancies were resolved by discussion.

Qualitative coding of entity vs skill theories: The interview protocols were scored for adherence to beliefs consistent with an entity theory and a skill theory about causes of memory (Elliott & Lachman, 1989). After reviewing each transcript, coders rated the person on a 3 point ordinal scale (0 = no evidence, 1 = some evidence, 2 = strong evidence of the implicit theory).

Qualitative coding of personal memory beliefs: Coders rated each participant's transcript for perceived memory self-concept and memory control on a 1 (*very low)* through 4 (*very high)* ordinal scale.

Qualitative coding of strategy reports: Two members of the coding team conducted the qualitative coding of all transcripts for strategy use, using responses to both the initial general memory questions and to the strategy questions. Raters were blind to participants' recall scores, questionnaire responses, and age. Respondents were classified into three strategy use groups: Relational, Marginal, and Low (Hertzog et al., 1998). Relational processors organized words into groups according to meaning, such as forming a story about several words. The Marginal group used organization based on characteristics other than meaning, such as all words beginning with the letter 'a'. The Low group included those individuals reporting no strategies or attempting but abandoning possibly effective strategies. Individuals reporting a mixture of relational and marginal strategies were assigned to the Relational group. The raters achieved 76% agreement in assignment to specific strategy groups; discrepancies were resolved by discussion.

Responses to the strategy effectiveness questions were also independently coded by the raters on a 5-point Likert scale, from 1 (*not well or very poor*) to 5 (*very well or very good*). Raters achieved 68% agreement, with discrepancies resolved by discussion.

Beliefs about memory questionnaires: Both personal and general beliefs about memory were assessed with abbreviated versions of the Personal Beliefs about Memory Instrument (PBMI) and the General Beliefs about Memory Instrument (GBMI) scales developed by Lineweaver and Hertzog (1998). These instruments use visual analog (graphic) rating scales to measure beliefs about memory for the average adult (the GBMI) or for oneself (the PBMI). Three GBMI items measured implicit theories about change from age 20 to 90 in (a) memory ability (or efficacy), (b) current control over memory, and (c) prospective control over memory (i.e. degree of control over future memory function). The PBMI measures included three items measuring global memory beliefs (rating of memory, in general; rating of memory, relative to persons of one's own age; rating of memory, relative to persons of all ages), and items measuring perceived control over memory functioning (current and prospective; e.g., "There are things I can do to help me remember."). For additional details see Lineweaver & Hertzog (1998).

Vocabulary: A modified version of the Educational Testing Service's Advanced Vocabulary Test (Ekstrom, French, Harman, & Dermen, 1976) was administered. This measure tests synonym recognition for relatively uncommon English words using a 36-item, multiple-choice format. Participants are given four minutes to choose between five alternative words and circle the number of the word most similar to the target word. Age differences in vocabulary scores were not significant; mean scores for older adults (M = 17.04, SD = 8.31) were slightly higher than the mean score for younger adults (M = 15.35, SD = 4.80).

Results

Findings are presented in two sections corresponding with the two research goals. The first section addresses implicit memory control theories by providing descriptive information and testing age differences in these theories. The second section examines whether the causal theories that one holds about memory predicted strategy use and recall performance.

Description of Implicit Memory Control Theories and Personal Beliefs

Table 1 reports the percentage of persons in each age group who spontaneously produced at least one statement in each of the different categories of control beliefs. Some categories of controllable and uncontrollable influences on memory were frequently cited (e.g., use of external aids, motivation to remember), some were relatively rare (e.g., manipulating current affective state). Pearson χ^2 tests showed that there were age differences in the likelihood of mentioning different kinds of causes. For example, older adults were more likely to state that exercising one's memory (e.g., retrieval practice) or exercising the mind (e.g., doing crossword puzzles) was a means to achieve control over memory. Conversely, young adults were more likely to mention knowledge about memory strategies or adaptation of strategies on the basis of results as means of achieving control (see Table 1).

Cluster analysis of control theory categories—Given the prevalence of arguments regarding qualitative differences in underlying theories of memory control in older adults (e.g., skill versus inevitable decrement; Elliott & Lachman, 1989), we analyzed the control theory statements in a cluster analysis. To reduce the complexity of the coded data, we took the binary variables indexing control beliefs and ran several cluster analyses using the Ward method. Against our expectations, we were not able to identify reliable clusters but rather detected one large group consisting of the majority of the sample and several small clusters not exceeding minimal memberships. Thus, we found no evidence of stable subtypes of control theories that could be revealed by clustering persons into subgroups of similar profiles of beliefs.

Factor analysis of control theory categories—We conducted a set of exploratory factor analyses of the incidence scores for control theory categories. Based on a scree test we extracted five factors, using unweighted least squares estimation with an oblimin rotation. Several variables had very low communalities, therefore we re-ran the model excluding those variables. We also excluded two variables that loaded on multiple factors. The final analysis of 27 variables resulted in a stable factor solution. This solution explained 25% of the variance, a small but acceptable proportion given the binary variables being analyzed (see Table 2). The factors were labeled: Lifestyle/Life practice (e.g., physical exercise, nutrition, active lifestyle), Positive Attitude (e.g., control dysfunctional thoughts, faith, self-efficacy), Uncontrollable Metacognitive Factors (e.g., selection instances, implementation instances), Motivation in Context (e.g., knowledge instances, internal aids, positive physiological states), and Perceptual and Cognitive Aging (e.g., aging, lack of concentration, sensory and perceptional deficits).

We then generated factor scores for the five dimensions for use in correlational analysis. These scores can be understood as representing the breadth of spontaneous mention of different aspects of the dimension, with high scores associated with citing that control could be achieved in multiple facets of that dimension. For example, a high score in the Lifestyle factor indicates that persons are more likely to mention multiple lifestyle influences on memory control, such as nutrition, engaging in cognitive activity, and physical exercise. As would be expected from individual responses (Table 1), there were reliable age differences in the Lifestyle, $F(1, 153) = 19.57$, $p < .001$, partial $\eta^2 = .11$, and Perceptual and Cognitive Aging, $F(1, 153) = 36.32$, $p < .001$, partial $\eta^2 = .11$, factors. Older adults produced more statements consistent with positive lifestyle effects and negative aging effects on memory control. Thus, older adults

simultaneously discussed loss of control due to effects of aging on the body and mind, while also stating that control over memory could be achieved through lifestyle practices.

Ratings of Entity Theory and Skill Theory—We cross-tabulated the skill theory and entity theory codings, separately for the two age groups. Fully 65% of young adults and 69% of older adults showed strong evidence of a skill theory, believing their behavior influenced memory performance; none of the young adults and only 4% of older adults showed no evidence of a skill theory. Likewise, 52% of young adults and 51% of old adults showed strong evidence of entity theory, believing memory was an innate quality that depended on natural endowments; 12% of both young adults and older adults showed no evidence of entity beliefs. There were no age differences in the likelihood of holding either type of belief ($p > .25$). Moreover, there was little correlation between the two sets of theories; the Goodman-Kruskal gamma correlation for the two variables was .18 in the young adults, and .00 in the older adults (both *ns*).

Memory Beliefs: GBMI scales—Responses on the GBMI scales global memory efficacy variable were analyzed in a 2 × 3 × 8 repeated measures ANOVA (Age group by Strategy Group by Target Age). No strategy group effects on GBMI ratings were detected, so we focus only on the target age effects.

For the global memory scale, sphericity assumptions were violated for the repeated measures factor of Target Age (Greenhouse-Geisser $\varepsilon = .29$), so adjusted-*df* significance tests were evaluated. The analysis revealed a robust effect of target age, $F(2.0, 307.9) = 375.43$, $p < .001$, partial $\eta^2 = .71$,_and an Age group × Target Age interaction, $F(2.0, 375.43) = 6.93$, $p < .001$, partial $\eta^2 = .04$. Figure 1 plots the implicit theory curves for each age group. Both groups believed that memory decline is curvilinear across the adult life-span, although older adults perceived a later onset of decline than younger adults. This interpretation was supported by a significant Age Group × Target Age (quadratic) trend component, $F(1, 153) = 15.07$, $p < .01$, partial $\eta^2 = .09$. Similar repeated measures analyses were conducted for the GBMI control and prospective control scales. In both cases, robust target age main effects were identified, showing that individuals believed that control over present and future memory performance declines with adulthood. For the Control scale, the Age group × Target Age interaction was also significant, $F(1.7, 254.2) = 3.81$, $p < .05$, partial $\eta^2 = .03$. Older adults perceived a later onset of decline in control over memory, as is shown in Figure 2. For the Prospective Control scale, there was again a significant interaction, $F(1.6, 245.5) = 5.19$, $p < .01$, partial $\eta^2 = .03$, but there was also an Age Group main effect, $F(1, 153) = 12.34$, $p < .001$,_partial $\eta^2 = .08$. On average, older adults believed in a greater possibility of control over future memory functioning (see Figure 3), and also perceived less decline in prospective control in early and middle adulthood.

Memory Beliefs: PBMI scales—We first examined people's self-rated memory self concept (MSC) and control from the PBMI questionnaire. Table 3 reports the age differences in mean PBMI scales. There were reliable age differences on two of the PBMI memory self-concept items, the global memory ability item, $t = 2.56$, $df = 157$, $p < .05$, and the memory ability relative to all ages item, $t = 3.39$, $df = 155$, $p < .001$. However, the age groups did not differ in the memory ability relative to one's own age peers, $t = 0.68$, $df = 156$, *ns*. This pattern of age differences replicated Lineweaver and Hertzog's (1998) findings of robust age differences on the general MSC rating and the explicit comparison to persons of all ages, but no age differences when rated relative to one's same-aged peers. In the present study, however, we also found no significant age differences in perceived control over memory on the PBMI Control scale, $t = 1.69$, $df = 155$, $p > .05$.

Coded Personal Beliefs—Table 3 also reports the mean age differences in experimenter-ratings of personal ability and perceived control. There were no age differences in either variable, $p > .15$.

Relationships of Coded Personal Beliefs and Beliefs Assessed by Questionnaires—The three PBMI memory self-concept items correlated about .70 with one another in the entire sample; hence, we computed a combined PBMI memory self-concept (MSC) scale as the mean of the three items. There were significant correlations between self-rated and coded MSC. Self-rated personal control correlated with coded personal control, with the highest significant correlations, $p < .01$, for the two future-oriented PBMI scales, Prospective Control ($r = .34$ and $r = .36$ for young and older adults respectively) and Future Control ($r = .27$ and $r = .37$ for young and older adults respectively). The correlations were not large, but suggested at least some convergent validity across methods. The variables also demonstrated reasonable divergent validity, given that, across the two methods, MSC scales generally correlated more highly with each other ($r = .56$ and $r = .49$ for young and older respectively) than with control scales ($r = .20$ and $r = .32$ for young and older respectively), and vice versa (control scales with rated ability all rs $\leq .20$; control scales with rated control rs $\geq .26$ with the exception of control for young adults $r = .16$, ns).

Summary for Question 1—Our examination of the personal control theories and beliefs about memory suggest that older adults are more likely to report beliefs that conform to the idea of "use it or lose it". On the other hand, young adults are more likely to report the importance of metacognitive control, strategy use and task characteristics as influences on their memory performance. Both young and older adults believed that memory decline is curvilinear across the adult life-span, although older adults perceived a later onset of decline than younger adults. No age differences were found in perceived control.

Relationships of Memory Beliefs, Strategy Use and Memory Task Performance

To address our second question of whether memory beliefs related to strategy use and task performance we first examined strategy use differences between young and older adults. More than half of the young adults used high-quality relational strategies (65%), whereas only 22% used marginally effective and even fewer reported low effective strategies (13%). However, the percentage of older adults was more evenly distributed between the Relational (39%), Marginal (27%) and Low (34%) categories. These age differences were reliable, Pearson χ^2 (2, $N = 157$) = 12.85, $p < .01$. Older adults manifest a production deficiency with free recall, being less likely to report using relational encoding strategies.

Use of relational strategies had a strong relationship to free recall performance. An ANOVA revealed a significant main effect for Strategy group, F (2, 151) = 13.43, $p < .001$. Tukey HSD post-hoc tests showed that individuals in the Relational group remembered more words (55%) than those in the Marginal group (47%), and the Low group (43%), ps $< .05$, but the Marginal and Low groups did not differ. There was also a significant main effect for Age, controlling for Strategy, F (1, 151) = 35.08, $p < .001$, and no Age × Strategy interaction, F (2, 151) = 0.21, $p = .81$. Both young and older adults who use high-quality relational encoding strategies show a similar benefit of doing so. Controlling on strategy use did not greatly affect age differences in free recall, consistent with Hertzog et al. (1998).

Next, we examined the correlations of the implicit theory measures (the five factor scores, plus Skill and Entity beliefs coding) to personal beliefs, strategy use, and recall in the free recall task. There were few significant relationships of the implicit theory measures to any variable. A reliable correlation was detected between Lifestyle Practices and PBMI Prospective Control ($r = .33$, $p < .01$ and $r = .27$, $p < .05$ for young and older adults respectively), and Lifestyle

Practices also correlated with rated personal control for older adults ($r = .32$, $p < .01$). Individuals who believed in use it or lose it had higher belief that what they were doing would influence future levels of their own control over memory, and in older adults, this translated into believing in higher levels of current control over memory. In addition, holding a skill theory was positively related to personal control beliefs, such that persons holding a skill theory perceived more personal control over memory (e.g., Lachman et al., 1995). In general, however, the dominant pattern was one of little connection between implicit theories and personal beliefs.

Moreover, the implicit theory measures, did not correlate with strategy use or performance in the recall task with only a few exceptions. The motivation in context factor related to strategy use for young adults ($r = -.30$, $p < .01$) and to recall for older adults ($r = .26$, $p < .05$).

To address our second question directly, we examined relationships among memory beliefs variables, strategy use, and recall. One surprising outcome, given earlier work (e.g., Hertzog et al., 1998), was that memory self-concept and perceived control (i.e., PBMI MSC and PBMI Present Control) were not associated with strategy use in either age group ($r < .2$). Consistent with the ANOVAs conducted earlier, strategy use correlated reliably with free recall for both age groups. Despite the finding that beliefs were not correlated with strategy use, we used exploratory regressions to determine if personal control beliefs, the five implicit theory factor score variables, Skill, or Entity would enter the regression equations for strategy use and recall. They did not.

Summary for Question 2—Our examination of the relationship between memory control theories, strategies and recall found few significant relationships. Strategy use was related to enhanced recall performance in both young and older adults; however, memory beliefs were essentially unrelated to strategy use or recall performance.

Discussion

The primary goal of this study was to examine individuals' underlying causal theories about memory control based on participant responses in an in-depth semi-structured interview following a memory task. A second goal was to investigate how causal theories about memory control and personal memory beliefs relate to recall performance. We found interesting age differences in underlying causal theories and surprisingly did not find evidence for a relationship between these theories and strategy use or recall.

Age Differences in Implicit Theories about Memory Control and Personal Beliefs

Our qualitative coding of the interviews about memory revealed interesting age differences in implicit theories about memory control. Older adults were more likely to spontaneously state that memory, including age-related changes in memory, can be controlled by lifestyle practices, including exercising the mind, exercising memory, and other wellness practices. Thus, a meaningful percentage of older adults stated that control over memory depends on what one does, a view consistent with some scientific evidence (e.g., Einstein & McDaniel, 2004; Hertzog, Kramer, Wilson, & Lindenberger, 2009; Stine-Morrow, 2007; but see Salthouse, 2006) and with popular literature about aging (e.g., Weil, 2006). On the other hand, young adults were far more likely to state that aspects of metacognitive self-regulation, such as selecting a strategy that is appropriate for a task, or switching strategies if one doesn't work, are means of controlling memory. This finding is interesting because both age groups were highly likely to state that internal mnemonics and external memory aids were means of achieving control. So individuals, immediately after taking the recall test, almost universally nominate encoding strategies as important means of control. Yet young adults are more likely to speak of using strategies in ways that imply flexible use of monitoring and prior knowledge

in controlling memory. This outcome may be a reflection of the fact that 80% of our young adult population were currently students and therefore well-practiced in intentional memorization (Zivian & Darjes, 1983). This outcome may also be a meaningful indication that young adults are more prone to engage in dynamic self-regulation in cognitive tasks, which has been demonstrated in at least some situations (Dunlosky & Connor, 1997; Murphy, Schmitt, Caruso, & Sanders, 1987; see Hertzog & Dunlosky, 2004).

Why was there no relationship between beliefs, strategy use and recall?

Young adults were more likely to report using effective relational strategies in the free recall task; however, individuals who reported metacognitive control beliefs in the interview were not more likely to use strategies and did not perform higher on the free recall test. In fact, generally speaking, relationships of implicit control theories to strategy use were few and weak in magnitude. This outcome might be due to the nature of the interview method and its primary focus on theories of memory control. Failing to spontaneously mention an aspect of an implicit theory of control does not imply one does not hold it; conversely, mentioning a feature of an implicit theory does not imply one acts upon it. For example, individuals who are overweight may understand that consistent caloric restrictions in diet will lead to weight loss, but they may not necessarily restrict their diet based on this knowledge. Certainly, more older adults nominated strategy use as an effective means of control in the interview than actually used strategies in the memory task, and our transcripts showed instances of individuals saying that ‘strategies can work, but not for me’. This pattern of results also suggests that questionnaires like Lachman et al.’s (1995) Memory Controllability Inventory (MCI), which ask about personal internalization of stereotypes about aging and memory, such as ‘It is inevitable that my memory will decline’, may do a better job of predicting behaviors in situations perceived to be memory-demanding than measures of one’s implicit theory of control per se. Having said that, our coded measure of skill theory correlated with coded personal control, and the Lifestyle Practices implicit theory scale correlated with PBMI Prospective Control and coded personal control. So there were links of implicit theories to personal control beliefs, but the relationship of implicit control theories to strategy use was negligible.

Social psychologists studying stereotype activation and its influences on memory argue that a stereotype must be, at some level, regarded as relevant to oneself in order to influence behavior (e.g., Hess et al., 2003). Therefore, even though individuals can be coded as holding specific beliefs about how different variables lead to control over memory (or a lack of it), it could be the case that these implicit theories must be internalized as negative stereotypes that are potentially self-relevant before they can influence personal behaviors, such as strategy use. In this vein, the type of questions asked by the MCI might indirectly capture the kind of self-stereotyping beliefs (O’Brien & Hummert, 2006) that impede effective strategy use and self-regulation in memory tasks.

Another important aspect of implicit theories of control discovered from the interview data is that older and younger adults simultaneously hold skill theory and entity theory views regarding the controllability of age effects on memory. Most individuals showed strong evidence of holding both types of implicit theories. The same individuals who produce perceived decline functions on the GBMI endorse the idea that motivations matter for memory, that one can affect memory performance through the use of mnemonics and memory aids, and that lifestyle practices can help achieve better control over memory. Young and older adults alike view memory ability and control, in general, as declining, but hold some view of the possibility of prospective control over memory aging (Lineweaver & Hertzog, 1998). Therefore, our results suggest that dichotomous classification of older adults as being either entity theorists or skill theorists regarding memory (Elliott & Lachman, 1989) may be inaccurate. We offer an alternative hypothesis, namely, that people simultaneously believe that (a) aging impairs

memory, but (b) there is much they can do to limit the functional impact of aging. As such, lay persons may hold views similar to some research scientists in the field; namely, that aging effects occur, but that there is a large zone of possible development of memory functioning that is amenable to personal intervention and lifestyle effects (see Hertzog, Kramer et al., 2009, for an extended discussion).

Surprisingly, we did not find evidence of age differences in the degree of perceived control over memory in this sample as measured by the PBMI, which is at variance with the PBMI validation study results (Lineweaver & Hertzog, 1998) and studies using other control beliefs scales (e.g., Lachman et al., 1995). The lack of age differences was also observed in our interview-coded ratings of personal control as well, so we are inclined to see this as a characteristic of this sample, and not a specific issue with the PBMI. Moreover, unlike other studies in the literature, personal control beliefs were not significantly linked to strategy use (Hertzog et al., 1998; Hertzog, Dunlosky, & Robinson, 2009; Lachman & Andreoletti, 2006; Lachman et al., 2006). The older adults in the present sample had lower perceived control and less variability in control ($M = 18.6$, $SD = 10.0$) than the Lineweaver and Hertzog (1998) sample ($M = 21.3$, $SD = 16.8$), despite similar mean ages. Hence we may have sampled fewer older adults with high levels of personal control in this study, attenuating the correlation of control and strategy use. The difference could also simply be random sampling error from a small population correlation (e.g., $\rho = .3$) of control and strategy use (Abelson, 1995). Furthermore, Hertzog, Dunlosky, and Robinson (2009) found stronger relationships of control beliefs to spontaneous strategy use in a paired-associate recall task than in a free recall task, so the effect size may be smaller in the present task environment.

Be that as it may, we cannot rule out the hypothesis that a personal sense of control over memory may not be necessary for the production of effective encoding strategies. A more refined and elaborate understanding of implicit theories about control over memory may be needed to understand when, and under what circumstances, perceived control will be correlated with encoding behaviors and memory performance. For example, it could be the case that a lower sense of control is correlated with propensity to experience stereotype threat (Hess et al., 2003) or anxiety in memory performance contexts (Davidson, Dixon, & Hultsch, 1991). In this sense, perceived control may not be a cause of strategy use in an agentic sense (e.g., Lachman & Andreoletti, 2006), but instead a reflection of an alternative set of causes of encoding behavior.

Although the lack of relationship between beliefs and strategy use was surprising, the memory findings of this study were relatively straightforward. First, individual differences in self-reported encoding strategies had a robust relationship to free recall performance for both young and older adults. Second, there were significant age differences in the likelihood that relational strategies were used. Older adults manifested a mild production deficiency, being less likely to report using the kinds of relational strategies that yield the best recall performance for the type of list used in this study. This study therefore replicates earlier work (e.g., Camp et al., 1983; Hertzog et al., 1998, 2009; Rankin et al., 1984; Sanders et al., 1980) demonstrating that encoding strategies influence older adults' free recall performance.

Third, this mild production deficiency accounts for some, but not much, of the age-related variance in recall performance. Older adults using relational strategies performed more poorly than young adults using relational strategies, as did older adults using poor or low strategies with their strategy-matched younger counterparts, and the age differences in recall were not reduced much by controlling on strategy use. Factors other than strategy production account for the bulk of the age differences in free recall performance, contrary to the hypothesis that age differences in strategic behavior are a primary cause of the age differences in episodic memory (cf. Devolder & Pressley, 1992).

These findings do not necessarily imply that age differences in strategic behavior are unimportant in understanding older adults' free recall performance, however. Production of a strategy is not the same as effectively using it. This study was primarily designed determine *what* strategy or strategies were used, rather than *how effectively* each reported strategy was used. Older adults who reported using effective relational strategies outperformed older adults who reporting using no such strategies, and the magnitude of the strategy effect was comparable in the two age groups – an outcome suggesting older adults were using relational strategies in an effective manner. However, a study using a more microanalytic evaluation of strategy implementation at the item level might reveal different outcomes. It is still possible that older adults who use relational strategies do not consistently use them as efficiently or effectively (but see Dunlosky, Hertzog, & Powell-Moman, 2005; Smith, Park, Earles, Shaw, & Whiting, 1998 for some evidence inconsistent with this hypothesis). Further research using think-aloud methods to reveal encoding practices could provide additional evidence regarding age differences in the quality of strategy implementation.

The fact that individual differences in strategy production did influence older adults' recall performance reinforces the argument that training strategic behavior for older persons may be important for enhancing memory functioning in everyday life (Dunlosky & Hertzog, 1998; Storandt, 1991; West, 1995). Fully 61% of our sample of older adults did not report employing the most effective relational strategies to learn the word list. There is an important distinction between age differences in processes and mechanisms involved in memory versus age differences in functional memory performance in everyday contexts, where a strategic approach to the problem can lead to qualitatively different routes to successful performance (e.g., Hertzog, 2002, West 1995). It may be the case, for example, that young adults can easily remember new information through incidental encoding – that is, by merely attending to it. Older adults, on the other hand, may need to use more deliberate internal mnemonics and external aids to ensure successful remembering. Doing so could lead to equivalent functional memory performance despite age changes in the effectiveness of cognitive mechanisms supporting incidental memory.

Limitations

One concern about this study is that the extensive face-to-face interview might have led participants to erroneously report using strategies when they actually employed either no strategy or a very ineffective strategy. However, we used a conservative criterion for strategy classification, excluding strategies mentioned only after strategy probes, as well as strategies that were reported as ineffective. We evaluated the alternative approach of including these reports in classifying persons into strategy groups (not reported here), but this approach actually led to lower recall performance in the relational strategy group, consistent with the idea that individuals who reported strategies only when explicitly probed about them may not have used them effectively or consistently. The present study also replicated results from Hertzog et al. (1998) regarding robust relationships of reported strategy production and recall, despite differences in how strategy reports were elicited.

Other limitations include the use of factor analysis to identify associations among the binary codings of aspects of control theory. Our factor analysis accounted for only 25% of the variance in these ratings. Given that dichotomous variables are known to be susceptible to correlations due to degree of endorsement (so-called difficulty effects), this level of communality is acceptable. However, future analyses could consider methods explicitly tailored for factoring discrete categorical variables. Moreover, the sample sizes in this study were relatively small for this kind of multivariate analysis. Qualitative coding of this many interviews was already quite laborious, but future research would benefit from larger sample sizes.

Conclusions

In conclusion, this study demonstrated interesting similarities and differences in younger adults' and older adults' implicit theories about memory control. Age differences in beliefs about the means by which control is achieved occurred despite the fact that there were no age differences in perceived personal control. These interview results encourage further exploration of how to measure implicit theories, and to compare and contrast the effects of implicit theories, activated stereotypes, and personal memory beliefs on strategic behavior in memory task contexts.

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Appendix A: Abridged Interview Script

I. **General Questions about Memory**

- **A.** You said you feel you remembered ___ words. How did you remember ___ words?
- **B.** If you were to participate in another memory task like this, what if anything would you do differently?
- **C.** Do you think this memory experiment was a good test of your memory? Why or why not?
- **D.** How much control over memory do you feel that you have in general?
- **E.** How much control over memory do you feel you do not have in general?
- **F.** How much control over memory did you have in this task?
- **G.** How much control over memory did you not have in this task?

II. **Strategy Questions**

- **A.** Introduction: If spontaneously mentioned at least one strategy previously, told that they would be asked some questions about them. If no strategy had been mentioned, asked if they used a strategy or method of remembering in the memory task. If not sure whether used strategy after being asked, given word list to look at and decide whether used any strategies.
- **B.** Questions, pt. 1 (#1-3 asked separately for each strategy, repeated for all, then to # 4).
  1. How well do you think you (used) ____ ?
  2. How effective of a strategy, in general, do you feel ____ is?
  3. THEN: could you give me some examples? Here is the list of words.
  4. Are there any other strategies you used? (if 'yes', repeat # 1-3; if 'no', go to part C).
- **C.** Questions, pt. 2 (each asked separately for each strategy, then to part III).
  1. Did you learn this strategy?

2. How long have you been using it?

III. Questions About Memory Characteristics and Memory Aging

- **A.** What kinds of things do you remember well?
- **B.** How often do you remember things/what % do you remember in general?
- **C.** What kinds of things do you not remember well?
- **D.** How often do you forget/what % of the time do you forget things in general?
- **E.** In what conditions do remember well?
- **F.** In what conditions do you not remember well?
- **G.** Why do you think different people remember more/fewer words than others?
- **H.** Do you think that age played a role in what you remembered today?
- **I.** Do you think age plays a role in how well you remember in general?
- **J.** Do you think that age plays a role in people's memory in general?
- **K.** Do you have anything else to say about any of the questions?

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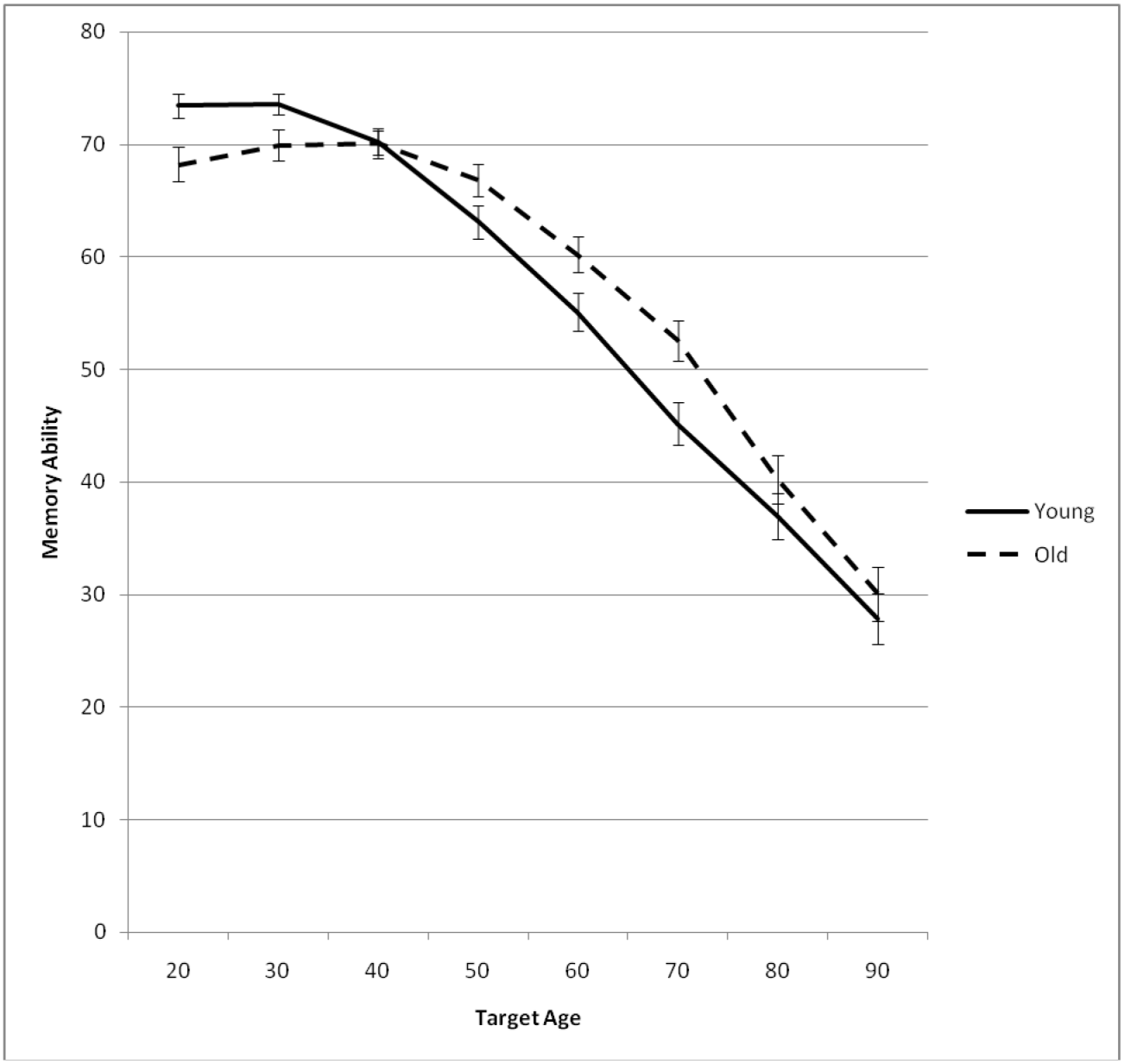

Figure 1.
Perceived developmental changes in general memory ability for the average adult from age 20 to age 90, graphed separately for young adult and older adult raters.

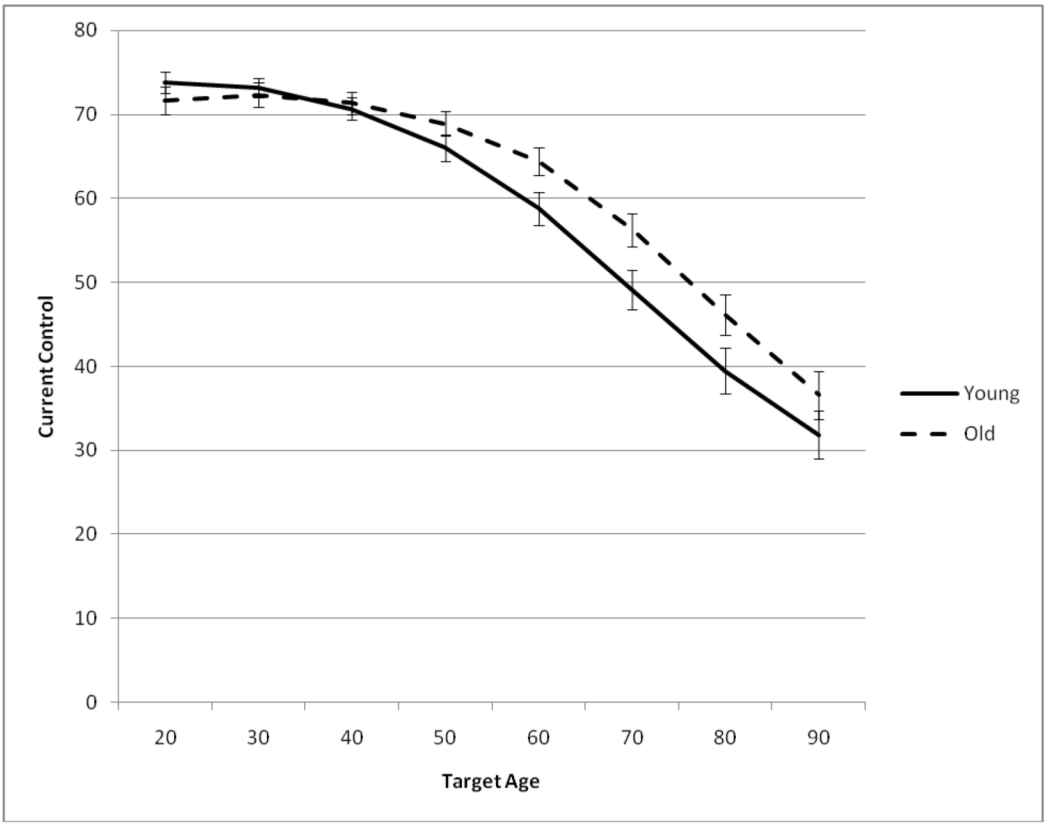

Figure 2.
Perceived developmental changes in current control over memory for the average adult from age 20 to age 90, graphed separately for young adult and older adult raters.

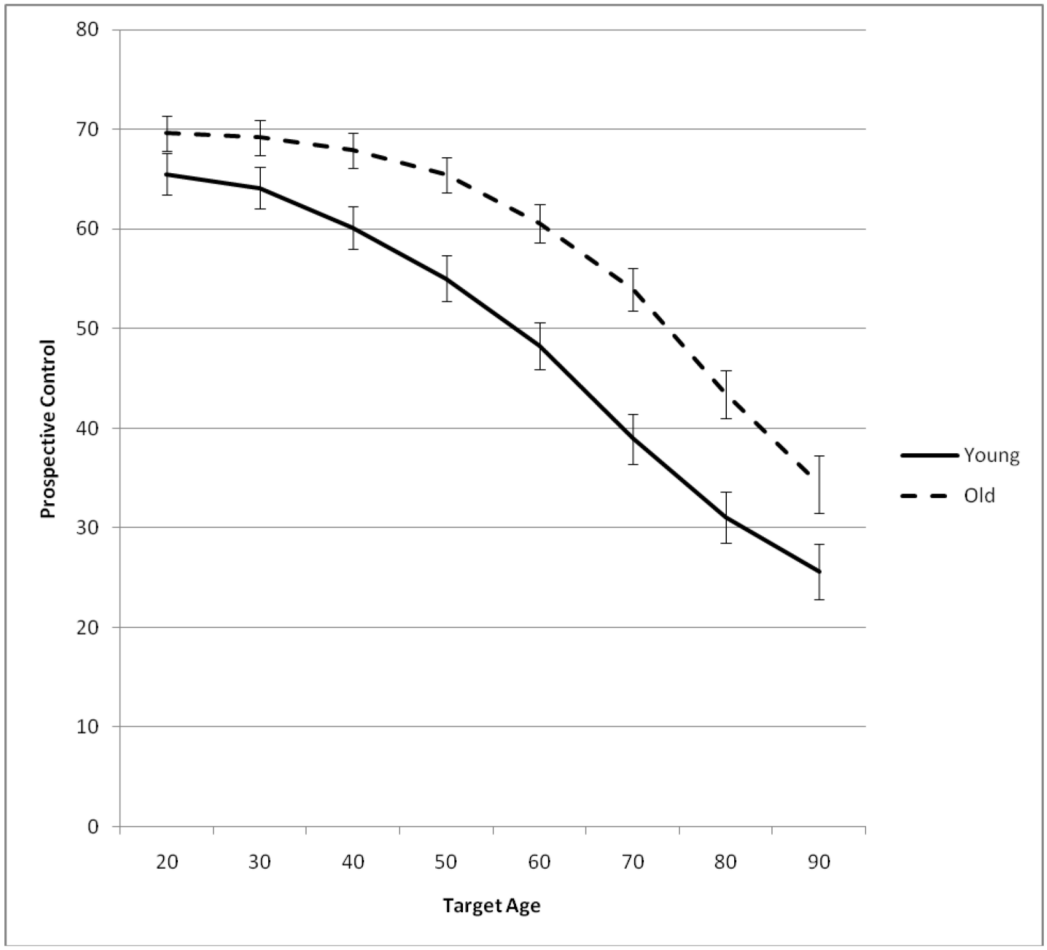

Figure 3.
Perceived developmental changes in control over future memory functioning (prospective control) for the average adult from age 20 to age 90, graphed separately for young adult and older adult raters.

Table 1

Memory Control Theory Classification Scheme, With Percentage of Each Age Group Who Were Coded as Manifesting Each Cause of Control

Control classification	Young	Older	Total Sample
1. Control over memory processes			
a. Internal aids	87.0	82.5	84.7
b. External aids*	58.4	75.0	66.9
c. Directed attention / concentration / practice	64.9	75.0	70.1
d. Metacognitive control **	72.7	35.0	53.5
2. Optimize PHYSICAL health to affect memory			
a. Nutrition, diet, vitamins	9.1	13.8	11.5
b. Physical exercise	6.5	12.5	9.6
c. Wellness practices (other than a or b)	3.9	5.0	4.5
d. Active lifestyle **	1.3	20.0	10.8
3. Optimize COGNITIVE health to affect memory			
a. Exercise mind **	11.7	41.2	26.8
b. Exercise memory (memory-specific exercises)*	19.5	37.5	28.7
c. Increase Knowledge*	5.2	15.0	10.2
4. Attitude and belief management to affect memory			
a. Positive attitude **	3.9	17.5	10.8
b. Motivation / goals / interest *	81.8	92.5	87.3
c. Control dysfunctional thought & belief restructuring	1.3	6.2	3.8
d. Faith, spiritual practice, prayer	0.0	3.8	1.9
e. Self-efficacy, confidence	1.3	6.2	3.8
5. Manipulate current affective or physiological state			
a. Positive states	3.9	7.5	5.7
b. Negative states	2.6	1.2	1.9
6. Manipulate environmental context (i.e., go to quiet place)*	9.1	1.2	5.1
Uncontrollable Influences / Ways of not having control			
1. General Lack of control	37.7	50.0	43.9
2. Internal Influences			
a. Poor skills	13.0	8.8	10.8
b. No metacognitive knowledge of skills*	18.2	5.0	11.5
c. Experience / life history	35.1	43.8	39.5
d. Retrieval block / temporary inaccessibility**	5.2	35.0	20.4
e. Age/aging	42.9	56.2	49.7
f. Genetics / heredity	11.7	22.5	17.2
g. Poor physical health (e.g., illness)**	16.9	35.0	26.1
h. Sensory / perceptual deficits (e.g. poor vision or audition)**	0.0	8.8	4.5

Control classification	Young	Older	Total Sample
i. Fixed ability (general)	48.1	52.5	50.3
j. Lack of concentration*	10.4	23.8	17.2
k. Fixed ability (+)	39.0	32.5	35.7
l. Fixed ability (−) due to insufficient cognitive resources	27.3	28.8	28.0
m. Emotional states	48.1	55.0	51.6
n. Dysfunctional beliefs	9.1	10.0	9.6
3. External Influences			
a. Context: Other persons (present only)			
i) Persons as external aids (+)**	5.2	18.8	12.1
ii) Persons as distractors (−)	13.0	5.0	8.9
b. Context: Environmental stressors **	84.4	65.0	74.5
c. Task characteristics **	98.7	86.2	92.4
d. Other (e.g., luck, hunger, sleepy)	41.6	32.5	37.0
e. External cause leading to Internal state	15.6	17.5	16.6

Note. Asterisks indicate significant χ^2 test for age group differences in proportions.

* $p < .05$.

** $p < .01$.

Table 2

Memory Control Theory Codes: Factor Loadings

	Lifestyle/Life practice	Positive Attitude	Uncontrollable Metacognitive Factors	Motivation in Context	Perceptual and Cognitive Aging
Physical exercise	.70				
Nutrition, diet	.63				
Exercise mind	.51				
Active lifestyle	.50				
Genetics, heredity	.43				
External cause leading to internal state	.38				
Poor physical health	.28				
Increase knowledge	.25				
Exercise memory	.23				
Directed attention, concentration, practice	.21				
Control dysfunctional thought		.62			
Positive attitude		.60			
Faith, spiritual, prayer		.48			
Self-efficacy, confidence		.39			
Fixed ability (+)		.27			
Emotional states		.24			
Metacognitive uncontrollable excerpt selection instances			.99		
Metacognitive uncontrollable implementation instances			.33		
Dysfunctional beliefs				.41	
Metacognitive control knowledge instances				.39	
Internal aids				.39	
Other external influences				.39	
Positive physiological state				.31	
External aids				.29	

	Lifestyle/Life practice	Positive Attitude	Uncontrollable Metacognitive Factors	Motivation in Context	Perceptual and Cognitive Aging
Lack of concentration					.50
Task characteristics					−.48
Retrieval block					.44
Age/aging					.33
Sensory, perceptual deficits					.30
Context- persons as external aids					.28
Metacognitive control selection instances					−.16

Note. Only largest factor loading from rotated solution listed.

Table 3

Age Differences and Effect Sizes (Cohen's d) for Memory Self-Concept and Memory Control Scales and Interview Ratings.

	Young Adults		Older Adults		
	Mean	**SD**	**Mean**	**SD**	**d**
PBMI Scales					
Global Memory ability	24.46	18.74	16.53	20.27	1.28**
Memory relative to all ages	23.03	17.45	6.60	17.52	2.77**
Memory relative to age peers	15.11	18.93	13.28	14.65	.31
Control	21.03	8.23	18.58	17.78	.47
Interview Ratings					
Present ability	2.91	.65	2.79	.81	.08
Perceived control	3.05	.58	2.91	.73	.17

** $p < .01$

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