The Journal of General Psychology

ISSN: 0022-1309 (Print) 1940-0888 (Online) Journal homepage: http://www.tandfonline.com/loi/vgen20

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To cite this article: Metehan Irak & Dicle Çapan (2018) Beliefs about Memory as a Mediator of Relations between Metacognitive Beliefs and Actual Memory Performance, The Journal of General Psychology, 145:1, 21-44, DOI: 10.1080/00221309.2017.1411682

To link to this article: https://doi.org/10.1080/00221309.2017.1411682

Published online: 16 Jan 2018.

THE JOURNAL OF GENERAL PSYCHOLOGY
2018, VOL. 145, NO. 1, 21–44
https://doi.org/10.1080/00221309.2017.1411682

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Beliefs about Memory as a Mediator of Relations between Metacognitive Beliefs and Actual Memory Performance

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ABSTRACT

The goal of the present study was to investigate relationships between personal beliefs about memory, metacognitive beliefs, and actual memory performance. One hundred thirty-seven participants' (aged 20 to 60 years) metacognitive beliefs were measured using the Metacognition Questionnaire (MCQ-30), memory beliefs were measured using the Personal Beliefs about Memory Instrument (PBMI), and an episodic memory task was used to measure actual memory performance, memory predictions, and postdictions. Younger adults had lower scores on the positive beliefs subfactor of the MCQ-30, higher scores on retrospective change and control subfactors of the PBMI, and outperformed middle-aged adults on recall and recall postdiction. Path analysis showed that individuals' beliefs about memory mediate the relationship between metacognitive beliefs and actual memory performance. Specifically, low lack of confidence (or less worry) in one's own memory and attentional capabilities was related to higher memory performance and positive personal beliefs regarding specific memory ability mediated relationship.

ARTICLE HISTORY
Received 29 June 2017
Accepted 24 October 2017

KEYWORDS
Aging; memory beliefs; metacognition; metamemory

Aging has been proposed to affect cognitive processes with general memory decline in old age (Dixon, de Frias, & Maitland, 2001; Reese & Cherry, 2006; see Lachman, 2004 for a review). Although individual differences, generally attributed to biological (e.g., diseases or neurological changes) or cognitive factors (e.g., storage and retrieval deficits), exist among older adults in memory performance (Lachman, Steinberg, & Trotter, 1987), the assumption that age-related memory decline might be tied to variations in metamemory and metacognition (Lachman & Andreoletti, 2006), and beliefs about memory (Hertzog, Sinclair, & Dunlosky, 2010), has emerged as a new explanation in recent years. With the shift from quantitatively investigating memory performance by recall and recognition tasks to investigating memory accuracy, the focus of traditional research on aging and memory also tended toward investigations of metamemory, metacognition (Pansky, Goldsmith, Koriat & Pearlman-Avnion, 2009), and memory beliefs (Hertzog & Dunlosky, 2011; Hertzog, Dixon, & Hultsch, 1990). This line of research mainly focuses on the roles

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of metacognition and beliefs about memory in the relationship between aging and actual memory performance. Both metacognition and beliefs about memory are complex concepts consisting of different subfactors. There are methodological differences across previous studies assessing the relationships between actual memory performance (including memory postdiction and prediction), metacognition, and beliefs about memory. Therefore, it remains unclear which types of metacognitive beliefs and memory beliefs affect the relationship between aging and actual memory performance.

Metacognition and aging

Metacognition refers to knowledge, thoughts, beliefs, and other cognitive processes devoted to assessing, interpreting, and controlling one's own cognition (Hertzog & Dunlosky, 2011, Wells & Cartwright-Hatton, 2004). Metacognitive ability has been shown to be associated with memory performance (Hertzog et al., 1990; McDonald-Miszczak, Gould, & Tychynski, 1999). It is suggested that metacognition becomes more explicit, powerful, and effective during development (e.g. Baltes & Staudinger, 1993; Labouvie-Vief, 1994; Kuhn, 2000; Pascual-Leone, 1995; Dittman-Kohli & Baltes, 1990). Thus, older adults are better able than younger adults to regulate their cognitive functioning, leading to more realistic and positive metacognitive strategies.

Significant differences in metacognitive performance have been observed over the life span, with older age characterized by greater awareness of one's own memory abilities. The most significant difference between older and younger individuals is the difference in accuracy of strategy detection, which includes metacognitive knowledge, awareness, and reflection on one's own thinking processes (Dittman-Kohli & Baltes, 1990; Baltes & Staudinger, 1993). Vukman (2005) argues that individuals become more reflective and self-aware over time due to increased inward orientation. This increased inward orientation results in better metacognitive ability characterized by an improved ability to regulate cognitive functioning. For instance, Halamish, McGillivray, and Castel (2011) found that although older adults exhibited impaired memory performance, this memory deficit did not interfere with their metacognitive abilities. They suggested that even though older adults remembered less information than younger adults, they were accurate in their postdictive judgments of forgetting. Therefore, adulthood may enable individuals to reflect on their thinking processes with high precision and with increased metacognitive ability. As many authors have observed, highly developed skills and functions associated with self-understanding and self-management can compensate for losses that occur with age (e.g. decline in processing efficacy after middle adulthood) at more fundamental levels of the mind (Baltes, Staudinger, & Lindenberger, 1999).

Metacognition is proposed to consist of different dimensions. Among these is the concept of metacognitive beliefs. Metacognitive beliefs are individuals' general ideas about the importance and consequences of controlling or managing their (and other people's) cognition (Flavell, 1979). According to Palmier-Claus, Dunn,

and Lewis (2011) metacognitive beliefs are burdens, which are sometimes irrational or unreasonable, that individuals place on their own thoughts. In this respect, metacognitive beliefs could affect emotions (Flavell, 1979), metacognitive strategy use (Vandergrift, 2002), and motivations behind actions (Graham, 2006). Wells and Matthews (1996), in the self-regulatory executive function (S-REF) model, suggested that since attention to and interpretation of events are self-focused, metacognitive beliefs may have a significant role in psychological dysfunction. The present study focuses on three aspects of metacognition: metacognitive beliefs, cognitive confidence judgments, and cognitive monitoring. Metacognitive beliefs, as defined here, were assessed using the Metacognitions Questionnaire-30 (MCQ-30; Wells & Cartwright-Hatton, 2004). The MCQ-30 was developed based on the S-REF model (Wells & Mathews, 1994) whereby the meta-cognitive system is designed to regulate the self by means of beliefs about the self. Distortions in meta-cognitive beliefs affect the meanings and functioning of cognition. Therefore, distortion of S-REF's control on affective regulation may bring about active worry about cognition. Negative metacognitions direct the individual to focus attention on situation congruent information; use inappropriate goals and internal criteria for the basis of cognition and action; engage unhelpful coping strategies of worry/rumination and anxiety; and use coping strategies such as thought suppression that fail to modify negative appraisals and beliefs.

The MCQ-30 scale assesses five distinct categories: *positive beliefs about worry,* incorporating the idea that worrying is beneficial for dealing with problems and avoiding unpleasant experiences; *negative beliefs about the uncontrollability of thoughts and corresponding danger*, relating to the idea that worry may cause physical and mental disruptions thus should be controlled even if it is not utterly possible; *cognitive confidence,* referring to one's view about the effectiveness of their cognitive abilities including memory and attentional processes; *negative beliefs about thoughts in general*, including superstitious beliefs and feelings of responsibility for having certain types of beliefs as they may cause negative outcomes; and *cognitive self-consciousness*, which corresponds to the extent to which a person focuses on his/her own cognitive processes. According to Cartwright and Wells (1997), subscales of the MCQ-30 are distinctive. Therefore, the scale may make it possible to determine metacognitive profiles of individuals and, subsequently, to investigate associations between those profiles and certain intrusive thoughts (e.g., worry), behaviors, and even disorders.

Metamemory, beliefs about memory and aging

Another way to understand age-related changes in memory performance and accuracy is to examine personal beliefs about memory and beliefs about memory in general. Previous studies (e.g. Cavanaugh, 1996; Davidson, Dixon, & Hultsch, 1991; Lachman & Andreoletti, 2006; Lineweaver & Hertzog, 1998) have suggested that older adults have lower self-efficacy, hold more negative beliefs about retrospective and prospective changes in their memory, and have lower control beliefs

than younger adults. Additionally, stereotyped beliefs about substantial memory decline with age have been found across various age groups, including older adults, middle-aged adults, and younger adults (Heckhausen et al., 1989; Hummert et al., 1994; Lineweaver & Hertzog, 1998). According to Levy (2003), stereotypes that are internalized and reinforced in childhood become self-stereotypes in adulthood. Therefore, the two components of memory beliefs: implicit theories about memory change; and personal beliefs about memory, are related and affect memory performance including the relationship between memory prediction and accuracy (Lineawer, Berger, & Hertzog, 2009).

Awareness of one's own memory functioning is linked to metamemory, which is composed of memory knowledge, memory monitoring, memory-related affect, and memory self-efficacy; it refers to knowledge, beliefs, and feelings about memory (Lovelace, 1990). Beliefs about memory are important aspects of metamemory (Lineweaver, Berger, & Hertzog, 2009); these beliefs are complex and affect actual memory performance (Horhota, Lineweaver, Ositelu, Summers, & Hertzog, 2012). People show differences in their metamemory abilities for prediction and accuracy of their memory performances (Wetherell et al., 2002) and views about when and to what extent changes would occur in their memory with aging (Crumley, Stetler, & Horhota, 2014). Therefore, whether there is a dissociation between self-evaluation and objective performance, which is affected by age, has been a focus of interest in recent literature.

Previous research investigating age-related changes in accuracy of memory predictions and memory performance has yielded inconclusive results. One line of research suggests similarities between older and younger adults in prediction accuracy for certain aspects of memory such as word and fact memory (Murphy, Sanders, Gabriesheski, & Schmitt, 1981; Woo, Schmitter-Edgecombe, & Fancher, 2008) and recall of paired associates (Rabinowitz, Ackerman, Craik, & Hinchley, 1982; Woo et al., 2008). However, other studies have found that older adults are less accurate in making memory predictions and are more likely to overestimate their performance on various cognitive tasks, including word recognition, working memory, vocabulary learning, and word list recall tasks (e.g. Lovelace, 1990).

Self-reported cognitive failures relate to confidence in one's cognitive abilities and a more urgent need to control worries about them (Cartwright-Halton & Wells, 1997). Pansky, Goldsmith, Koriat, and Pearlman-Avnion (2009) stated that poorer memory quantity and accuracy in older adults may emerge due to less efficient memory monitoring resulting from poor encoding. In contrast, Woo et al. (2008) showed that older adults are quite accurate in making general memory predictions and in estimating cognitive failures in tasks such as visual reproduction and face-name learning tasks. Their results add to the growing literature, which suggests more similarities than differences in metamemory accuracy across age groups (Eakin & Hertzog, 2006).

In the present study, memory performance and accuracy were evaluated using an episodic memory task, which incorporates performance prediction and post-dictions. Early decline in episodic memory has been associated with an increased

risk of memory disorders in future (e.g. Alzheimer's disease, mild cognitive impairment). Among various memory domains, episodic memory has been proposed to show the highest correlation with memory self-assessments (Crumley et al., 2014; Rickenbach, Agrigoroaei, & Lachman, 2015); therefore, it is sensitive to normal and early variations in cognitive performance of which individuals may be aware (Rickenbach et al., 2015).

In the present study, the Personal Beliefs about Memory Questionnaire (Lineweaver & Hertzog, 1998) was used in order to examine memory efficacy, change, and control beliefs. Two components of memory efficacy are measured: global and specific memory ability. *Global memory ability* refers to general beliefs about memory ability; and *specific memory ability* refers to beliefs about ability for specific aspects of episodic memory (e.g. memory for names and faces). Two components of change are measured: *retrospective change* is the perceived change from past to present; and *prospective change* is the expected change in the future. Lastly, three components of control are assessed: control, prospective control, and future control. *Control* refers to individuals' beliefs about the control that they currently have over their memory functioning; *future control* refers to individuals' beliefs about the control that they have over their future memory functioning; and *prospective control* refers to the level of control a person of a given age has over their memory functioning.

The goal of the study

Studies to date have provided inconsistent results regarding the relationships between metacognitive beliefs (consisting in the present study of positive and negative metacognitive beliefs, cognitive confidence judgments and metacognitive monitoring), actual memory performance, and aging; and the magnitude of these relationships. Further, the question of which self-evaluation or metacognitive beliefs can be used as the sole source of information about the degrees of objective performance has not been addressed. Thus, it is interesting to investigate whether (and why) there is an association between metacognitive beliefs and actual memory performance. According to Bandura (1989), there is a bidirectional relationship between individuals' efficacy beliefs and cognitive functioning. Thus, it is possible that another process, namely personal beliefs about memory, mediates the relationship between metacognitive beliefs and actual memory performance. Specifically, self-efficacy beliefs affect human functioning through various processes, including motivational, cognitive, affective, and decisional processes (Benight & Bandura, 2004). When individuals have strong beliefs in their memory capacities, they expend more effort during cognitive processing of memory-related tasks and, as a result, memory performance is enhanced. As well as the level of motivation devoted to tasks, the level of stress and depression in threatening situations has been linked to individual's efficacy beliefs. Individuals with low control beliefs believe that they cannot manage potential threats, and they experience higher levels of stress and anxiety compared to individuals with higher control beliefs. These enhanced feelings of

stress and anxiety, in turn, result in coping deficiencies and perceptions of danger in the surroundings. Such thought processes lead to impaired cognitive functioning in individuals with low control beliefs (Benight & Bandura, 2004; Lazarus & Folkman, 1984). In this study, as mentioned earlier, metacognitive beliefs were measured using the MCQ-30, which assesses individual differences in metacognitive beliefs about worries and intrusions, judgments, and cognitive monitoring. Personal beliefs about memory was measured using the PBMI, which measures memory efficacy, change, and control beliefs. Based on the information above, we hypothesized that beliefs about memory might mediate the relationship between individuals' metacognitive beliefs and actual memory performance. Worry involves a predominance of verbal activity, functions as a type of cognitive avoidance, and inhibits cognitive and emotional processing. According to Eysenck and Calvo (1992) worry consumes memory resources and reduces cognitive efforts, performance, and capacity. Although previous studies indicated that worry leads to restricted cognitive functions (e.g. memory capacity), these studies do not provide direct evidence that the low cognitive performances are related to worry. Thus another variable, such as beliefs about memory may help us to understand negative relations between metacognitive beliefs and actual memory performance. Actual memory performance may not affect directly metacognitive beliefs (worry), but to a certain extent, there may also exist an intermediary role of beliefs about memory between metacognitive beliefs and actual memory performance. In details, increased metacognitive beliefs about worry might negatively influence cognitive performance as mediated by decreased self-efficacy and control beliefs, and vice versa. Also, as mentioned above, age-related differences in the ability to regulate cognitive functioning and in beliefs about cognitive functioning may underlie metacognitive strategies. To the best of our knowledge, no previous study has addressed these questions directly. Previous studies investigating the relationships between aging, memory performance, and metacognition have typically compared younger adults and older adults. Therefore, there is relatively limited information about memory performance and metacognition in midlife (Dixon et al., 2001; Hertzog & Dixon, 2005).

While basic monitoring abilities are protected in older age (see Hertzog & Hultsch, 2000 for a review), some impairments are evident during complex types of monitoring (e.g. remembering the source of an information) (Hertzog & Dixon, 2005). Despite the findings suggesting efficiency of monitoring ability in older adults, to the best of our knowledge no study has assessed whether there are unique characteristics of metacognitive beliefs, related to and/or affecting memory performance and personal beliefs about memory, during midlife. Middle age has generally been perceived to be a stable period with minimal change; however, midlife is an important period covering a large portion of a person's lifetime. Although there are individual differences, the onset of various physiological, psychological, and social changes associated with aging occur in middle age, and early determinants of cognitive aging become evident during this period (e.g. failures in remembering information) (Lachman, 2004). Therefore, beliefs about memory and aging, along with metacognitive beliefs, may be assumed to undergo major changes during

middle age. In light of this, the current study compared younger (20–40 years of age) and middle-aged adults (41–60 years of age), with an aim to identify the roots of those changes.

It is difficult to predict the performance of middle-aged adults from the limited literature to date, as studies have shown that they perform similar to younger adults in some aspects but resemble older adults in other aspects (Lachman, 2004). Some aspects of cognitive functioning have been shown to be improved or at least maintained in middle-aged adults (i.e. pragmatic knowledge, vocabulary, inductive reasoning) (Willis & Schaie, 1999), while other aspects begin to decline (e.g. processing speed or working memory) (Baltes et al., 1999). In line with previous studies (Baltes et al., 1999; Blatt-Eisengart, & Lachman, 2004; Zimprich & Mascherek, 2010), and considering that an episodic memory task is employed in this current study, we assumed that middle-aged adults would have lower memory performance (including predictions and postdictions) compared to young adults. Also, a limited number of studies (e.g. Blank & Levesque, 1993; Rickenbach et al., 2015) have revealed that although middle-aged adults' performance resembles those of either young or older adults' depending on the memory domain, they generally show similar patterns of attribution for memory ability to those by older adults. Therefore, middle-aged adults were predicted to have more negative beliefs about memory than young adults, assuming that changes in psychological, social, and biological functioning that become evident by midlife may influence middle-aged adults' perceptions of their memory ability.

In order to assess the relationships between these variables and aging, we developed a mediation model for path analysis (see Figure 1). We hypothesized that individuals' personal beliefs about memory mediate the relationship between metacognitive beliefs and actual memory performance. Since previous studies showed significant relationships between age and memory beliefs, metacognition, and memory, our mediation model may be affected by age. Therefore, the second step of the path analysis controlled for effects of age. Thus, in this model the following research questions were investigated:

1. Do metacognitive beliefs predict actual memory performance?
2. Do metacognitive beliefs predict personal beliefs about memory?
3. Do personal beliefs about memory mediate the relationship between metacognitive beliefs and actual memory performance?
4. Do personal beliefs about memory mediate the relationship between metacognitive beliefs and actual memory performance after controlling for age?

Method

Participants

One hundred and forty-one adults participated in the study. Four participants were excluded from the analyses due to missing data. All statistical analyses were

Table 1. Participants' level of education according to age and gender.

	Age			
	Young-Adults		Middle-Aged Adults	
	Gender			
Level of Education	Female (n =45)	Male (n = 20)	Female (n = 39)	Male (n =33)
5-8 years	6 (14%)	1 (5%)	17 (44%)	12 (36%)
9-11 years	10 (22%)	4 (20%)	9 (23%)	9 (28%)
12 years or above	29 (64%)	15 (75%)	13 (33%)	12 (36%)

carried out for 137 participants (83 female, 54 male; $M_{age} = 39.67$, $SD = 13.04$). The majority of the participants were community-dwelling adults recruited through public and private work places, community centers, and schools (for younger participants). The inclusion criteria were: (1) aged between 20 to 60 years; and (2) at least 5–8 years of education. The exclusion criteria were: (1) history of psychiatric/neurological disorder or head injury; (2) current use of medications with central nervous system effects; (3) substance use disorder; and (4) color blindness.

The young adult group consisted of 65 participants (45 female, 20 male; $M_{age} = 26.72$, $SD = 6.45$), and the middle-aged adult group consisted of 72 participants (39 female, 33 male; $M_{age} = 50.21$, $SD = 4.81$). Levels of education were divided into three categories. 37 subjects (27%) had 5–8 years of education. This group included the 20- to 60-year-old subjects, who were, at the time of testing, at various grades of junior high school; the group also included primary and junior secondary school graduates. Thirty-one subjects (22.6%) had 9–11 years of education. This group included the 20- to 60-year-old subjects, who were, at the time of testing, at various grades of senior high school. Sixty-nine subjects (50.4%) had 12 years of education or above. This group included participants who were undergoing university education at the time of testing. The group also included participants at all age levels (20–60 years) who had at least license degrees. Participants' level of education according to age group and gender is presented in Table 1.

Measures

Personal Beliefs about Memory Instrument (PBMI; Lineweaver & Hertzog, 1998). The PBMI consists of 57 items asking participants to rate their memory. It assesses three main aspects: memory efficacy (global and specific), change, and control beliefs. Confirmatory factor analysis showed that these items measure seven components. These are: global memory ability, retrospective change in memory, prospective change in memory, control, prospective control, future control, and specific memory ability. This instrument was adapted to Turkish culture by Irak and Çapan (2016).

Meta-Cognitions Questionnaire-30 (MCQ-30; Wells & Cartwright-Hatton, 2004). The MCQ-30 assesses beliefs about worry and intrusive thoughts. It is comprised of five factors: positive beliefs, uncontrollability and danger, cognitive confidence,

need to control thoughts, and cognitive self-consciousness. The MCQ-30 was adapted for a Turkish population by Tosun and Irak (2008).

Memory task. A word list was used to measure actual memory performance. This episodic memory task (Irak & Özgör, 2014; Irak, Çapan, & Soylu, 2015) consisted of performance predictions and postdictions. In the first step, before being given any particular practice or training to the memory task, participants were told that there is a memory test that consists of words. Participants were asked to predict how well they would perform on such a memory task. They rated their expected performance (expected memory performance) on a 5-point Likert-type scale (1: very bad; 5: very good). The test consisted of 40 words. These words were selected from a word-frequency database in Turkish (Göz, 2003). All words were high-frequency nouns, five or six letters long. In the statistical analyses, four words (two at the beginning and two at the end of each list) were not included in order to minimize primacy and recency effects. During the assessment, each word was shown in black lower case letters in 16-point font for two seconds. Then, after the presentation, but before the recall, participants made a performance prediction. Performance prediction consisted of the estimated number of words to be recalled ranging from 0 to 40 (recall prediction). After this prediction, a free recall test was administered for which participants were given a blank sheet of paper and asked to recall as many of the presented words as possible in 10 minutes. Following the recall test, participants made a second performance judgment in which they were asked to estimate how many of the 40 words they correctly recalled (recall postdiction). A recognition test was then administered. Participants were presented with a list of words containing the original words along with an equal number of novel (distractor) words (80 words in total). Participants were asked to indicate for each word whether or not they believed it was in the original word list. There was no time limit during the recognition test. Following the recognition test, participants made a second performance postdiction in which they were asked to estimate how many of the 40 words they correctly recognized (recognition postdiction).

Wechsler Adult Intelligence Scale (WAIS) Vocabulary Sub-Test. This sub-test was used to measure verbal ability of the participants. This sub-test consists of 35 words of increasing difficulty and is presented orally and visually. Examinee required defining the words. Score (0, 1, or 2) based on sophistication of definition (Zimmerman & Woo-Sam, 1973). This sub-test basically measures verbal knowledge and concept formation. Turkish standardization and adaptation was completed by Savaşır (1995).

Procedure

The study was conducted following the approval of the ethics committee at the university. Participants gave informed consent to participate in the study after the purpose and the nature of the experiment was fully explained. All participants were tested individually. All administrations were done at a particular testing room (for younger participants) or in a quiet room at participants' home in a single session. The duration of each session was approximately 45 to 60 minutes. Each session

Table 2. Comparisons between younger and older adults on MCQ-30 subfactors, memory task variables, and PBMI subfactors: Variance analysis results.

	Variables	*F*	*p*	Partial Eta
MCQ-30 subfactors	Positive beliefs	4.87	.029	.040
	Cognitive confidence	0.67	.416	.006
	Uncontrollability and danger	2.25	.137	.019
	Cognitive self-consciousness	3.57	.061	.029
	Need to control thoughts	0.15	.700	.001
Memory Task	Expected memory performance	0.39	.535	.003
	Recall prediction	1.15	.285	.008
	Actual recall performance	31.83	.000	.191
	Recall postdiction	11.04	.001	.076
	Actual recognition performance	3.71	.056	.027
	Recognition postdiction	1.80	.182	.013
PBMI subfactors	Global memory ability	2.97	.087	.021
	Retrospective change	8.00	.005	.056
	Prospective change	1.39	.240	.010
	Control	8.41	.004	.059
	Prospective control	3.07	.082	.022
	Future control	0.16	.688	.001
	Specific memory ability	0.93	.336	.007

began with a demographic questionnaire form that recorded the following information: participants' age, gender, years of education, highest degree attained, work status, health status, and medical history (including medication use). The presentation of memory tasks and questionnaires was counterbalanced across testing sessions.

Results

Before the analyses, the data were screened for missing values, as well as univariate and multivariate outliers (Tabachnick & Fidell, 2007). There were no outliers identified as multivariate using Mahalanobis distance with $p < .001$, nor univariate using z-scores ($|z| > 3.30$). Statistical analyses were carried out in two steps to test our hypotheses. In the first step, the relationships between age and personal beliefs about memory (PBMI subfactors), actual memory performance, and metacognitive beliefs (MCQ-30 subfactors) were investigated using multivariate variance analysis. In this analysis age was the independent variable, and it was divided into two categories: young adults (20 to 40 years; $M = 26.72$, $SD = 6.45$); and middle-aged adults (41 to 60 years; $M = 50.21$, $SD = 4.81$). The dependent variables were PBMI subfactors, MCQ-30 subfactors, and actual memory performance, including expected memory performance, recall prediction, recall postdiction, recognition performance, and recognition postdiction. In the second group of analyses, accuracy between memory predictions and actual memory performance was assessed. In the third group of analyses, the proposed full mediation model (see Figure 1) was tested using path analysis.

Variance analysis results are presented in Table 2, and means and standard deviations are presented in Table 3. Levene's test showed that error variance of the dependent variable was equal across groups ($p \geq .096$). Variance analysis indicated

Table 3. Mean (and standard deviations) of the MCQ-30 subfactors, memory task variables, and PBMI subfactors across age groups.

		Age Groups	
		20–40	41–60
MCQ-30 subfactors	Positive beliefs	13.67 (4.15)	15.39 (4.33)
	Uncontrollability and danger	18.32 (4.89)	17.35 (4.41)
	Cognitive confidence	12.86 (3.98)	13.09 (4.24)
	Needs to control thoughts	16.30 (3.74)	16.57 (3.46)
	Cognitive self-consciousness	15.20 (2.94)	15.88 (2.69)
Memory Task	Expected memory performance	3.40 (.68)	3.36 (.69)
	Recall prediction	15.43 (7.14)	14.36 (6.24)
	Actual recall performance	10.74 (4.89)	7.12 (3.18)
	Recall postdiction	11.66 (5.35)	9.17 (5.29)
	Actual recognition performance	23.37 (7.40)	21.04 (7.43)
	Recognition postdiction	23.17 (8.42)	20.93 (7.90)
PBMI subfactors	Global memory ability	3.75 (.93)	3.57 (.88)
	Retrospective change	3.58 (.79)	3.34 (.85)
	Prospective change	2.82 (.74)	2.77 (.76)
	Control	4.25 (.56)	3.96 (.79)
	Prospective control	4.08 (.70)	3.89 (.72)
	Future control	3.69 (.64)	3.70 (.73)
	Specific memory ability	4.06 (.50)	4.02 (.52)

that the main effect of age was significant for the MCQ-30 positive beliefs subfactor, actual recall performance, recall postdiction, and PBMI control and retrospective change subfactors (Wilks' Lambda $\geq .797$; $p \leq .01$). In detail, young adults had lower scores (less worry) on the MCQ positive beliefs subfactor and higher scores on the PBMI control and retrospective change subfactors. They also showed better performance in memory tasks (i.e. actual recall performance and recall postdiction) compared to middle-aged adults (see Table 2 and Table 3).

To investigate accuracy between metamemory predictions and actual memory performance, multiple paired-samples t-tests were conducted. Results revealed significant differences between recall predictions and actual recall performance in the young adults group, $t(62) = 5.055$, $p < .01$, indicating that young adults gave higher recall predictions ($M = 38.57$, $SD = 2.25$) compared to their actual recall performance ($M = 26.84$, $SE = 1.54$) (mean values were given as percentages). Similar results were obtained for the middle-aged adults group, meaning that middle-aged adults gave higher recall predictions ($M = 35.90$, $SE = 1.81$) compared to their actual recall performance ($M = 17.80$, $SE = 0.93$). Additional separate analyses were conducted to compare young and middle-aged adults' actual recall performances with their recall postdictions and actual recognition performances with their recognition postdictions. Results revealed no significant differences between the groups. In the middle-aged adults group, actual recall performance ($M = 17.80$, $SE = .093$) was significantly lower compared to recall postdictions ($M = 22.93$, $SE = 1.54$), $t(73) = 4.133$, $p < .01$, indicating an overestimation in postdictive judgments of remembering. In the middle-aged adult group, there was no significant difference between actual recognition performance and recognition postdictions as well as young adults, $p > .05$.

Results showed that recall predictions overestimated actual recall performance in both age groups and recall postdictions overestimated actual recall performances in the middle-aged group. In order to investigate which group was more accurate in their predictions, multiple independent samples t-tests were conducted, with calculating an index showing the difference between recall predictions and recall performance. Young adults ($M = 4.69$, $SE = 0.93$) were more accurate in their recall predictions compared to middle-aged adults ($M = 7.24$, $SE = 0.70$), $t(135) = 2.22$, $p < .05$. Young adults were also more accurate on their recall postdictions, but the difference was not statistically significant, all p's $> .05$.

Results of structural equation modeling

To test the mediation model, IBM SPSS Amos 21 was used. A series of statistics and indices common for path analyses were used to assess model-data fit. In addition to a chi-squared (χ^2) test and its associated probability (p), we also used related indexes (Hu & Bentler, 1999): the comparative fit index (CFI); and a close-fit parsimony-based index—the root mean square error of approximation (RMSEA), including 90% confidence intervals. For RMSEA, a common rule of thumb is that a value of RMSEA less than or equal to .08 implies close approximate fit, with values between .06 and .10 indicating acceptable fit, but values greater than .10 indicating poor approximate fit. We also used CMIN/DF criteria, which several authors (e.g. Byrne, 2009) have suggested as a measure of fit. This ratio should be close to one for good fit or less than five for correct models.

The first step was to verify whether the variables in the model were significantly correlated. Firstly, the Pearson correlations between PBMI subfactors and memory variables were analyzed, and results are presented in Table 4. Actual recall performance and expected memory performance were significantly correlated with PBMI subfactors ($r \geq .17$; $p \leq .05$). Secondly, the correlations between PBMI subfactors and MCQ-30 subfactors were tested. Except the PBMI prospective control subfactor, the MCQ-30 cognitive confidence was significantly correlated with all subfactors of PBMI ($r \geq -.18$; $p \leq .05$). In addition, MCQ-30 cognitive self-consciousness was correlated with PBMI global memory ability and specific memory ability subfactors only ($r \geq .22$; $p \leq .01$). Thirdly, Pearson analyses indicated that MCQ-30 cognitive confidence was significantly correlated with recall performance, expected memory performance, and recall prediction ($r \geq -.19$; $p \leq .05$). In the fourth step, relationships between age and subfactors of the PBMI, MCQ-30, and memory variables were tested. Results showed that, except for the expected memory performance and recognition postdiction, age was significantly correlated with all memory variables ($r \geq -.16$; $p \leq .05$). Age was also significantly correlated with PBMI global memory ability, control, and specific memory ability subfactors ($r \geq -.18$; $p \leq .05$). Lastly, no significant correlations were found between age and MCQ-30 subfactors. None of the above-reported correlations were excessively high, so problems with multicollinearity among variables were not an issue.

Table 4. Pearson Correlations among variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Age	1																	
2. GMA	− .298*	1																
3. RC	− .133	.588**	1															
4. PC	− .006	.437**	.663**	1														
5. Cont	− .177*	.449**	.522**	.471**	1													
6. PrC	− .066	.190*	.320**	.363**	.479**	1												
7. FC	.019	.201*	.389**	.563**	.449**	.628**	1											
8. SMA	− .312**	.646**	.608**	.505**	.488**	.269**	.287**	1										
9. PB	.196	− .034	.081	− .034	.056	.007	.047	− .068	1									
10. CoCo	− .009	− .523**	− .292**	− .317**	− .186*	− .089	− .183*	− .512**	.127	1								
11. U&D	− .106	− .013	.096	− .009	.058	.002	− .036	− .129	.262**	.281**	1							
12. CoSC	.169	.249**	.274**	.141	.155	.063	.159	.221*	.239**	.014	.223*	1						
13. NCT	.030	.032	.130	− .169	.024	− .054	− .101	− .027	.413**	.181*	.383**	.380**	1					
14. EM	− .153	.316**	.271**	.261**	.169*	.174*	.199*	.366**	.001	− .375**	− .008	.006	− .083	1				
15. RePr	− .189*	.159	.127	.052	− .013	.016	− .048	.231**	− .101	− .192*	.042	− .006	.084	.226**	1			
16. AcRP	− .515**	.215*	− .236*	− .191*	.274*	.060	− .189*	− .241**	− .196	− .261**	.013	− .133	− .061	.024	.303**	1		
17. RePo	− .298**	.053	.023	.014	.091	.107	− .019	.091	− .105	− .050	.062	− .083	− .013	.017	.417**	.578**	1	
18. RcPe	− .196*	− .023	.037	− .076	.019	.052	− .075	.013	− .050	.065	.221*	.032	.051	.057	.203*	.378**	.228**	1
19. RcPo	− .150	− .051	− .019	− .027	− .021	.078	.014	− .019	− .130	.077	.122	.043	− .014	− .025	.243**	.341**	.398**	.708**

*$p < .05$; **$p < .01$.

Abbreviations: GMA. Global Memory Ability; RC. Retrospective Change; PC. Prospective Change; Cont. Control; PrC. Prospective Control; FC. Future Control; SMA. Specific Memory Ability; PB. Positive Beliefs; CoCo. Cognitive Confidence; U&D. Uncontrollability and Danger; CoSC. Cognitive Self-Consciousness; NCT. Needs to Control Thoughts; EM. Expected Memory Performance; RePr. Recall Prediction; AcRP. Recall Performance; RePo. Recall Postdiction; RcPe. Recognition Performance; RcPo; Recognition Postdiction.

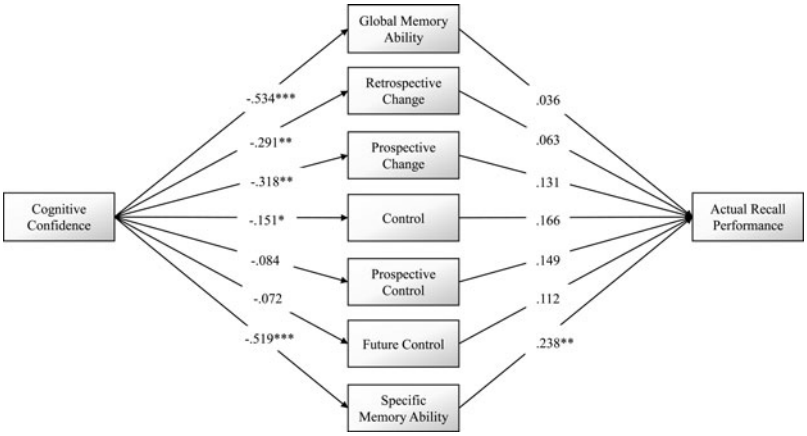

Figure 1. Graphical representation of hypothesized model showing relationships between cognitive confidence, PBMI subfactors, and actual recall performance. (*$p < .05$; **$p < .01$; ***$p < .001$)

Consequently, based on the correlation analyses, the final mediation model was created (see Figure 1). All variables in the model were observed variables. According to correlation analysis and based on our hypothesis, in this model the MCQ-30 cognitive confidence subfactor was the predicted (independent) variable, actual memory (or actual recall) performance was the outcome (dependent) variable, and PBMI subfactors were mediators. Based on the correlation results, we predicted that (1) cognitive confidence is directly related to PBMI subfactors, (2) PBMI subfactors are directly related to actual memory performance, (3) cognitive confidence does not have a direct effect on actual memory performance but PBMI subfactors mediate the relationships between cognitive confidence and actual memory performance, and (4) relationships between the variables might be affected by age.

The full model (see Fig. 1) was tested for the total sample. Table 5 presents the regression coefficients, direct and indirect effects, and statistical significance for the relationships between the variables. The results of fitting the hypothesized full mediation model were acceptable ($\chi^2 = 68.158$, $df = 10$, $p < .001$, GFI = .983, CFI = .901, RMSEA = .074, 90% CI [.023 – .119], CMIN/DF = 6.816; $p < .001$), indicating that the model represented the tested relationships well. As shown in Figure 1, from cognitive confidence to PBMI subfactors, all paths were significant

Table 5. Standardized path coefficients (direct and indirect effects) for the proposed model for study variables.

Independent Variable	Dependent Variable	Indirect Effects	Direct Effects
Cognitive Confidence	Global Memory Ability	0.036	− 0.534***
	Retrospective Change	0.063	− 0.291**
	Prospective Change	0.131	− 0.318**
	Control	0.166	− 0.151*
	Prospective Control	0.149	− 0.084
	Future Control	0.122	− 0.072
	Specific Memory Ability	0.238	− 0.519**
	Actual Memory Performance	0.023**	− 0.008

*$p < .05$; **$p < .01$.

except the path from cognitive confidence to prospective and future control. That is, cognitive confidence was directly related to global memory ability, retrospective and prospective change, control and specific memory ability. In support of our hypothesis, there was no direct effect of cognitive confidence on actual memory performance; however, cognitive confidence was indirectly related to actual performance, and only PBMI specific memory ability mediated this relationship (see Table 5).

As hypothesized, relationships between predictor, outcome, and mediating variables might be affected by individuals' age. Therefore, the model was tested with age as a covariate. Contrary to our hypothesis, the results of fitting the hypothesized full model were not acceptable ($\chi^2 = 2.28$, $df = 10$, $p > .05$, GFI = .722, CFI = .688, RMSEA = .145). The data suggested that the outcomes and the mediator variables did not behave differentially depending on individuals' age.

Young and middle-aged participants' vocabulary knowledge and concept formation was compared using the WAIS-R Vocabulary Sub-Test. Results revealed that both groups had above-average knowledge of vocabulary, with young adults showing 87%, and middle-aged adults showing 77% success in task ($t(135) = 4.213$, $p < .05$). On the other hand, there was no significant effect of gender.

Discussion

In the present study, the relationships between aging, personal beliefs about memory, and metacognitive beliefs were investigated. Firstly, young and middle-aged adults' performances were compared. In comparison to middle-aged adults, young adults had lower scores on the positive beliefs about worry subfactor of the MCQ-30, indicating that they are less likely to believe in beneficial effects of worry on memory performance compared to middle-aged adults; young adults had higher scores on retrospective change and control subfactors of PBMI, indicating that they are more likely to believe that their memory ability has improved over time and that they have control over their memory functioning, and young adults showed better actual recall and recall postdiction performance compared to middle-aged adults.

Secondly, we hypothesized that individuals' memory beliefs mediate the relationship between metacognitive beliefs (i.e. cognitive confidence) and actual memory performance. Path analysis results supported this hypothesis. In the model, apart from future and prospective control subfactors, PBMI subfactors (i.e. global and specific memory ability, retrospective and prospective change, control) were significantly predicted by cognitive confidence. In addition, specific memory ability (PBMI subfactor) was found to be a significant predictor of actual recall performance. Lastly, to control for possible effects of age, a second path analysis was conducted with age as covariate. Results showed that relationships between actual memory performance and mediator variables were not affected by age.

Our results have revealed a significant effect of age on particular aspects of memory beliefs—namely, retrospective change and controllability, with young adults showing more positive beliefs than middle-aged adults. Also, consistent with previous literature (Baltes et al., 1999; Heckhausen et al., 1989; Hummert et al., 1994;

Zimprich & Mascherek, 2010), actual memory performance and accuracy of memory predictions decreased with age. These results, which suggest that young adults hold more positive views about memory and have better memory performance compared to middle-aged adults, might provide an opportunity for attaining a sophisticated understanding of what is termed secondary factors by Berger and Thompson (1998). According to Berger and Thompson, holding a negative view or beliefs of oneself (e.g. negative metacognitive beliefs, negative beliefs about cognitive abilities) and of old age implicitly and prejudicially affects cognitive performance, and our results could be echoing this hypothesis. Although further research is needed to explain the underlying mechanisms of memory decline with growing age, which is strongly associated with neurological and biological changes, decreased memory performance observed in middle-aged adults partially reflected age-related differences in cognitive functioning and related memory beliefs.

It was also considered that the level of general vocabulary knowledge might be an issue in measuring memory performance with a task that is composed of word-pairs. To control for this possible effect, young and middle-aged participants' vocabulary knowledge and concept formation was assessed using the WAIS-R Vocabulary Sub-Test. Results revealed that both groups had above-average knowledge of vocabulary. Previous literature (e.g. Bowles & Salthouse, 2008; McArdle, Grimm, Hamagami, Bowles, & Meredith, 2009; McGinnis & Zelinski, 2000) suggests that vocabulary knowledge increases throughout early adulthood, settles down in middle-age years, and becomes stable or declines in old age. Additionally, Bowles and Salthouse (2008) suggested that different vocabulary tests (e.g. picture identification, multiple choice, produce the definition) are differentially related to age. They found that increased rate during early adulthood was weaker, and decline rate was stronger during old age in a produce-the-definition test (i.e. WAIS Vocabulary). They concluded that since memory and reasoning ability peak during early adulthood, it is reasonable to expect scores obtained from a vocabulary test that is strongly related to reasoning and memory ability to decline with age. Also, according to the Dual Representation Theory (McGinnis & Zelinski, 2000), there are two ways of cognitively representing vocabulary knowledge: providing an exact definition and having a general opinion. Previous studies have shown that older adults are less able than young adults to provide detailed definitions (McGinnis & Zelinski, 2000), and they use more general representations (Tun, Wingfield, Rosen, & Blanchard, 1998). Since the WAIS Vocabulary Subtest values sophisticated definitions rather than general representations, our results appear to be consistent with this hypothesis, showing that generating and accessing detailed definitions start to decline by middle age.

In addition to previous literature, which has primarily investigated the relationship between general beliefs about memory and memory performance, we investigated the relationship between memory performance and personal (or self-referent) beliefs. In addition to middle-aged adults' significantly lower memory performance compared to young adults, middle-aged adults self-reported lower levels of control over memory, lowered feelings of retrospective change in memory ability over time, and more positive beliefs about worry compared to young adults. These observations are consistent with earlier findings (e.g. Dark-Freudeman,

West, & Viverito, 2006; Lachman & Andreoletti, 2006; Lineweaver & Hertzog, 1998; Miller & Lachman, 2000), which suggest control needs and worries increase with advancing age as a result of declining memory ability. We interpreted this to mean that middle-aged adults are aware of the emerging decline in some of their cognitive abilities (especially memory), and that subsequently they believe they have less control over their cognitive functions. Additionally, we observed that middle-aged adults held more positive beliefs about the effects of worry on memory performance compared to young adults. Such views may have a self-protecting or self-enhancing purpose in middle age. Since middle-aged adults start to experience changes in memory functioning and sense that they have decreased control over their memory, they may feel extensive worry. Interpreting this feeling as a beneficial one may improve middle-aged adults' resilience in coping with their cognitive changes. In this respect, middle-aged adults' beliefs about memory could be said to resemble those of older adults rather than young adults.

Our model indicated that the relationships between cognitive confidence and PBMI's global and specific memory ability subfactors were stronger than for other PBMI subfactors. Additionally, specific memory ability was the only significant predictor for actual memory performance. The specific memory ability contained a group of specific ratings of different kinds of memory-related functions. The global memory ability consisted of three items: a global memory rating; an item asking the participant to compare his or her memory to other adults of the same age; and an item asking the participant to compare his or her memory to that of adults of all ages (Lineweaver & Hertzog, 1998). In support of previous findings (Lineweaver & Hertzog, 1998), although young adults scored better for both global and specific-ability subfactors, these differences were not statistically significant. The MCQ-30 cognitive confidence subfactor assesses lack of cognitive confidence in one's own memory and attentional capabilities. It is possible that less worrying about cognitive confidence related to higher specific memory ability. Our results indicated that cognitive confidence was not directly related to actual memory performance; however, low lack of confidence in one's own memory and attentional capabilities was related to higher memory performance, and positive personal beliefs regarding specific memory ability mediated this relationship.

Metacognition can be defined by beliefs about one's own competency in tasks. High metacognition is assumed to result in increased motivation, effort, and persistence (Bandura, 2001) while low metacognition is associated with higher levels of anxiety that can lead to impairments in performance. Earlier studies (e.g. Bandura, 1989; Hertzog, McGuire, & Lineweaver, 1998; Lachman, Lachman, & Thronesberry, 1979) have consistently revealed that metacognitive beliefs could affect memory-related behaviors. Lachman and Leff, (1989) showed that older adults become less internal and more external in their locus of control beliefs over metacognitive beliefs and cognitive functions, including memory, as they grow older. Moreover, during expression of internal locus of control, they prefer to make internally focused attributions of impaired cognitive ability, rather than internal attributions based upon skill or effort (e.g. Devolder & Pressley, 1992; Lachman & McArthur, 1986). According to Lachman (2006), older and middle-aged adults

have standards to define their competence, but they acknowledge the constraints and limitations of their memory that are associated with aging, and this in turn results in decreased control beliefs. Correspondingly, we found that the MCQ-30 cognitive confidence subfactor was negatively correlated with all PBMI subfactors as well as actual memory performance. Although cognitive confidence is generally reviewed under the concept of metacognitive beliefs in this study, consistent with the scale (MCQ-30), it is a form of metacognition and differentiated from beliefs in a way that it reflects confidence in monitoring ability for memory and attention processes. Therefore, the cognitive confidence subfactor contains items that relate to lack of confidence in one's own memory and attentional capabilities. These results and previous studies support our proposed model, which suggests that low memory performance is related to a lack of cognitive confidence and global memory ability, and that personal beliefs about memory mediate these relationships. We also assume that participants' attitudes toward their cognitive activity, arising from metacognitive beliefs (less worry about cognitive confidence), is related to self-evaluation of age-related increase in cognitive failures—e.g., in global and specific memory ability. Future studies may follow Rabbitt and Abson's (1991) suggestion and investigate other factors that might play a role in this phenomenon, such as the general attitude middle-aged adults have toward their current cognitive status.

Our results also revealed that both young and middle-aged adults' recall predictions overestimated their actual recall performance, whereas only middle-aged adults' recall postdictions overestimated their recall performance. Also, when compared to middle-aged adults, young adults were more successful in making memory predictions and postdictions regarding their recall performance, indicating increased accuracy in their judgments. In the present study, young adults remembered or recognized more information than middle-aged adults, and they were also more accurate in their predictive and postdictive judgments of forgetting. This awareness might lead to more effective strategy use and control processes to enhance memory performance. These results suggest that young adults are more self-aware than middle-aged adults, and that this in turn results in increased metamemory ability. This assumption is consistent with previous findings showing good memory performance and metamemory abilities in young adults (Halamish et al., 2011). The finding that suggests reduced accuracy between memory prediction and performance in middle-aged adults could be explained by previous results obtained from studies conducted with young and old participants. Consistent with the present study, Pansky, Goldsmith, and Koriat (2009) observed lower memory performance and accuracy in middle and old age. They suggested that both reduced monitoring ability (originating from poor memory encoding) and diminished control beliefs (reflecting less reliance on self-confidence) account for such results. In this respect, our results seem consistent with theirs, but they also highlight the importance of conducting further studies to investigate which characteristics of middle-age are related to reduced accuracy and performance, if any.

Increased control and positive metacognitive beliefs have been assumed to result in enhanced motivation and volition in the face of cognitive challenges (Bandura,

2001; Hertzog & Hultsch, 2000; Lachman & Andreoletti, 2006). According to this assumption, control beliefs may mediate future performance by promoting behavioral, physiological, motivational, or affective changes (Cohen et al., 2003). Conversely, lower levels of perceived control over memory may inhibit adaptive or strategic behaviors or result in stress and anxiety, which impairs memory performance. Consistently, negative beliefs about memory (e.g., the belief that memory, cognition, and control of cognition decline after middle age) have been shown to be associated with lower expectations about cognitive functioning and reduced effort devoted to tasks in older age (Heckhausen, Dixon, & Baltes, 1989; Lineweaver& Hertzog, 1998; Mas Tous, 2008). Given that young, middle-aged, and older adults perceive memory ability to decline with age (Heckhausen et al., 1989; Lineweaver et al., 2009), poorer memory performance is expected from middle-aged adults compared to young adults (Lachman, 2006). This assumption is in line with other studies that find a difference in attribution patterns between older and younger adults. Young adults tend to attribute memory mistakes to external and controllable factors, which in turn results in more positive self-assessments and better performance (Lachman et al., 1987), whereas older adults are more likely to attribute mistakes to internal and uncontrollable factors (Lachman, 1990). Weiner (1985) proposed that attributing memory failures to controllable factors might be related to increased responsibility and increased effort for using new strategies. Taken together, these findings indicate a more adaptive strategy in young adults.

Magnussen, Andersson, Cornoldi, De Beni, Endestad, and Goodman (2006) suggested a possible link between psychological characteristics and actual memory performance. Among them, beliefs about memory is a dynamic concept that could be a mediator of the relationship between metacognition and memory. Therefore, the results of the present study may support findings from the literature showing a relationship between metacognition-related beliefs and memory performance.

Limitations and further studies

In the previous literature, subjective memory, measures and timing of memory performance (e.g. predictions or postdictions), and metacognition have been operationalized in a variety of ways, therefore the operationalization of memory performance and metacognition may be unique to this present study, and the results should be interpreted in light of this. In the present study, the mediation model showed that beliefs about memory mediates the relationship between metacognitive beliefs (i.e. cognitive confidence) and actual memory performance.

There were some limitations to the present study. First, there were problems related to the demographic characteristics of the participants. Whereas individuals of all ages were required to have a certain level of education, young adults (20–40 years of age) were more likely to have completed higher education (e.g., university degree or graduate studies). It has previously been shown that high sense of control (which decreased with age in the present study) is associated with higher socioeconomic status, increased health, and education (Lachman, 2006).

Also, a number of studies (Crumley et al., 2014; Lachman, 2006) suggest that, whereas individuals with lower education are more open to stereotype threats, highly educated individuals are more aware of their own memory processes and use more efficient strategies to compensate for perceived losses in memory. Thus, further studies are needed to investigate the effect of education on susceptibility and resilience to negative beliefs about memory across the life-span. Additionally, it would be interesting to investigate other questions that the present study raises, such as whether personality characteristics affect metacognitive beliefs and memory beliefs in a way that either increase or decrease memory performance. Lastly, we did not include a measure of mood (e.g. depression), which may relate to beliefs about worries. Although we used strict inclusion/exclusion criteria, this issue should be controlled for in future studies.

Author note

Metehan Irak is a professor at Bahcesehir University. His current research interests involve cognitive and neurobiological aspects of metacognition and game addiction and cognition. Dicle Çapan is a PhD student at Koc University. Her current research interests involve developmental aspects of metacognition and circadian rhythm and memory.

Acknowledgments

We thank our graduate and undergraduate students at Bahcesehir University Brain and Cognition Research Laboratory for data collection. We also thank Katie Peterson for proofreading.

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