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Cognitive Performance and the Role of Control Beliefs in Midlife*

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ABSTRACT

Midlife has been touted as being a time of peak performance in many different areas of functioning. In the present study, we investigated whether this was true for cognitive functioning on tasks assessing speed, reasoning, short-term memory, and vocabulary. We also explored the extent to which levels of cognitive functioning could be attributed to individual differences in general control beliefs. Middle-aged adults showed little or no cognitive declines on speed, reasoning, and short-term memory measures relative to the young and outperformed the young on vocabulary. Relative to the elderly, middle-aged adults scored higher on all tasks except vocabulary, for which there were no differences. Adults in midlife, on the other hand, had lower scores on measures of general control beliefs compared to younger adults. Thus, although midlife is a time of high cognitive functioning, it is also a time of lower beliefs about control. To investigate the relationship between control beliefs and cognitive performance, we used structural equation modeling. The models showed that for adults in midlife, control beliefs were predictive of performance but only for the reasoning task after background variables were considered. Specifically, high levels of control beliefs were associated with better cognitive performance. More work is needed to identify mediational processes linking control beliefs and cognitive performance for various age groups and to determine whether some cognitive processes are more controllable than others.

The developmental period of midlife has received little attention relative to the earlier periods of infancy, childhood, and adolescence and the later period of old age (Brim, 1992; Lachman & James, 1997b; Willis & Reid, 1999). Whereas some research has addressed midlife issues of menopause (e.g., Lennon, 1982; Matthews et al., 1990) and the notion of a midlife crisis (e.g., Davidson, 1979; Rosenberg, Rosenberg, & Farrell, 1999), less attention has been paid to cognitive changes during this time.

Midlife is a potentially rich area for investigation of cognitive processes for a number of reasons. For example, a good deal of knowledge has been accumulated by this point in life (cf. Ackerman & Rolfhus, 1999), yet the sharper declines associated with old age are not prevalent. It is also a time when multiple and divergent demands are placed upon individuals from career, social, and community commitments and from children and parents (cf. Lachman & James, 1997a). In fact, due to the joint demands of a younger and an older generation on adults in midlife, this time period has been labelled *the sandwich generation* (e.g., Roots, 1998). Because of these types of experiences, in her pioneering work on middle age, Neugarten described midlife as ''a period of maximum capacity and ability to handle a highly complex environment and a highly differentiated self'' (1968, p. 97). This is consistent with implicit theories of midlife depicting middle-aged adults as competent and productive (Lachman, Lewkowicz, Marcus, & Peng, 1994). Thus, it seems likely

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that this developmental time period would provide ample opportunities for adults to maintain or sharpen various cognitive skills.

Some empirical work is consistent with this notion of peak performance during midlife. The bulk of the research on intellectual functioning in midlife is based on data from the Seattle Longitudinal Study (e.g., Schaie, 1984, 1996; Willis & Schaie, 1999), which in part support Neugarten's (1968) notion that midlife is a time of peak performance. This work shows that adults achieve peak performance on complex higher order abilities such as inductive reasoning, spatial orientation, and vocabulary during midlife. However, processes such as perceptual speed and numerical ability show declines beginning early in midlife. Aside from this research, historically, most work assessing cognitive performance in midlife has been indirect, as a data point between elderly- and young-adult comparison groups.

Consequently, little is known about the factors that contribute to high levels of performance during midlife. In particular, we were interested in control beliefs as a potential predictor of cognitive performance. General control beliefs have been linked to a number of outcomes such as health, life satisfaction, and well-being (e.g., Lachman & Weaver, 1998a), and domain-specific control beliefs have been linked to cognitive performance (e.g., Grover & Hertzog, 1991; Riggs, Lachman, & Wingfield, 1997; Stine, Lachman, & Wingfield, 1993; for a review, see Miller & Lachman, 1999). Although individual differences in control beliefs are related to cognitive performance in young and elderly adults (e.g., Stine et al., 1993), little work has directly examined this relationship among middle-aged adults. One goal of the present study was to examine whether control beliefs are related to cognitive performance during midlife.

Research linking control beliefs and cognition could yield important data because information about individual differences in control beliefs during midlife may be useful for predicting or preventing negative outcomes in later life. Past work has shown control beliefs to be modifiable and therefore they could be useful as an effective intervention mechanism (Lachman, Weaver, Bandura, Elliot, & Lewkowicz, 1992). In intervention research, cognitive-behavioral strategies are used to modify beliefs about control over memory as well as physical exercise (Lachman et al., 1997). Thus, a long-term goal of this line of research is to identify factors in midlife that could potentially remediate or even prevent cognitive declines in later life.

Control Beliefs and Age

A sense of control refers to the belief that individuals feel able to affect their performance (Abeles, 1990; Rodin, 1990), or more specifically, that individuals are responsible for their outcomes because of their own efforts (Rodin, Timko, & Harris, 1985). Weisz (1983) and others (e.g., Skinner, 1996) have identified two key components of control called competence and contingency. Competence is often described in terms of one's judgments about his or her ability to achieve a goal (sometimes referred to as self-efficacy). Within a coping framework, Pearlin and Schooler (1978) referred to this belief as mastery, suggesting that this is an important psychological resource that is available to help individuals cope with stress and strain. Contingency refers to the belief that one's actions will lead to intended consequences, also called outcome expectations (Bandura, 1977). Related to this construct is the notion of perceived constraints (Lachman & Weaver, 1998a), which refers to the extent to which there are factors that are believed to interfere with reaching goals. Within these and other frameworks, a strong sense of control (higher mastery and lower perceived constraints) has been repeatedly linked to higher levels of well-being (e.g., Albert et al., 1995; Lachman, Lyons, & Staudinger, 1999; Rodin, 1990).

Some have argued that, with advancing age, individuals begin to lose control over physical and cognitive abilities, which then leads to decreases in perceived control. However, the data do not uniformly support this notion (Rodin, 1990; Rodin et al., 1985). Research has yielded results showing increases, decreases, and no differences in control beliefs with increasing age (for reviews, see Lachman, 1986; Rodin et al., 1985). Brandstädter and Rothermund (1994) have suggested that the data are equivocal because research has failed to take into account the accommodative process of goal adjustment that may buffer age-related declines. Still others have stated that the use of different types of measures – domain-specificity versus generalized and multidimensional versus unidimensional – are responsible for the disparate findings (Lachman, 1986).

Nevertheless, relatively few of these studies have included a middle-age group (Brandstädter & Rothermund, 1994), and even fewer have explicitly addressed how this group differs from other age groups. Unfortunately, the little work that has investigated midlife has also yielded inconsistent findings. In a study in which men in midlife were compared to younger and older men, Lao (1975) found that men in midlife were more internal than were younger men; however, no differences were found between middle-aged and older males. Thus, contrary to the notion that control beliefs decrease across the life span, these data show that, for men at least, beliefs become stronger in middle adulthood and remain constant into old age. On the other hand, among samples of men and women, lower levels of memory self-efficacy have been reported for older and middle-aged adults relative to younger adults (Hertzog et al., 1998; Hultsch, Hertzog, & Dixon, 1987). Thus, the status of control beliefs in midlife remains unclear.

Control Beliefs and Cognitive Performance

Although it is uncertain whether control beliefs change with age, a positive relationship between beliefs and cognitive outcomes has been reported consistently in the literature. This link can be investigated with either general control beliefs or domain-specific control beliefs, that is, those that specifically assess beliefs about cognitive performance. The use of general control beliefs is typically preferred when multiple domains are being considered. Similarly, when investigating a specific domain of functioning, a specific measure of control beliefs is typically preferred. One reason for this preference is because age differences are more likely to be found using domain-specific measures than by using generalized measures (Lachman & Weaver, 1998b). Moreover, relationships between control beliefs and behaviors or outcomes typically are stronger when using domain-congruent measures (Lachman & Weaver, 1998b). However, in past work (Lachman, 1986) these relationships were more pronounced for the elderly than for the young, which may indicate that control beliefs are more differentiated for the elderly.

Nevertheless, generalized control measures were preferred in the present study because we were interested in determining the extent to which generalized perceptions of control over one's life affected cognitive performance. Thus, whereas domain-specific measures would be expected to highlight differences in control over cognition between the young and the elderly, general measures were expected to provide a more balanced approach to studying belief-performance relations in midlife that would more likely tap into the multiple demands placed on adults during this time of life.

The research consistently shows that those who feel they have greater control over their cognitive performance are able to achieve higher levels of performance than those who do not (Lachman & Jelalian, 1984; Lachman & Leff, 1989; Riggs et al., 1997; Stine et al., 1993). For example, Riggs et al. (1997) administered a speech processing task to older adults who were either high (''internals'') or low (''externals'') in perceived control. Participants were required to listen to recorded passages in order to recall the text verbatim and were told to interrupt the flow of speech where they wanted in order to segment the text into recallable units. They found that externals were more likely than were internals to make inaccurate predictions about the number of words they could accurately recall. These data suggest that individuals who are low in perceived control are poorer at monitoring on-line memory processing.

There are a number of other factors that potentially mediate and moderate the relationship between control beliefs (domain-specific or general) and cognitive performance. For example, individuals who believe they can affect their memory performance are likely to devote more effort to solving memory problems (Bandura,

1977) and may be more likely to apply suitable strategies (e.g., Hertzog et al., 1998; Stine et al., 1993). Bandura (1977, 1997) has argued that beliefs are especially crucial to perseverance when individuals are faced with adversity and challenge, which could be the case when dealing with difficult cognitive tasks. At midlife, some individuals report experiencing problems with cognitive functioning, especially memory (Lachman, in press). This in turn can lead to increased distress and anxiety as well as decreased motivation to use adaptive strategies and effort, all of which can interfere with effective performance (Lachman, in press). Although not assessed in the present study, cognitive performance can also influence beliefs (e.g., Grover & Hertzog, 1991), suggesting that this relationship is reciprocal in nature.

Past research also suggests that control beliefs are associated with performance on some cognitive tasks but not on others (Gold, Andres, Etezadi, Schwartzman, & Chaikelson, 1995; Lachman & Jelalian, 1984; Seeman, McAvay, Merrill, Albert, & Rodin, 1996). For example, control beliefs have been found to be more related to verbal than to nonverbal tasks (Gold et al., 1995; Seeman et al., 1996). However, it is possible that the extent to which beliefs are related to performance also depends on whether the outcomes are age-sensitive or age-insensitive tasks. That is, if declines on certain tasks are keenly felt by middle-aged adults, control beliefs may be relatively more important than they would be for tasks in which age-related declines are less evident and successes are more common. This is because age-sensitive tasks presumably require more effort and therefore allow greater opportunity for motivational and strategic influences. As mentioned above, these factors have been implicated as possible mediators between beliefs and performance (Hertzog et al., 1998; Riggs et al., 1997; Stine et al., 1993; cf. Bandura, 1997; Miller & Lachman, 1999).

In the present study, we explored cognitive performance and predictors of performance for middle-aged adults relative to younger and older adults within four areas of functioning that were more (reasoning and speed) or less (short-term memory and vocabulary) age sensitive (cf. Salthouse, 1991). These factors were selected to represent the multidimensionality and multidirectionality inherent in cognitive abilities in adulthood (Horn & Cattell, 1967; Schaie, 1996). To illustrate, age-related declines in reasoning ability are commonly found (e.g., Schaie, 1985), even after specialized cognitive training (Willis & Schaie, 1986). Prominent age-related declines have also been found on simple speeded tasks in which participants, for example, compare two strings of digits to determine, as quickly as possible, whether they are the same or different (Salthouse & Babcock, 1991). Short-term memory tasks which require individuals to passively hold recently encountered materials for a brief period of time often fail to show age differences (cf. Smith & Earles, 1996). Lastly, age-related declines on vocabulary measures are seldom found (cf. Salthouse, 1991) and, in fact, older adults sometimes show advantages in this area (e.g., Horn & Cattell, 1967; Schaie, 1996). One could argue that the tasks that show the earliest declines are the most challenging for all individuals and therefore may show the greatest effects of control beliefs.

Because background variables such as health, education, and age tend to be related to control beliefs and to cognitive performance (e.g., Lachman, 1991; Schaie, 1996) and, further, tend to attenuate the relationship between control beliefs and cognitive performance (e.g., Miller & Lachman, 1998), we analyzed the data both with and without controlling for background variables. Although these variables, particularly health, could be outcomes to be examined in their own right, our aim was to focus on beliefs and performance while controlling for these factors. This decision was based on research showing that health problems may result in lowered sense of control (Lachman & Leff, 1989) as well as decreased cognitive functioning (Schaie, 1990) and on research showing that younger and more educated adults typically have higher control beliefs and better cognitive performance (Lachman, 1991).

We also conducted group comparisons to investigate whether associations among these variables were similar for young, middle-aged, and older adults. Because the separate age group samples were relatively small, these analyses should be considered as preliminary.

Our hypotheses were that younger adults would outperform middle-aged and older adults on speeded tasks and that adults in midlife would outperform older adults on measures of speed and reasoning. We also predicted that middle-aged and older adults would outperform younger adults on vocabulary. We did not expect to find any age differences on the short-term memory tasks. Based on theoretical work (Bandura, 1997) and empirical evidence (e.g., Hertzog et al., 1998; Riggs et al., 1997) suggesting that one's beliefs can influence performance, we expected control beliefs to predict performance on most if not all the cognitive outcomes variables. We expected the relationship between control and performance to be stronger for age-sensitive than age-insensitive tasks because age-sensitive tasks were thought to require more effort, which is believed to be a mediator between beliefs and performance (Bandura, 1977).

Past work has shown that health predicts control beliefs and cognitive performance such that those who had more health problems were more likely to show declines in control beliefs and intellectual functioning (Lachman & Leff, 1989). Therefore, the relationships between control beliefs and all measures of cognitive performance were expected to be attenuated when health (as well as age and education) was controlled. It was predicted that control beliefs would be related to cognitive performance within all three age groups; however, the strength of the associations between the age-sensitive tasks and beliefs were expected to be most evident for the middle-aged and oldest groups. This expectation was based on the assumption that age-sensitive tasks would require more effort and effective strategies, particularly among older individuals. These within-group predictions are tentative, however, given the limited sample size.

METHOD

Participants

These data were a subset of the Midlife in the United States (MIDUS) Survey conducted by the John D. and Catherine T. MacArthur Foundation Network on Successful Midlife Development. This subset, the Boston In-Depth Study of Management Processes in Midlife, consisted of an intentional oversample (using random digit dialing) of 500 adults in the Greater Boston metropolitan area. A total of 429 participants completed the telephone and mail questionnaire portions of the MIDUS survey, which was the criterion for inclusion in the Boston In-depth Study. Of the 391 who could be reached by phone 6 months after the initial MIDUS survey, 302 (77%) agreed to participate in a three-wave, short-term longitudinal study of life management processes that included a face-to-face interview. There were no significant differences between the participants and the nonparticipants on any demographic variables.

Thus, the current sample consisted of 302 noninstitutionalized, English-speaking adults between the ages of 25 and 75 (M = 47.8, SD = 13.1) who resided in the Greater Boston area. The sample was 41.1% female and roughly half of the participants had a college degree or more education. Participants were further screened for English as their native language and for absence of stroke. Of the remaining 272 participants, 13 failed to complete all of the cognitive measures (these participants did not differ in gender, education, or age from those who did complete the cognitive tests). The resulting sample (N = 259) consisted of 84 young adults (ages 25-39; M = 32.6, SD = 4.1), 108 middle-aged adults (ages 40-59; M = 49.6, SD = 5.0), and 67 older adults (ages 60-75; M = 65.7, SD = 4.1). A chi-square test showed that the age groups were comprised of comparable distributions of males and females, Pearson $\chi^2(2, N = 259) = .41$, $p = .82$. Further, an Age × Sex ANOVA on education level showed that education did not vary as a function of Age, $F = 1.70$, $p = .18$, or Sex, or of a combination of the two, $F < 1$, for both.

Measures

Cognitive Measures

Speed was assessed by the digit symbol substitution test of the Wechsler Adult Intelligence Scale (WAIS; Wechsler, 1955) and a letter comparison task (Salthouse & Babcock, 1991). Reasoning was assessed by the Schaie-Thurstone letter series (Schaie, 1985) and Raven's Advanced Progressive

Matrices (Raven, Raven, & Court, 1991). Short-term memory was assessed by the WAIS forward and backward digit spans as well as a counting backward task requiring participants to count backwards by sevens starting from a three-digit number. For the analyses of variance reported below, scores on the component tasks of the speed, reasoning, and short-term memory factors were transformed into z scores and then averaged to form a composite. For vocabulary, which was assessed via the WAIS vocabulary subscale, the z score transformation was used alone (see Table 1 for means and standard errors as a function of age group). We expected these cognitive measures to form a four-factor model: speed, short-term memory, reasoning, and vocabulary.

Health

Health was assessed using: (a) a checklist of nine acute illnesses experienced within the last 30 days on a six-point scale (1 = *almost everyday*, 6 = *not at all*); (b) the number of chronic illnesses, out of 29, participants had been treated for within the last 12 months; and (c) the number of different prescription medications currently being taken. The health factor was computed by summing the z scores of each subcomponent; therefore, a higher score indicates poorer health.

Control Beliefs

Control beliefs were assessed via two seven-point scales: mastery and perceived constraints (Lachman & Weaver, 1998b; Pearlin & Schooler, 1978). The mastery scale, designed to assess one's beliefs about his or her ability to master the environment, contained items such as ''what happens to me in the future mostly depends on me'' and ''when I really want to do something, I usually find a way to succeed at it.'' The perceived constraints scale was designed to capture the extent to which one perceives uncontrollable constraints in the environment which limit one's pursuits. This scale contained items such as ''other people determine most of what I can and cannot do'' and ''there is little I can do to change the important things in my life.'' In order to facilitate convergence of the measurement model, we created three indicators of control by parceling perceived constraints items into two indicators. This was done by randomly assigning scale items into one of two parcels and then using each as a separate indicator (for a detailed discussion on this procedure, see Kishton & Widaman, 1994). These two parcels had high reliability, as indicated by an internal consistency estimate (coefficient α = .84). The coefficient α for the mastery scale was .70. Thus, together with mastery, we had three indicators of control, with the mastery scale loading negatively and the perceived constraints scales loading positively such that higher scores indicated lower levels of perceived control.

Although this data set contained primarily generalized measures of control beliefs, there were a few items that tapped domain-specific beliefs specific to cognitive abilities. However, the domain-specific measures were collected six months after the cognitive battery. Therefore, we used the generalized measures of control because the model of interest specifies cognitive variables as outcomes. Domain-specific measures are typically more sensitive than are generalized measures, often showing stronger relationships with performance in the corresponding domain than do generalized measures (Lachman, 1986). Thus, by using the generalized measures, we created a more stringent test of our model.

Procedures

Measures were administered over two time intervals that were 10 to 12 months apart. Demographic information of age and education, control beliefs, and health measures were collected via telephone

Table 1. Means (and Standard Errors) of Variables (in z score units) as a Function of Age Group.

	Young adults		Middle-Aged adults		Older adults	
Variables	*M*	(*SE*)	*M*	(*SE*)	*M*	(*SE*)
Health (lack)	–.41	(.25)	.03	(.20)	.50	(.31)
Control (lack)	–.17	(.07)	.12	(.09)	.03	(.10)
Speed	.37	(.08)	.10	(.08)	–.64	(.10)
Reasoning	.32	(.09)	.09	(.09)	–.62	(.10)
STM	–.07	(.08)	.13	(.08)	–.18	(.05)
Vocabulary	–.28	(.10)	.19	(.09)	.05	(.12)

Note. STM = short-term memory.

and mail questionnaires in 1995 as part of the MIDUS Survey. Cognitive measures were collected in participants' homes during the second wave of the Boston Study in 1996. For the cognitive measures, participants were tested individually in a quiet area of their home and received the forward and backward digit spans, vocabulary test, counting backwards task, letter comparison task, digit symbol substitution test, letter series test, and the Raven's Advanced Progressive Matrices, in that order.

RESULTS AND DISCUSSION

Control Beliefs

A composite index of control beliefs was computed by averaging a standardized measure of the constraints scale with a standardized measure of the mastery scale multiplied by negative one. This yielded a summary variable representing a lack of control, consistent with our LISREL model. To examine age differences in control beliefs, a one-way 3(Age: young, middle, old) ANOVA on control beliefs was conducted. The results showed a marginally significant main effect of age, $F(2, 268) = 2.98$, $p = .052$. To determine whether the middle-aged adults differed from the other two age groups, a Tukey's post hoc test was performed. The results indicated that the young ($M = -.17$, $SD = .70$) had significantly higher levels of control beliefs than the middle-aged adults ($M = .12$, $SD = 1.01$), $p < .05$, but that the middle-aged adults did not differ from the older adults ($M = .03$, $SD = .82$). Further, the youngest and oldest groups did not differ. These findings are consistent with those that show that middle-aged adults perceive a loss of control relative to the young, although some past work has found this to be true for the elderly as well (Hertzog et al., 1998; Hultsch et al., 1987; Lachman, 1991). However, these data are not consistent with data showing increases in control beliefs for middle-aged adults relative to young adults (Lao, 1975).

Performance Levels

In order to determine whether there were age differences on the four factors of cognitive abilities, we performed a one-way 3(Age: young, middle, old) ANOVA on each. In addition, post hoc tests were conducted to test whether middle-aged adults performed differently than younger or older adults on these factors (see Figure 1). Significant effects of Age were found for all four analyses; however, the nature of the effects differed across cognitive abilities.

Speed

The Age effect in this analysis was significant, $F(2, 250) = 28.68$, $p < .001$. Specifically, the difference between young and middle-aged groups approached significance ($p = .06$); however, both the young and middle-aged groups significantly differed from the older group. As predicted, performance decreased with age.

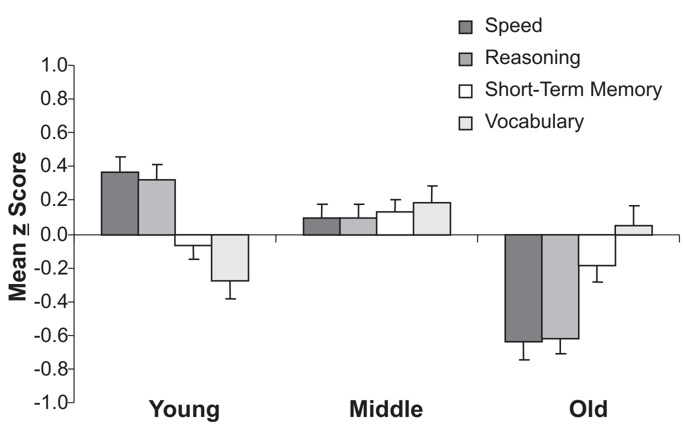

Fig. 1. Cognitive performance by age group.

Reasoning

The Age effect on reasoning, $F(2, 247) = 24.21$, $p < .001$, was attributable to significant differences between the younger two age groups and the oldest. These data are consistent with past research showing that there are steep declines in reasoning abilities after midlife (cf. Schaie, 1990).

Short-Term Memory

The results of the analysis on short-term memory scores showed that Age was significant, $F(2, 256) = 3.44$, $p < .05$; however, this effect was attributable to the middle-aged adults performing significantly better than did the older adults. The young and older groups did not differ. These data are consistent with past research showing no age differences between younger and older adults on short-term memory tasks (cf. Smith & Earles, 1996). However, unlike past research, these data show that for the middle-aged group there was a trend toward peak levels of performance in this area.

Vocabulary

The analysis on vocabulary scores also yielded an effect of Age, $F(2, 255) = 34.02$, $p < .001$, which was due to lower performance levels of younger adults compared to those of the two older groups.

Overall, these data are consistent with our hypotheses by showing that speed and reasoning were particularly age sensitive whereas short-term memory and vocabulary were not. In fact, Figure 1 shows that adults in midlife, unlike younger and older adults, scored above the sample mean (i.e., had positive z scores) on all four factors. Despite some evidence of perceptual slowing, this suggests that midlife is a time of relatively strong performance across abilities.

Structural Equation Models

Structural equation models were used to explore the nature of individual differences in the correlates of cognitive functioning across the entire age range (correlations among variables are presented in Table 2). For all models presented here, we used LISREL 8.14 (Jöreskog & Sörbom, 1996). Because multiple indexes of fit are preferable when conveying how well the data fit the hypothesized structural equation model (cf. Byrne, 1998), we chose the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), and the Goodness of Fit Index (GFI). The RMSEA is an index of fit that takes into account the error of approximation in the population, with less than .05 reflecting a good fit and values greater than .10 reflecting a poor fit. The CFI reflects the degree of match between an independent model and the observed data with values greater than .90 reflecting a relatively good fit. The GFI is based on a comparison of the hypothesized model with no model such that indexes close to 1.00 represent a good fit.

Table 2. Correlations among Background Variables, Control Beliefs, and Cognitive Variables.

	1	2	3	4	5	6	7	8
1. AGE	1.00							
2. EDUCATION	–.04	1.00						
3. HEALTH (lack)	.16**	–.11	1.00					
4. CONTROL (lack)	.08	–.16**	.37**	1.00				
5. STM	–.08	.29**	–.09	–.04	1.00			
6. SPEED	–.46**	.28**	–.18**	–.06	.38**	1.00		
7. REASONING	–.41**	.44**	–.25**	–.17**	.51**	.64**	1.00	
8. VOCABULARY	.14*	.55**	.01	–.10	.45**	.25**	.47**	1.00

Note. For health, control, short-term memory (STM), speed, and reasoning, z scores for the individual measures were computed and then combined to yield a summary score.

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

Measurement Model

The first step was to confirm our predicted four-factor structure (speed, short-term memory, reasoning, and vocabulary) of the cognitive measures. The measurement model indicated a good fit to the data, $\chi^2(14, N = 272) = 20.16$, $p = .12$, RMSEA = .04, CFI = .99, GFI = .98. The fit was improved by allowing the error variance in the backward and forward digit spans to covary. This modification (with a modification index of 19.04, .32 standardized) appeared reasonable given the two items shared high method variance. Because vocabulary was a single-indicator factor, we fixed the measurement error (θ) estimate based on a reliability coefficient of .95 (Matarazzo, 1972).

Control Predicting Cognitive Performance

Next we investigated whether control beliefs predicted performance in all four cognitive domains. As shown in Figure 2, the model yielded a good fit, $\chi^2(34, N = 272) = 43.86$, $p = .12$, RMSEA = .033, CFI = .99, and GFI = .97. The paths from control to the cognitive factors were significant for the reasoning and vocabulary factors but not for the speed and short-term memory factors. The path from control to speed, however, was significant, $t(34) = 1.87$, $p < .05$, for a one-tailed test. Thus in general the data support the notion that higher levels of control are associated with better cognitive performance. However, our hypothesis that control beliefs are more highly related to age-sensitive cognitive domains was only partially supported. Although reasoning, an age-sensitive ability, did show a strong relationship to control beliefs, vocabulary (an area that typically remains stable or even increases into late life) also did. Thus, it appears that control beliefs are not associated with cognitive abilities based only on the extent to which they are age sensitive.

One factor that both reasoning and vocabulary did share in the current study was their response format. Both of these tasks contained problems that were relatively long in duration, requiring sustained attentional resources. Because of this, effort may be particularly important. Additionally, it may be easier to develop effective strategies within this type of format relative to those associated with, for example, counting backwards or letter comparison tasks. Thus, rather than distinguishing which tasks are

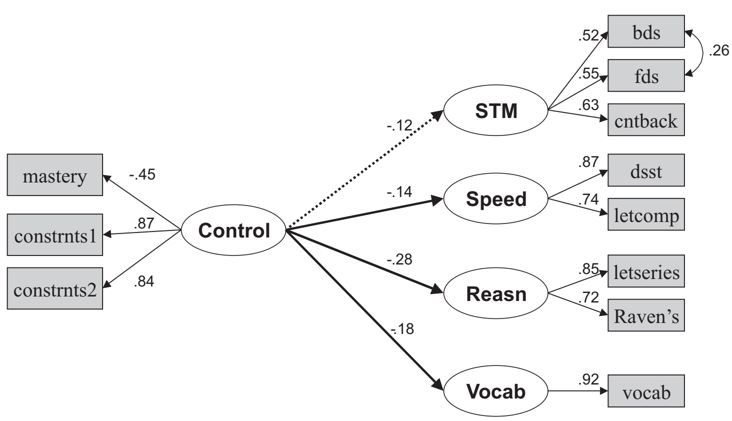

Fig. 2. LISREL model of control predicting cognitive performance. Chi-square = 43.86, *df* = 34, $p = .12$, Root Mean Square Error of Approximation = .033, Comparative Fit Index = .99, and Goodness of Fit Index = .97. All path coefficients are standardized. Solid lines indicate paths significant at $p < .05$ (for a two-tailed test, except control→speed path, which is significant at $p < .05$, for a one-tailed test) and dashed lines indicate nonsignificant paths. Constrnts1 = perceived constraints in parcel 1, constrnts2 = perceived constraints in parcel 2, STM = short-term memory, Reasn = reasoning, Vocab = vocabulary, bds = backward digit span, fds = forward digit span, cntback = counting backwards task, dsst = digit symbol substitution, letcomp = letter comparison, letseries = letter series, Raven's = Raven's Progressive Matrices.

more or less related to control beliefs by virtue of their age sensitivity, relations to control beliefs may also hinge on the response format of the task itself.

Because past research has shown that control beliefs are related to background variables, which in turn are linked to cognitive performance, the next model included background factors. Correlations among background variables, control beliefs, and cognitive factors are presented in Table 2. The table shows significant zero-order correlations between control beliefs and reasoning; however, control was uncorrelated to speed, short-term memory, and vocabulary. The finding that vocabulary was associated with control beliefs in the LISREL model but not in the correlational analyses could be due to the correction for measurement error inherent in structural equation modeling (Byrne, 1998).

Control Predicting Cognitive Performance after Controlling for Background Variables

Past research has shown that control beliefs are related to health (Rodin, 1986), education, and age (Lachman & Weaver, 1998a), and further, that these variables are in turn related to cognitive performance (e.g., Earles, Connor, Smith, & Park, 1997; Hultsch, Hammer, & Small, 1993; Luszcz, Bryan, & Kent, 1997; Perlmutter & Nyquist, 1990). Based on these findings, in addition to those more directly showing that the association between control beliefs and cognitive performance is attenuated when background variables are first taken into consideration (Miller & Lachman, 1998), we controlled for health, education, and age in a mediational model (see Appendix for the covariance matrix). For this model, we first determined the significant paths from the background variable to control beliefs, independent of the cognitive outcome variables. In this case, only health and education significantly predicted control beliefs; therefore, we allowed age to have only direct paths to the cognitive outcome variables. This finding was not entirely unexpected because, although age is sometimes related to control beliefs, research does not consistently show this relationship (e.g., Rodin, 1990), particularly when generalized measures are used (e.g., Lachman, 1986).

The model depicted in Figure 3 has a relatively good fit, $\chi^2(81, N = 272) = 118.59$, $p = .01$, RMSEA = .041, CFI = .97, and GFI = .95. The paths linking control beliefs to speed and vocabulary, however, dropped below significance. Only the path linking control beliefs to reasoning remained significant after controlling for background variables. Thus, in a more stringent test of the associations between control beliefs and cognition, control was positively related to reasoning ability only. It is not surprising that when education was controlled, the path from control to vocabulary was no longer significant given that this factor is highly dependent on experience and acculturation (Horn & Cattell, 1967). The finding that the path from control beliefs to speed fell below significance probably reflects the fact that this association was weak prior to controlling for background variables.

Consistent with past research, health significantly predicted control beliefs (Lachman & Leff, 1989), indicating that those who have more health problems are less likely to feel a general sense of control over their lives. Although not assessed in this study, other research has shown that control beliefs affect health via their impact on health-promoting behaviors and physiological factors (Rodin, 1986). Most likely, health and control beliefs are best represented by a reciprocal relationship in which beliefs and health influence each other (Lachman, Ziff, & Spiro, 1994; Miller & Lachman, 1999).

Our prediction that control beliefs predict reasoning was supported. This is consistent with social-cognitive theory (Bandura, 1997) suggesting that control beliefs exert their influence on cognitive performance through behavioral and physiological factors. Specifically, those who have a higher sense of control are more likely to exert sustained effort and to have lower anxiety and stress reactivity relative to those with low control beliefs (Bandura, 1997).

To test the direct effects of health on reasoning ability, the control beliefs factor was removed from the model. The results showed that health predicted reasoning. This is consistent with past research showing that lower reasoning

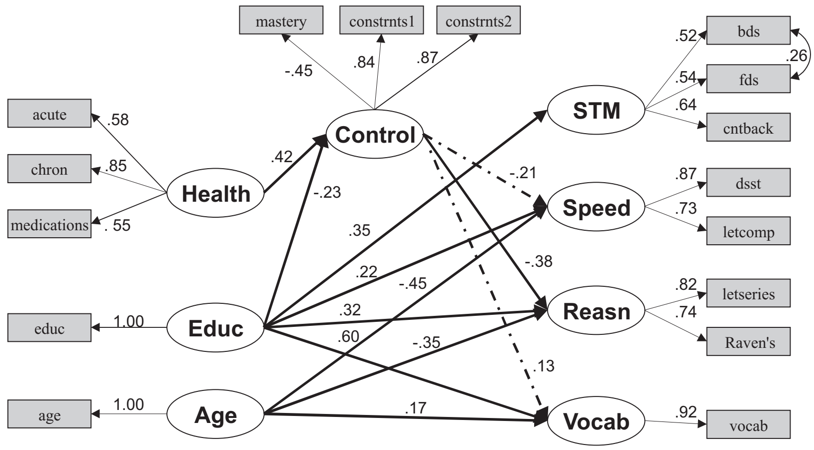

Fig. 3. LISREL model of control predicting cognitive performance after controlling for background variables. Chi-Square = 118.59, *df* = 81, $p < .01$, Root Mean Square Error of Approximation = .041, Comparative Fit Index = .97, and Goodness of Fit Index = .95. All path coefficients are standardized. Solid lines indicate paths significant (for a two-tailed test) at $p < .05$, and dashed lines indicate nonsignificant paths. Acute = number of acute illnesses, chron = number of chronic illnesses, medications = number of prescription medications, educ = education, constrnts1 = perceived constraints in parcel 1, constrnts2 = perceived constraints in parcel 2, STM = short-term memory, Reasn = reasoning, Vocab = vocabulary, bds = backward digit span, fds = forward digit span, cntback = counting backwards task, dsst = digit symbol substitution, letcomp = letter comparison, letseries = letter series, Raven's = Raven's Progressive Matrices.

ability was linked to physiological factors such as cardiovascular and pulmonary problems (Albert et al., 1995; Schaie, 1996). Interestingly, the direct path from health to reasoning dropped below significance when the control beliefs factor was added to the model, suggesting that control beliefs may partially mediate the relationship between health and reasoning. This suggests that health-related factors have an impact on reasoning via the self-beliefs one holds about control. Although past work has shown that health is a significant predictor of both control beliefs and cognitive functioning (Lachman & Leff, 1989), the role of health as a mediator was not examined. Thus, the present results add to our knowledge about the nature of the relationships between health, control beliefs, and cognition.

In summary, the two structural models taken together suggest that control beliefs are related to cognitive functioning; however, this association is strongest for reasoning ability. The relationship between control beliefs and reasoning ability was present even after controlling for age, education, and health. Thus, independent of these factors, control beliefs may affect performance through the influence on more sustained effort, the use of more adaptive strategies, and possibly the reduction in anxiety associated with cognitive testing (Lachman, Ziff, & Spiro, 1994). Reasoning in the present study was assessed by an inductive reasoning task as well as a figural relations task, both representing an ability involving a higher level of processing that could well be suited to these mediating influences. These results suggest the possibility for preventive cognitive interventions for those who show declines in midlife by enhancing the sense of control.

Cognitive restructuring techniques have been successfully used to enhance the sense of control over memory and exercise (Lachman et al., 1997). If beliefs about memory control begin to decline in midlife this may be related to the decrements in cognitive functioning that begin to occur for some individuals in midlife even though in general adults in midlife perform above average. The relationship between control beliefs and reasoning found in this study suggests that such interventions to increase the sense of control may be promising for minimizing cognitive declines.

The attenuation of the relationships between control beliefs and cognitive performance on vocabulary and speed tasks when background variables were included, however, suggests that although control beliefs are an important contributor of cognitive performance, the predictive power of these background variables appears to overlap with beliefs to a large extent. Naturally, none of these relationships can be taken as evidence of causality. Structural equation modeling with cross-sectional data is designed to test associations among variables (cf. Hoyle, 1995), not causality. Because the data in the present study are correlational, we can only conclude that control beliefs are associated with some domains of cognitive functioning; longitudinal work is needed to more precisely address the issue of causality. This type of research could address a presumably more accurate model depicting the reciprocal nature among beliefs and cognition.

Exploratory Subgroup Analyses

In order to explore the possibility that there are age differences in the model presented above (where control beliefs were examined as predictors of cognitive performance on four measures, after considering individual differences in age, education, health, and gender), we tested a model of group invariance using LISREL. In this analysis, we were specifically interested in determining whether the structural relations among the constructs were equivalent across young, middle-aged, and older adults. Therefore, we constrained the factor loadings of each latent construct to be equal across all age groups and then estimated the paths between the constructs separately for each age group.

Among the youngest group, the paths from health to control beliefs, and from education to reasoning and vocabulary, were significant. Table 3 contains the regression coefficients predicting cognitive performance from beliefs. None of the paths linking age to cognitive factors reached significance and control beliefs failed to predict any of the four cognitive factors.

For the middle-aged group, the path from health to control beliefs was significant and education significantly predicted all cognitive variables but reasoning. Education also predicted control beliefs for this group. As was the case among younger adults, age failed to predict cognitive performance. The paths linking control beliefs to the cognitive factors were significant for reasoning ability but this was not the case for the other three factors. Thus, this pattern is consistent with that found for the entire sample. It appears that control beliefs are an important component of cognitive performance for adults in midlife. The finding that control beliefs only significantly predicted reasoning ability could indicate that the challenge posed by this ability together with the response format inherent in the reasoning task both contributed to the effects of perceived control. That is, it is possible that both of these aspects of reasoning ability motivate those individuals in midlife who do have high

Table 3. Regression Coefficients (and Standard Errors) of Control Beliefs Predicting Cognitive Variables for Young, Middle-aged, and Older Adults.

	STM		SPEED		REASON		VOCAB	
	B	(*SE*)	B	(*SE*)	B	(*SE*)	B	(*SE*)
Young	0.20	(0.26)	–4.23	(2.79)	–0.27	(1.52)	4.46	(3.06)
Middle	–0.11	(0.19)	0.38	(1.78)	–2.27	(1.09)	–0.69	(1.71)
Old	–0.36	(0.71)	–6.46	(7.25)	–4.50	(4.31)	0.66	(6.47)

Note. STM = short-term memory; REASON = reasoning; VOCAB = vocabulary; B = regression coefficients.

levels of perceived control to apply their effort and to use effective strategies.

For the oldest group, health failed to predict control beliefs, and education predicted only vocabulary and control beliefs. Unlike the results for the two younger groups, age predicted cognitive performance on two factors: speed and reasoning. Finally, control beliefs failed to significantly predict cognitive performance on any of the factors. However, we should point out that this group was the smallest (67 participants), which may limit the power of the analyses and the generalizability of these findings. Also, in some past research, the relationship between control beliefs and cognitive functioning among the elderly was based on samples in which the mean age was younger than in the current study. For example, the mean age of the older samples was between 70 and 71 for Hertzog et al. (1998), Riggs et al. (1997), and Stine et al. (1993). However, in the present study, the mean age of the older group was roughly 5 years younger. Thus, it could be that the relationship may be stronger for the older elderly where decreased levels of perceived control beliefs (Lachman, 1991) and cognitive performance (e.g., Schaie, 1996) are particularly evident.

In general, the pattern of findings from the subgroup analyses suggests that, after controlling for background variables, reasoning ability among middle-aged adults is influenced by one's control beliefs. It is important to keep in mind that our sample size was relatively small for subgroup analyses and the null findings linking control and cognitive performance in the youngest and oldest groups must be interpreted with caution.

In summary, the analyses performed on the entire sample suggest that cognitive performance and control beliefs are linked and that this association holds for adults in midlife. Although theoretical models propose a reciprocal relationship such that beliefs affect performance, which in turn affects beliefs (Bandura, 1997; Lachman, Ziff, & Spiro, 1994; Miller & Lachman, 1999), this could not be tested with the current data set. However, the nature of this association changes as a function of background variables and specific cognitive ability, consistent with past work showing that beliefs are not linked uniformly across cognitive factors (see also Miller & Lachman, 1998; Seeman et al., 1996).

CONCLUSIONS

Our findings suggest that although some degree of age-related decline is evident in speed of processing in midlife, overall the picture is one of above-average performance on all four abilities relative to other age periods. Thus, consistent with the notion that midlife is a time of peak performance (Neugarten, 1968), in general adults in midlife demonstrated cognitive performance levels comparable to those of younger adults.

These data also show that beliefs about control are related to cognitive performance; however, this relationship is attenuated if background variables are considered. These data suggest that if we are to intervene in the cognitive aging process, control beliefs could be an advantageous starting place but that they need to be considered in tandem with health factors as well as the educational background of the participants.

Reasoning performance, unlike the other areas, remained significantly associated with control beliefs even after background factors were considered. This finding, as well as others (e.g., Gold et al., 1995; Seeman et al., 1996), suggests that some processes are more controllable than others. In the present study, the notion of age sensitivity was considered as a possible candidate; however, the data do not entirely support this notion. More work is needed to determine whether demand characteristics of the tasks themselves can offer another possible explanation. Nevertheless, because control beliefs predicted performance on the reasoning task, these data indicate that reasoning ability may be a promising target for intervention work (Lachman et al., 1992; Willis & Schaie, 1986). Early intervention may be possible for those who are at risk for health problems which may impact cognitive functioning.

Finally, these analyses suggest that control-cognition relations are salient for adults in midlife. Subgroup analyses showed that beliefs are related to cognitive performance within the middle-aged group but could not be confirmed for the younger or older groups, perhaps due to a limited within-group sample size. Interestingly, there was an apparent paradox in that low levels of control beliefs and high levels of performance were found among middle-aged adults, but nevertheless high levels of perceived control predicted better cognitive performance. It is possible that low levels of control beliefs reflect demands made on adults in midlife from many facets of life. If this is true, however, these pressures do not appear to exert a toll on cognitive processes and on the contrary may provide opportunities for sharpening skills. On the other hand, it is also possible that declines in levels of perceived control during midlife are caused by anticipatory declines in perceived control and could be a warning sign for declines in cognitive functioning in later life. Longitudinal research is needed to more fully explore the effects of life-task demands on beliefs and the effects of beliefs on future cognitive performance. More research is also needed to determine the mechanisms linking beliefs with performance, and to determine whether these become increasingly more important as we progress from young adulthood into midlife and from midlife into later adulthood.

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APPENDIX

Covariance Matrix used in LISREL Model Containing Background, Control Beliefs, and Cognitive Variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. BDS	2.53															
2. FDS	1.19	1.89														
3. Cntback	4.27	4.55	79.67													
4. DSST	6.23	3.78	22.72	151.98												
5. Letcomp	2.16	1.48	10.68	38.72	23.86											
6. Letseries	3.82	3.12	24.10	49.33	17.14	45.33										
7. Raven's	1.87	1.35	10.28	22.06	6.96	14.67	12.90									
8. Vocab	5.46	5.38	41.43	32.16	11.45	28.68	17.61	132.62								
9. Mastery	-0.05	-0.04	-0.55	-0.17	-0.25	0.71	0.16	-0.72	0.95							
10. Constrnts 1	-0.20	-0.19	-0.44	-1.45	-0.51	-2.00	-0.47	-2.11	-0.50	1.64						
11. Constrnts 2	-0.18	-0.12	-0.35	-1.88	-0.60	-1.73	-0.59	-2.13	-0.40	1.04	1.22					
12. Acute	-0.15	0.62	1.15	-7.18	-2.35	-3.63	-1.54	1.74	-1.55	2.53	2.27	43.73				
13. Chron	-0.27	-0.07	-0.45	-3.77	-1.25	-2.54	-1.51	0.23	-0.52	0.90	0.75	7.27	4.91			
14. Medications	-0.22	-0.21	-0.34	-2.02	-0.50	-1.07	-0.72	-0.11	-0.12	0.17	0.14	1.58	0.92	0.74		
15. Educ	0.89	0.64	5.46	8.65	2.30	5.89	3.34	15.38	0.10	-0.61	-0.89	-0.99	-0.65	-0.18	6.65	
16. Age	-1.62	-1.29	-0.58	-70.89	-22.44	-28.93	-15.78	20.27	-0.34	1.41	1.80	-3.77	4.83	2.86	- 1.41	181.13

Note. Acute = number of acute illnesses, Chron = number of chronic illnesses, Medications = number of prescription medications, Educ = education, Constrnts1 = perceived constraints in parcel 1, Constrnts2 = perceived constraints in parcel 2, Vocab = vocabulary, BDS = backward digit span, FDS = forward digit span, Cntback = counting backwards task, DSST = digit symbol substitution, Letcomp = letter comparison, Letseries = letter series, Raven's = Raven's Progressive Matrices.