Ryff, Carol D.
(Project 3/Lachman, Margie E.)

(1999), In T.M. Hess & F. Blanchard-Fields(Eds.), Social Cognition and Aging (pp. 17-41). New York, NY: Academic Press

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THE SENSE OF CONTROL AND COGNITIVE AGING

TOWARD A MODEL OF MEDIATIONAL PROCESSES

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INTRODUCTION

At least since the 1970s, researchers have been interested in the relationship between control beliefs and cognitive performance in later life. Using longitudinal data, Lachman (1983) asked the question whether control beliefs and self-efficacy are antecedents or consequences of cognitive decline. With cognitive behavioral and social learning theories as a conceptual framework (Bandura, 1977; Meichenbaum, 1977; Mischel, 1973), this work built on preliminary evidence that beliefs and performance were related at earlier ages as well as in later life (Cattell, 1971; Costa, Fozard, McCrae, & Bosse, 1976; Lachman, Baltes, Nesselroade, & Willis, 1982; Perlmutter, 1978). Although we are still not fully able to answer the question about directionality, the nature of the question we are asking has changed, and we have made some progress in understanding how beliefs and cognitive aging are related. In this chapter, we review past research investigating the impact of control beliefs on cognitive performance as well as new findings that expand our understanding of control beliefs in relation to other predictors of performance. These findings demonstrate the importance of considering the overlap between control beliefs and background factors when decomposing age-

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related variance in cognitive performance. We then examine evidence addressing the relationship from another perspective: that cognitive performance has an impact on control beliefs. Last, we describe a conceptual model designed to move us forward in our quest to understand the mediational processes involved in the association between control beliefs and cognitive performance in later life.

THE CONTROL CONSTRUCT

Most conceptualizations of control beliefs use a multidimensional approach (cf. Skinner, 1995) in an attempt to capture the intricacies of the construct. Although there are many overlapping constructs, such as self-directedness, choice, decision freedom, agency, mastery, autonomy, self-determination, and self-efficacy, most working definitions of control include at least two components. Our conceptualization contains two components: (1) beliefs about one's own abilities and capacity to bring about a given outcome and (2) beliefs about the role of factors other than the self that are responsible for outcomes—for example, other people or environmental contingencies (Lachman & Weaver, 1998b). Definitions can also differ in terms of whether they focus on general control beliefs or beliefs that are specific to domains such as memory or health. The domain-specific approach assumes that control beliefs may vary across different spheres of life (Lachman & Weaver, 1998a). We refer to both domain-specific and general conceptualizations of beliefs throughout this chapter.

Very closely related to the notion of control beliefs is the concept of self-efficacy; in fact, the terms are often used interchangeably. Self-efficacy, however, tends to emphasize the component of control that focuses on self-beliefs about one's capability to accomplish a specific task. According to Abeles (1990), self-beliefs about abilities (e.g., skills) and capabilities (e.g., to exert effort) combine with beliefs about the nature of the task (e.g., difficulty) to produce self-efficacy expectations. Cavanaugh and colleagues (Cavanaugh, Feldman, & Hertzog, 1998) emphasize the personal agency aspect of self-efficacy, stating that beliefs about one's ability to use a particular skill effectively are a central component of the construct. Regardless of which term is used, control beliefs are important determinants of well-being. In their analysis of important contributors to successful aging, Rowe and Kahn (1997) identified the sense of control as an important ingredient. The contribution of control beliefs to positive outcomes in later life has been most notably demonstrated in the area of cognitive functioning (Albert et al., 1995; Lachman, Ziff, & Spiro, 1994).

CONTROL OVER COGNITIVE AGING

Consistent with the aforementioned description of a sense of control, control over cognitive aging also includes a constellation of beliefs. These include beliefs about one's own problems, capabilities, or competence (self-efficacy) and the responsiveness of the environment as well as attributions that one makes about the causes of cognitive performance, both successes and failures (Lachman, in press). Not surprisingly, then, there are also a number of constructs that fall under the rubric of control beliefs within the domain of cognitive aging. These include memory complaints or problems, attributions, metamemory, and self-efficacy (e.g., Ryan, 1996). We include each of these constructs in addition to the broader notion of control beliefs in our discussion of how a sense of control may change in later life as well as review evidence that beliefs affect performance. Following this, we present data indicating that the reverse effect is also possible: that performance affects beliefs. However, research investigating the effects of performance successes and failures on subsequent self-beliefs is scant, which limits our discussion to the constructs of self-efficacy and control beliefs.

THE EFFECTS OF BELIEFS ON COGNITIVE PERFORMANCE

One's sense of control is believed to have a variety of effects on cognitive performance (Rodin, 1990). Rodin stated, "People who believe strongly in their problem-solving capabilities are more efficient in their analytic thinking and complex decision-making situations. Those who are plagued by self-doubts are erratic in their analytic thinking. The quality of analytic thinking in turn affects performance accomplishments" (Rodin, 1990, p. 8). People high in perceived control are able to see themselves as successful, and this in turn serves to motivate performance. By contrast, if individuals see themselves as inefficacious, they dwell on failure, which could undermine performance. Perceived control can also affect performance by increasing effort and endurance and by decreasing anxiety and stress (Bandura, 1997).

BELIEFS

As mentioned above, a number of beliefs have been investigated in relation to cognitive performance and aging: memory complaints, attributions, metamemory, self-efficacy, and control. We review findings of age differences and the effects of beliefs on cognitive performance, highlighting the common threads that are closely related to the construct of control.

Memory Complaints

Complaints about memory problems typically include the frequency of memory-problem occurrence as well as the type of concern. They often reflect a concern about perceived decline and the anticipation of further decrement. Although memory complaints appear to be prevalent in later life (Aldwin, 1990; Cutler & Grams, 1988; Jonker, Launer, Hooijer, & Lindeboom, 1996; Zelinski, Gilewski, & Anthony-Bergstone, 1990), recent evidence suggests that the frequency of complaints does not vary throughout adulthood. In a study of adults ranging in age from 25 to 75, memory problems were investigated in the context of 22 other domains of life (Lachman, Maier, & Budner, in preparation). No age differences were found in the reported frequency of general memory problems: 30% of adults at all ages identified problems with memory as occurring several times a week or more. Consistent with findings from other surveys (e.g., Aldwin, 1990; Lachman, 1991), these problems were not rated as highly stressful even though they were one of the most frequently occurring problems identified.

However, some research indicates that the elderly report more problems than do the young with some types of memory—for example, remembering names and telephone numbers (Cohen, 1993). This is consistent with research showing that forgetting names is the most prevalent memory problem reported among older adults given a list of different types of memory problems (e.g., remembering where they parked the car) (Leirer, Morrow, Sheikh, & Pariante, 1990). However, there are some areas in which older adults rate their memory as better than do the young—for example, paying bills, keeping appointments, and taking medicine (Cohen, 1993). These subjective reports have been validated through observations of performance in daily life in which older adults are more likely than are the young to use external memory aids to remember things they need to do (Cohen, 1993).

It has become more common in the late twentieth century for older adults to report concerns about developing Alzheimer's disease. Older adults tend to overestimate the incidence of Alzheimer's disease (Gatz & Pearson, 1988). Furthermore, the Alzheimer's Likelihood Scale (Lachman, Bandura, Weaver, & Elliott, 1995) revealed that those who thought they would be more likely to get Alzheimer's disease had lower perceived memory ability and stronger beliefs about the inevitable decrement of memory. Thus, these fears and concerns about memory loss or Alzheimer's disease may reflect a lack of perceived control over cognitive aging.

Unfortunately, the data at this point are equivocal as to whether memory complaints predict actual memory deficits. For example, data have been reported showing no relationship (Smith, Petersen, Ivnick, Malec, & Tangalos, 1996) and showing a strong relationship (Jonker et al., 1996) between complaints and performance. Some researchers argue that memory complaints are less related to cognitive performance and more to anxiety or depressed affect (Gilewski, Zelinski, & Schaie, 1990; Smith & Earles, 1996; Zarit, Cole, & Guider, 1981). On the basis of findings from the Memory Functioning Questionnaire (MFQ) (Gilewski et al., 1990), the issue remains unclear. This instrument is widely used to assess memory problems and consists of 64 items reduced to 4 factors (frequency of forgetting, seriousness of forgetting, retrospective functioning [memory decline], and mnemonic use). Scores from the MFQ were found to be significantly correlated to word list recall and recognition scores even after controlling for subject background variables, including depression (Zelinski et al., 1990). Thus, although depression and memory complaints appear to be highly correlated in some cases, the overlap is not complete (Lachman et al., 1995).

Although at present the data fail to make a strong case that concerns about memory affect cognitive performance in later life, future work may uncover this association by considering the impact of control beliefs. If one is concerned about performance getting worse and believes that there is little one can do to improve or prevent decline, this could result in fear, anxiety, or depression (Bandura, 1989). These emotional reactions can interfere with performance by limiting effort or even by leading to withdrawal from cognitive tasks because of fear of failure or judgment of incompetence by others (Bandura, 1997). Research also indicates that these emotions can themselves lead to cognitive declines through disruption of thoughts and concentration (cf. Bandura, 1989; Centofanti, 1998). Moreover, attributing isolated incidents of forgetting to internal stable causes such as Alzheimer's disease can be associated with a sense of helplessness (Lachman et al., 1995). Thus, concerns about memory performance may influence actual performance via beliefs about control.

Attributions

Attributions are explanations individuals make regarding successful or unsuccessful performance outcomes (Abramson, Seligman, & Teasdale, 1978). Older adults are more likely to explain outcomes in a disadvantageous way (Lachman, 1990; Lachman & McArthur, 1986; Rodin & Langer, 1980.) For example, Lachman and McArthur (1986) found that when older adults failed to remember something, they blamed it on internal and stable causes, such as their poor memories, whereas young adults blamed failure on internal and unstable factors, such as lack of effort. Younger adults' attributional style is more adaptive because it implies that something can be done to improve functioning the next time, namely, trying harder. Conversely, those who blamed failure on internal stable factors did not improve, perhaps because of feelings of helplessness (Abramson et al., 1978). These perceptions are not held only by older adults. Erber, Szuchman, & Rothberg (1990) found that both younger and older judges were more likely to attribute memory difficulties of older adults to mental difficulties needing treatment, whereas the same mistakes made by younger adults were more likely to be attributed to attentional problems.

Importantly, these beliefs have an impact on subsequent performance. For example, older adults who attributed successful performance to internal and stable factors were more likely to improve over time (Lachman, Steinberg, and Trotter, 1987). Attributions have also been found to have an effect on performance levels of elderly adults through subliminal priming. Older adults who received subliminal priming of words describing positive aspects of aging and who were told that their successful performance was attributable to internal (i.e., modifiable) factors improved their memory scores over two trials (Levy, 1996). On the other hand, older adults who were primed with negative age-stereotypic words and given external (i.e., nonmodifiable) attributions showed decrements in performance. Similarly, cross-cultural work investigating age differences in beliefs indicates that age-related declines that are typically found in memory performance are not found in cultures where age stereotypes are positive (Levy & Langer, 1994). Thus, older adults tend to make less adaptive attributions that may be due in part to cultural values, and these attributions in turn can have negative effects on performance.

Metamemory

Metamemory, or metacognition, examines the knowledge the individual holds about cognitive faculties and how they work, including beliefs about abilities and control (Cavanaugh & Baskind, 1996; Dixon, 1989; Dixon, Hultsch, & Hertzog, 1988; Zelinski et al., 1990). Metamemory knowledge is assessed, for example, by how much an individual knows about circumstances that facilitate or hinder memory and about strategies that support faster learning. One widely used tool to assess metamemory is the Metamemory in Adulthood instrument (MIA; Dixon et al., 1988). This instrument contains seven subscales: self-reported use of strategies, knowledge about basic memory processes, perceived capacity of memory, beliefs surrounding the stability and modifiability of memory, anxiety surrounding memory performance, perceived importance of memory achievement, and locus of control. Factor analyses reveal that there are two higher-order factors, memory knowledge and memory self-efficacy, the latter of which includes perceived capacity of memory and locus of control (Hertzog, Dixon, Schulenberg, & Hultsch, 1987). Reports of age differences in metamemory depend on the specific aspect under investigation. In general, however, younger adults tend to score higher on perceptions of abilities and strategy use (although some research has found no age differences), whereas older adults tend to score higher on perceptions of decline and problems associated with memory (cf. Dixon, 1989).

More importantly, metamemory has been found to be related to memory performance among older adults; those who have higher levels show superior performance on a wide range of memory tasks (e.g., Cavanaugh & Poon, 1989; Hertzog, Dixon, & Hultsch, 1990). The focus of much of this research has used MIA subscales assessing beliefs about one's own cognitive abilities (i.e., self-efficacy beliefs or control beliefs), both of which are described below.

Self-Efficacy

As mentioned earlier, self-efficacy refers to beliefs about one's ability to bring about desired outcomes (Bandura, 1997). Self-efficacy beliefs are assessed in terms of the degree to which individuals expect to be able to perform a particular task as well as their level of confidence in this belief (or prediction). The data suggest that beliefs about cognitive performance, especially memory, tend to be at lower levels among older adults relative to younger adults (cf. Berry & West, 1993). However, both young and older adults tend to become more accurate over time, especially for tasks on which they performed well (Lachman & Jelalian, 1984).

Self-efficacy has been shown to be associated with cognitive performance in a number of different ways. For example, those who believed they had better memories outperformed those with lower self-efficacy scores (Lachman et al., 1987)

and they were more likely to improve their performance in response to memory training (Rebok & Balcerak, 1989). Similarly, findings from a longitudinal study of older adults showed that efficacy for influencing everyday tasks was one of four predictors (the others being education, physical activity, and pulmonary functioning) of maintenance of cognitive functioning (Albert et al., 1995).

Self-efficacy predicts not only current performance but also changes in performance (Seeman, McAvay, Merrill, Albert, & Rodin, 1996) and confidence in one's abilities to improve (Bandura, 1997; Lachman et al., 1995). Some work suggests that those who have higher self-efficacy beliefs are likely to exert more effort and to spend more time studying or learning the material (Berry, 1987). Thus, the higher performance levels of individuals with high self-efficacy could be in part attributable to motivational factors (Bandura, 1997).

Control Beliefs

The constructs of self-efficacy and control overlap, with the former being more closely related to beliefs about one's capabilities and the latter being more closely related to beliefs about factors that are responsible for performance outcomes. As mentioned above, however, control is sometimes considered to be a broader concept in that both self-efficacy and outcome expectations are important facets of control (Bandura, 1997). A similar distinction can be made within the locus of control literature between the constructs of internal and external control (Levenson, 1974). In this case, internal control refers to internal causes of behavior, such as self-efficacy, and external control refers to external factors that influence outcomes. Despite these subtle differences, we use the broader conceptualization of control beliefs in the discussion that follows and include both the internal and external dimensions of control.

Although age differences in control beliefs have been reported (Lachman, 1986), more finely grained analyses indicate that these differences are more pronounced for external control than for internal control. This suggests that although older adults are more likely than are the young to believe that external factors are responsible for their cognitive performance, they nevertheless have similar beliefs about their abilities and the role that internal factors such as effort play in achieving outcomes. That is, older adults are more likely to report that external factors contribute to their performance—for example, that they need to rely on others to help them with cognitive tasks. Even though age differences in internal control beliefs are minimal, older adults tend to hold the belief that age-related decrements in performance are inevitable (Lachman, 1986).

A good deal of research is consistent with the notion that control beliefs affect cognitive performance (e.g. Berry, 1987; Cavanaugh & Poon, 1989; Grover & Hertzog, 1991; Lachman et al., 1982; Riggs, Lachman, & Wingfield, 1997; Stine, Lachman, & Wingfield, 1993). This relationship is even stronger for domain-specific control beliefs (e.g., Lachman, 1986) and for older adults (Dixon & Hultsch, 1983; Lachman et al., 1982). Specifically, these data suggest that those with high levels of control beliefs outperform those with lower levels.

For example, Lachman and colleagues (Stine et al., 1991) used the Personality in Context Scale (PIC) (Lachman et al., 1982) to assess the relationship of perceived control to cognitive performance. This instrument contains three control scales regarding everyday cognitive tasks: internal, chance, and powerful others. The internal scale is designed to tap beliefs that improvements are possible through one's own effort and contains items such as "I know if I keep using my memory I will never lose it." The chance scale includes items such as "There's nothing I can do to preserve my mental clarity," which are designed to capture beliefs that performance is controlled by fate or chance. The powerful others scale refers to a reliance on other people for achieving outcomes and includes items such as "I can only understand instructions after someone explains them to me." The external scales of chance and powerful others were negatively correlated to performance on a prose recall task, and interestingly, this relationship was stronger when adults had no control over the speech input (relative to when they could pause the recorded narratives). Thus, these data suggest that perceptions of external control are particularly important when actual control is absent (Stine et al., 1993).

In another study, older adults were divided into "internals" and "externals" on the basis of their scores on the PIC to determine whether these two groups differed in terms of memory monitoring and prose recall (Riggs et al., 1997). Participants were required to select the size of speech input they believed they could accurately recall for both word lists and meaningful passages. Internals showed higher levels of recall for the prose passages and were better able to monitor their memory as indexed by the segment sizes they could accurately recall. These data lend some insight into potential mediational processes in that older adults with high internal control beliefs were better at monitoring their memory capacity, which in turn led to more accurate recall.

Because Lachman and colleagues (Lachman, Weaver, Bandura, Elliott, & Lewkowicz, 1992) were interested in investigating perceptions of ability and controllability that were specific to the domain of memory, the Memory Controllability Inventory (MCI) was developed. This instrument includes items that assess controllability, as does the PIC, but it also attempts to distinguish between perceptions of present and future abilities through the use of four scales: present ability, potential improvement, effort utility, and inevitable decrement. The data thus far indicate that these perceptions are indeed related to cognitive performance. For example, the inevitable decrement scale was correlated with working memory and text recognition, present ability and potential improvement scales were related to name–face recall, and all four scales were correlated with list recall (Lachman et al., 1995).

In their investigation of the psychometric properties of the MCI, Cavanaugh and Baskind (1996) found significant correlations between subscales of the MCI and the MIA. Similarly, Bachrach (1998), using four subscales of the MCI (present ability, potential improvement, effort utility, and inevitable decrement), found significant correlations with MIA subscales, in particular, with the capacity, change, and locus of control subscales. Thus, these data support the notion that the constructs of control and metamemory have a high degree of overlap.

It is interesting, however, that control and self-efficacy do not affect all cognitive abilities uniformly (Gold, Andres, Etezadi, Schwartzman, & Chaikelson, 1995; Lachman & Jelalian, 1984; Miller & Lachman, 1998; Seeman et al., 1996). For example, some work has shown that control beliefs are more highly related to verbal relative to nonverbal tasks (Gold et al., 1995; Lachman & Jelalian, 1984; Seeman et al, 1996). One of the goals of future research, therefore will be to determine which cognitive domains are more closely linked to a sense of control and to uncover the factors responsible for these differences across cognitive domains.

In summary, the evidence presented in this section suggests that the beliefs we hold about our abilities vary by age and influence our performance levels. For older adults, this implies that a sense of control has a positive influence in the face of an age-related decline in cognitive performance (e.g., Salthouse, 1991). Positive attributions, knowledge of memory processes, high self-efficacy, high control beliefs, and perhaps low levels of memory complaints bode well for cognitive outcomes. As we show next, however, the nature of the relationship between beliefs and performance is somewhat complicated by whether background factors, which appear to have an impact on the magnitude of this association, are taken into consideration.

CONTROL BELIEFS IN RELATION TO OTHER PREDICTORS OF COGNITIVE PERFORMANCE

In addition to the literature surrounding control beliefs, there is a large body of research addressing the nature of other sources of individual differences in cognitive performance in later life. Some longitudinal research, for example, has shown that good health and education (e.g., Albert et al., 1995; Katzman, 1997; Schaie, 1990) contribute to cognitive performance. Similarly, other work has shown correlations between cognitive performance and social activity (Hultsch, Hammer, & Small, 1993; Luszcz, Bryan, & Kent, 1997) health (Earles, Connor, Smith, & Park, 1997; Hultsch et al., 1993; Perlmutter & Nyquist, 1990), gender and vocabulary (Luszcz et al., 1997), speed of processing (Earles et al., 1997; Luszcz et al., 1997), and exercise (Simonsick, 1997; Dustman et al., 1984). Given that these factors are important contributors of cognitive functioning, we were interested in determining how these variables compared to control beliefs in their ability to predict cognitive performance across the life span. Specifically, our goal was to determine whether the effects of control beliefs on cognitive performance were altered by the presence of other predictors and to explore age–performance relations by decomposing the age-related variance in cognitive ability.

To do this, we categorized predictors (Table 2.1) into noncognitive factors (activity, health problems, exercise, gender), cognitive control (beliefs about control over thinking and learning), distal cognitive ability (vocabulary and educa-

TABLE 2.1 Independent and Dependent Measures

Independent variables	Dependent variables
Noncognitive	**Short-term memory**
Health problems: Self-report scales measuring acute illnesses, chronic illnesses, and number of prescription medications	*Forward digit span:* WAIS subscale
Activity: Number of meetings attended per week, hours worked for pay and as a volunteer per week, and student status (none, part time, full time)	*Backward digit span:* WAIS subscale
Exercise: Frequency of engagement in moderate-to-vigorous physical activity	*Counting backward task:* Beginning with 478, the number of times participants correctly subtracted 7 within 30-second interval
Gender	**Divided attention**
Cognitive control beliefs	*Letter comparison task* (Salthouse)
Perceptions of control: Learning processes	*Counting backward task:* Beginning with 350, the number of times participants correctly subtracted 7 within 30-second interval
Perceptions of control: Thinking processes	**Reasoning**
Distal cognitive	*Raven's Advanced Progressive Matrices*
Vocabulary: WAIS subscale	*Schaie–Thurstone letter series*
Education level: Years of education broken down into 12 levels	
Proximal cognitive	
DSST: WAIS (speed)	
Age	
Age: Years of age	
Age²: Age squared	

DSST = digit symbol substitution test; WAIS = Wechsler Adult Intelligence Scale.

tion), and proximal ability (speed). This categorization scheme allowed us to evaluate predictors vis-à-vis proximal and distal influences (Salthouse, 1991). Hierarchical regressions were used to predict age-related and total variance in cognitive performance in a representative sample of adults. To have a wide range of cognitive abilities, we selected three domains of cognitive functioning, reasoning, short-term memory, and divided attention. These domains represent areas that typically show (reasoning), fail to show (short-term memory), and sometimes show (divided attention) age-related declines.

Data presented here (based on Miller & Lachman, 1998) are a subset of those from the Midlife in the United States (MIDUS) Survey conducted by the John D. and Catherine T. MacArthur Foundation Network on Successful Midlife Development (MIDMAC). This subset, the Boston In-Depth Study of Management Processes in Midlife, consists of an intentional oversampling of noninstitutionalized, English-speaking adults, between the ages of 25 and 75 ($M = 47.8$, $SD = 13.1$) in the greater Boston area. Of the sample, 41.1% were women and roughly half of the participants had college degree or higher. The sample ($n = 253$) was

composed of 83 young adults, 105 middle-aged adults, and 65 older adults (ages 60–75; $M = 65.7$, $SD = 4.1$). Age groups comprised comparable distributions of men and women, and education did not vary as a function of age, gender, or a combination of the two.

Data collection occurred over three time periods, 6–8 months apart. For the cognitive measures, participants were tested individually in their homes at Time 2. Demographic information (gender, age, education) as well as health, activity, and exercise measures were collected through both interview and questionnaire formats at either Time 1 or Time 2. Cognitive control was assessed at Time 3.

We found the expected age-related declines in reasoning abilities such that younger adults outperformed middle-aged adults, who in turn outperformed the oldest group (e.g., Schaie, 1990). The analysis on divided attention also showed significant age differences; however, these were attributable to declines for the oldest relative to the younger two groups, who did not differ from each other. The results of the analysis on short-term memory showed that middle-age group outperformed the older adults; however, the younger adults did not differ from either the middle-aged or older groups. Thus, this pattern of declines in reasoning and divided attention but not in short-term memory among the oldest group relative to the youngest group is consistent with past research (cf. Salthouse, 1991; Smith & Earles, 1996). Furthermore, because the middle-aged group scored above the sample mean on three abilities, these data suggest that midlife is a time of relatively high levels of performance across several different abilities.

To examine the degree of overlap among the predictors and outcome measures, we first computed zero-order correlations (Table 2.2) among all variables. The two predictors that appeared to show the greatest number of significant correlations to other predictors were exercise, which correlated with all other predictors except quadratic age, and speed of processing, which was related to all other predictors except activity. Control beliefs were positively correlated to exercise and to both cognitive predictors (vocabulary, speed) and negatively correlated to health problems and age, however, beliefs were uncorrelated to activity, gender, education, and quadratic age. All three cognitive variables were significantly correlated to each other and each showed a distinct constellation of correlations with the predictors. Thus, these findings show that although there is some degree of overlap among predictors, the magnitude and the patterns of the correlations varied across cognitive factors.

To assess the individual contributions of each category of predictor, we entered them into three hierarchical regressions separately by cognitive outcome variable (Table 2.3, Models 2–5). Noncognitive factors explained between 5% and 15% of the variance in cognitive performance. This is consistent with past research demonstrating that noncognitive factors, such as health and lifestyle, are associated with cognitive abilities in a variety of domains (e.g., Earles et al., 1997; Hultsch et al., 1993; Luszcz et al., 1997; Perlmutter & Nyquist, 1990). Cognitive control beliefs significantly predicted performance on the short-term memory task and reasoning task (3% and 5% of variance, respectively) but not on the

TABLE 2.2 Correlations among Predictors and Outcome Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Activity	1.00													
2 Exercise	0.12	1.00												
3 Health	0.08	−0.18	1.00											
4 Gender	−0.05	−0.12	0.10	1.00										
5 Control—thinking	0.09	0.19	−0.30	−0.08	1.00									
6 Control—learning	0.08	0.12	−0.18	−0.03	0.47	1.00								
7 Education	0.22	0.27	−0.11	−0.05	0.10	0.09	1.00							
8 Vocabulary (WAIS)	0.15	0.16	0.01	−0.12	0.15	0.09	0.55	1.00						
9 DSST (WAIS)	0.09	0.17	−0.19	0.24	0.14	0.14	0.29	0.24	1.00					
10 Age	−0.08	−0.26	0.16	−0.03	−0.09	−0.18	−0.04	0.14	−0.46	1.00				
11 Age squared	−0.07	−0.05	0.03	−0.04	−0.02	−0.10	−0.10	−0.13	−0.18	0.10	1.00			
12 Reasoning	0.13	0.29	−0.25	0.07	0.18	0.20	0.44	0.47	0.63	−0.41	−0.18	1.00		
13 Short-term memory	0.13	0.20	−0.09	−0.18	0.16	0.14	0.29	0.45	0.34	−0.08	−0.16	0.51	1.00	
14 Divided attention	0.09	0.19	−0.11	−0.04	0.04	0.05	0.27	0.26	0.42	−0.20	−0.14	0.46	0.43	1.00

DSST = digit symbol substitution test; WAIS = Wechsler Adult Intelligence Scale. $r > .12$, $p < .05$ (in bold).

TABLE 2.3 Hierarchical Regressions Predicting Short-Term Memory, Divided Attention, and Reasoning

Model Predictor	Short-term memory				Divided attention				Reasoning			
	Cumulative R^2	R^2 change	F(R^2 change)	Reduction of age-related R^2	Cumulative R^2	R^2 change	F(R^2 change)	Reduction of age-related R^2	Cumulative R^2	R^2 change	F(R^2 change)	Reduction of age-related R^2
1 Age/age²	0.03	0.03	3.75*		0.06	0.06	6.93***		0.19	0.19	28.59***	
2 Noncognitive	0.08	0.08	5.26***	25%	0.05	0.05	3.01*	39%	0.15	0.15	11.01***	40%
Age/age²	0.10	0.02	2.95*		0.09	0.04	4.31*		0.26	0.11	18.48***	
3 Cognitive control	0.03	0.03	3.86*	18%	0.00	0.00	0.27 *ns*	4%	0.05	0.05	6.49**	14%
Age/age²	0.05	0.02	3.04*		0.06	0.06	6.54**		0.21	0.16	24.72***	
4 Distal cognitive	0.21	0.21	32.78***	7%	0.09	0.09	11.49***	2%	0.27	0.27	46.15***	NA
Age/age²	0.23	0.03	4.20*		0.15	0.06	7.50**		0.48	0.21	49.74***	
5 Proximal cognitive	0.12	0.12	33.77***	39%	0.18	0.18	50.76***	91%	0.39	0.39	160.22***	88%
Age/age²	0.14	0.02	2.45*		0.18	0.01	0.64 *ns*		0.42	0.02	4.69**	
6 Noncognitive	0.08	0.08	5.06***		0.05	0.05	2.97*		0.15	0.15	10.88***	
Cognitive control	0.09	0.01	1.76 *ns*		0.05	0.00	0.15 *ns*		0.17	0.02	2.48*	
Distal cognitive	0.24	0.15	24.42***		0.12	0.07	8.16***		0.38	0.21	40.83***	
Proximal cognitive	0.31	0.07	23.62***	82%	0.24	0.12	34.57***	95%	0.56	0.17	92.14***	77%
Age/age²	0.32	0.01	0.81 *ns*		0.24	0.00	0.44 *ns*		0.60	0.04	12.58***	

NA resulted in a negative value likely due to suppression.
†$p < .10$ *$p < .05$ **$p < .001$.

divided attention task. Although in past work control beliefs have been associated with memory (Stine et al., 1993) and reasoning performance (Grover & Hertzog, 1991; Lachman & Jelalian, 1984; Lachman & Leff, 1989), we are unaware of work addressing control in relation to divided attention performance. Distal cognitive factors (9–27% of variance) and speed of processing (12–39% variance) significantly predicted cognitive performance on all tasks. This was not surprising given that past research has also shown speed of processing (Earles et al., 1997; Luszcz et al., 1997; Park et al., 1996) and education (i.e., distal cognitive) (Albert et al., 1995; Schaie, 1990) to be important predictors of cognitive performance. These data are consistent with past research showing that both noncognitive and cognitive background variables predict performance across a wide range of abilities and with research showing that control beliefs predict performance for some, but not all, cognitive abilities (e.g., Seaman et al., 1996).

Although these data support the notion that background variables and cognitive control beliefs are both important factors of cognitive performance, two further sets of inquiry are needed to help clarify the relationship between control and cognition and how this relationship may differ with age. First, it is theoretically important to determine the extent to which variance explained by control beliefs and the other predictors is age related (cf. Salthouse, 1996). For example, do beliefs about cognitive control explain variance that is attributable to age alone? Second, given that there was a moderate degree of overlap among the predictor variables (cf. Table 2.2), it is also important to determine whether the relationship between control beliefs and cognitive performance will be diminished or even disappear after background variables are considered.

So that we could investigate the proportion of age-related variance explained by each predictor category, we first calculated the total amount of variance explained by age alone. As shown in Table 2.3, age (Model 1) accounted for 3%, 6%, and 19% of the variance in short-term memory, divided attention, and reasoning performance, respectively. Next, the unique age-related variance was calculated by determining how much variance age explains after partialling out the other predictor variables. The difference between this unique age-related variance and the total age-related variance was then be divided by the total age-related variance. The results of this step, depicted in Models 2–5, indicate the degree to which each category of predictor explained variance in cognitive performance that was attributable to age alone. A comparison of these models shows that cognitive control beliefs were moderately strong in their ability to account for age-related variance. Beliefs attenuated the age-related variance for short-term memory by 18% and for reasoning by 14%.

Last, Model 6 (see Fig. 2.1) shows the total model with all five sets of predictors entered hierarchically to assess the relative strength of factors ranging from distal to proximal (cf. Salthouse, 1991). In this analysis, noncognitive background variables were entered before cognitive control beliefs to assess the effects of beliefs after partialling out gender and individual differences in activity, exercise, and health. This model, summarized in Table 2.3, accounted for between

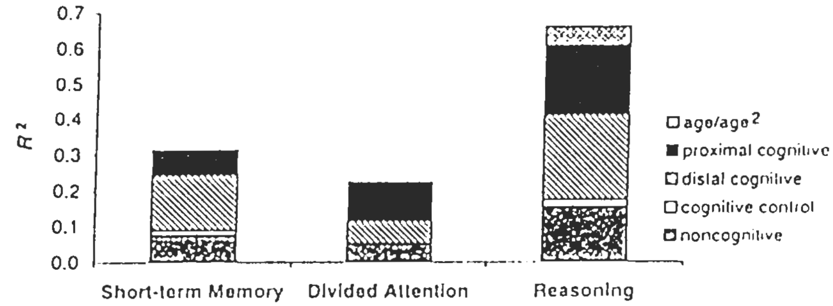

FIGURE 2.1 Total variance accounted for in short-term memory, divided attention, and reasoning performance.

24% and 60% of the variance in cognitive performance. Importantly, when noncognitive factors were controlled for, control beliefs were only marginally significant for reasoning ability and dropped below significance for short-term memory. These data suggest that beliefs about control overlap with some combination of health, activity, exercise, and gender. Significant correlations between control beliefs and health problems and exercise (see Table 2.2) suggest that these two variables may be responsible for this overlap. Further research may be able to shed light on possible mediational processes linking control beliefs, health, exercise, and cognitive performance.

Given that the total variance explained differed across cognitive factors, it is helpful to consider variance explained by each predictor (taken from hierarchical analyses) as a proportion of the total variance. Figure 2.2 shows that control beliefs explain the same proportion of variance in both short-term memory and reasoning. These data beg the question as to why these two variables are associated with beliefs whereas divided attention fails to show this association. It could indicate that our domain-specific measures of control need to be more specific to the cognitive task under investigation. Alternatively, it could be that the divided attention task is too difficult to be influenced by control beliefs and that beliefs are more likely to affect cognitive tasks that are only moderately challenging to older adults.

In summary, this study demonstrated that the strength of each predictor category, whether distal or proximal in nature, varied as a function of cognitive domain and varied in the extent to which it shared age-related variance. Furthermore, beliefs about control predicted cognitive performance within the domains of short-term memory and reasoning but not for divided attention. It is important to note, however, that these significant relationships were attenuated when background variables were taken into consideration. Finally, the large overlap between control beliefs and noncognitive measures suggests that more work is needed to uncover processes underlying these factors so that we can better understand factors contributing to successful cognitive performance.

Before we conclude the sections dealing with the effects of control beliefs on performance, we must point out that not all research has found a link between

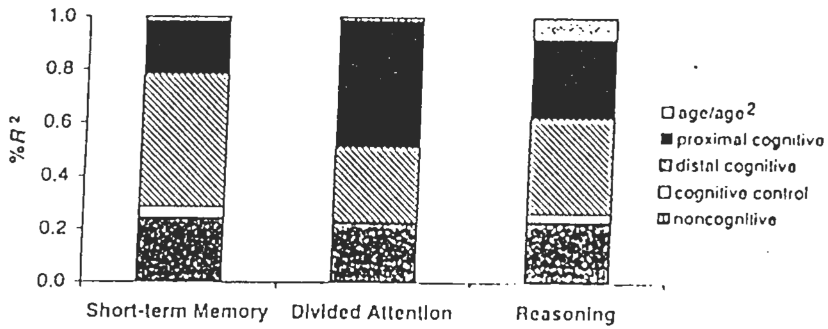

FIGURE 2.2 Relative proportion of variance accounted for across cognitive domains.

beliefs about cognitive ability and cognitive performance. Jonker, Smits, and Deeg (1997) administered both metamemory (MIA) and memory measures within the less-threatening environment of participants' homes. They found little evidence of a relationship between metamemory and immediate recall, delayed recall, and prospective memory performance. In fact, after controlling for age, education, and gender, they found that affective subscales of metamemory (achievement and anxiety) were stronger predictors of memory performance than was the locus of control subscale. Other research, however, argues that the relationship between cognitive performance and affective measures may be moderated by self-efficacy (van den Heuvel, Smits, Deeg, & Beekman, 1996), a possibility that we explore in our model described at the conclusion of this chapter. Thus, although it is possible that moving away from laboratory testing practices will weaken the association between self-efficacy and cognitive performance, the overall pattern of findings suggests that self-efficacy is an important factor associated with cognitive performance among the elderly.

Within a social learning perspective, Bandura (1997) suggested that control beliefs affect performance in part because low efficacy is associated with anxiety and low levels of effort, which lead to decreased levels of performance. An important aspect of this model is that the relationship is reciprocal in that beliefs are influenced by multiple factors, including performance experience. Individuals judge their abilities on the basis of past performance on similar tasks. Moreover, expectancies can be affected vicariously by watching others or through knowledge of aging stereotypes about performance (Bandura, 1997; Levy & Langer, 1994). Thus, we also need to consider the effects of cognitive performance on control beliefs.

THE EFFECTS OF COGNITIVE PERFORMANCE ON CONTROL BELIEFS

In addition to the well-established findings reviewed in the preceding section that beliefs affect performance, Bandura's (1997) notion that performance influences self-efficacy is also supported by research on aging (e.g., Albert et al., 1995; Bachrach, 1998; Berry & West, 1993; Bandura, 1997; Lachman, 1991). Relative to the previous section, however, this perspective is underrepresented within the adult development and aging literature; therefore, we have not attempted to separate the findings into subheadings. Instead, we review the relevant literature on control beliefs and related constructs together.

One example of how cognitive performance influences control beliefs can be found in an experiment in which participants were randomly assigned to one of two instruction groups: memorize a list of activities (e.g., close the window) to pantomime them or to recall them verbally (Bachrach, 1998). Those in the pantomime group showed higher levels of recall than did the other group, and this benefit was greater for older adults, suggesting that encoding instructions can be particularly important to older adults. Importantly, this performance benefit appeared to affect perceptions of memory controllability in that older adults in the pantomime group scored higher on control belief measures than did those in the verbal recall group. Not only did recall performance predict perceptions of memory control immediately following the task (using the MCI), but this difference persisted up to 2 weeks later (using the MIA).

There is also some evidence that prior experience with memory tasks can affect levels of self-efficacy in terms of memory monitoring. That is, past performance can affect self-beliefs about future performance. For example, some research shows that beliefs about performance levels are typically more accurate after the task has been completed and this accuracy increases over trials (Hertzog, Dixon, & Hultsch, 1990; Lachman & Jelalian, 1984). West, Dennehy-Basile, and Norris (1996) assessed both everyday tasks (presumably highly familiar) and laboratory tasks and found that older adults improved memory monitoring over time for only the more familiar tasks. This suggests that knowledge inherent in everyday tasks enables older adults to make better use of actual performance levels to modify their self-beliefs. This line of research showing that past performance can influence self-perception is important because these beliefs can significantly impact learning. Specifically, learning can be compromised if older adults are investing too little or too much of their cognitive resources (Connor, Dunlosky, & Hertzog, 1997). In fact, some evidence suggests that older adults are not as adept as are younger adults in using information regarding past performance, which has the effect of making older adults more confident than they should be on the basis of their recall ability (Dunlosky & Connor, 1997). Not surprisingly, then, this misperception can affect future performance levels, illustrating the cyclical nature of this relationship, a topic that explored in greater detail in the next section.

Finally, data from longitudinal (Lachman, 1983; Lachman & Leff, 1989) and intervention (Caprio-Prevette & Fry, 1996; Dittmann-Kohli, Lachman, Kliegl, & Baltes, 1991; Lachman et al., 1992) studies, also support the notion that cognitive performance influences beliefs. In two short-term longitudinal studies, cognitive performance predicted change in control beliefs. Those who had higher levels of performance were less likely to show declines in control beliefs (Lachman, 1983; Lachman & Leff, 1989). Similarly, cognitive skills training for laboratory tasks led to increases in self-efficacy for these tasks; unfortunately, however, this training failed to transfer to beliefs about abilities in everyday tasks (Dittmann-Kohli et al., 1991).

In a memory intervention study designed to improve both memory performance and control beliefs, individuals who received both cognitive restructuring and memory training showed greater increases in memory control than did those who received only memory skills training (Lachman et al., 1992). In a similar study, memory training that targeted self-beliefs in addition to traditional metamemory training was found to be more effective in improving memory self-efficacy than was traditional metamemory training alone (Caprio-Prevette & Fry, 1996). Thus, performance success as a result of training appears to influence subsequent self-beliefs about performance, especially when the beliefs are directly targeted in the training.

To summarize, the findings surrounding the effects of performance on beliefs support the notion that our past performance has an impact on how we perceive ourselves. Data from both cross-sectional and longitudinal work show that higher levels of performance bode well for subsequent positive self-beliefs. This line of research, however, is somewhat sparse and could benefit from a more in-depth look into feedback mechanisms that are responsible for this link. This may help improve our ability to intervene in cases in which negative performance lowers self-beliefs and help to stem future harmful effects that may result.

The research reviewed in this chapter has drawn from a wide variety of methodologies including correlational, cross-sectional, short-term longitudinal, intervention, and experimental designs. It has also included a comparison of age groups such as young and older adults, or a wide continuum of ages, or only older adults. These studies have also used different measures of control beliefs and related constructs, as well as many different facets of cognitive performance. With all these variations, the bulk of the research supports the notion that the beliefs we hold about our cognitive capabilities have an impact on our subsequent performance levels. Similarly, the little research that has addressed the effects of performance on beliefs suggests that this too occurs; our performance influences our self-beliefs. Although some research suggests that the association between beliefs and performance is stronger among older adults (Dixon & Hultsch, 1983; Lachman et al., 1982), more research is needed to systematically determine specific factors responsible for this relationship as well as which cognitive domains are most closely linked to beliefs. Such background variables as gender, health, activity, and age appear to overlap with beliefs; however, the mechanisms responsible for these links are not well articulated. Nevertheless, the evidence reviewed thus far is consistent with social learning theories (Bandura, 1997) showing that those who have high levels of perceived control actually do show higher levels of performance and that this in turn affects self-beliefs.

A CONCEPTUAL MODEL OF THE RELATIONSHIP BETWEEN SENSE OF CONTROL AND COGNITIVE AGING

Research findings reported above are consistent with a reciprocal model of the relationship between control beliefs and cognitive functioning in later life. There is evidence that control beliefs affect performance, and there are also findings suggesting that cognitive functioning affects control beliefs. Moreover, the effects of control beliefs are not isolated; the variance associated with control beliefs overlaps with other noncognitive variables, such as health and exercise, in predicting cognitive functioning. However, more research is needed to uncover the mediational processes involved in linking control beliefs and performance. Using a cognitive social learning theory perspective (Bandura, 1997), we developed a conceptual model to represent this relationship, with the goal of guiding future research on the mediational processes involved (Lachman et al., 1994; Lachman, in press). The model suggests that the mediational processes include behavioral, physiological, motivational, and affective factors.

The conceptual model presented in Figure 2.3 illustrates the interplay of age-related losses and changes in attitudes and motivation and captures the cyclical nature of aging processes (Lachman, Ziff, & Spiro, 1994). Similar to the social breakdown syndrome proposed by Kuypers and Bengtson (1973), this model examines the relationship between internalized negative expectations and age-related declines. To illustrate one possible chain of events (cf. Figure 2.3), age-related losses in cognitive functioning can lead to a lowered sense of control. This may involve a lowered sense of self-efficacy (lack of confidence in abilities), external beliefs (feeling one cannot do something about decling performance because doing so is not under one's own control), and/or attributions to internal stable causes (it is due to aging or poor ability). This lowered control in turn may affect motivation to change, resulting in lower levels of effort and less persistence in the face of difficulties, and may result in affective changes, such as depression and/or anxiety. This process is cyclical in that lowered effort can result in further cognitive decline through disuse, deconditioning, or atrophy.

A similar chain of events can be triggered by beliefs that declines are present rather than the actual presence of declines. For example, if older adults perceive themselves as becoming less capable (low efficacy) and attribute these perceived declines to unchangeable aspects of the aging process (maladaptive attributions), they may feel that nothing can be done (low sense of control) (Lachman et al., 1994). These lowered control beliefs may be associated with decreased motivation to engage in daily activities with cognitive demands and with physiological changes due to increased distress about one's limitations and the potential downward course of aging. The cyclical nature of the model indicates that regardless of where one begins, this is an ongoing process. That is, motivational deficits can trigger memory decrements and, at the same time, memory declines can trigger a lowered sense of control. These dynamics help explain why, for example, mem-

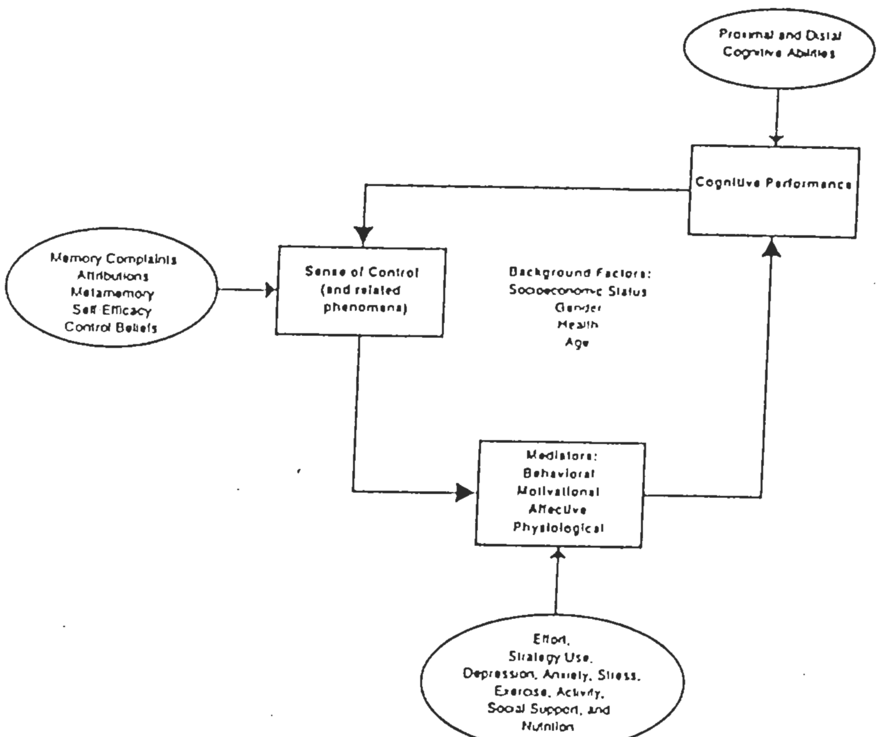

FIGURE 2.3 Mediational model linking control beliefs and cognitive performance.

ory loss may be accepted as inevitable among older adults (e.g., Smith & Earles, 1996), despite the fact that some of these declines are modifiable or even reversible (Schaie & Willis, 1986). Once the process is in motion, therefore, it may continue in a downward path unless interventions are introduced to modify beliefs, affect/motivation, and/or performance (Lachman, in press).

In the cyclical model of age-related loss, the sense of control, motivation, and affective factors are considered as antecedents, consequences, and mediators of age-related losses. Consistent with social cognitive behavioral theory (e.g., Bandura, 1997; Seligman, 1991), the relationship between beliefs and performance is dynamic and reciprocal in nature. Although there has been little empirical work on the mechanisms that link control beliefs and cognitive performance in later life, several classes of mechanisms have been identified (Bandura, 1997): behavioral/motivational (e.g., effort, attention, activity level), affective (e.g. depression, anxiety), or physiological (e.g., stress, exercise, social support). Future research is needed to test the viability of these hypothesized mediators. As data presented here suggest, it is likely that these mediators

are not isolated influences but operate together. Ultimately, this work may be useful for refining intervention programs to improve cognitive functioning in the elderly.

The model in Figure 2.3 suggests that intervention programs to improve cognitive functioning should be multifaceted (cf. Lachman, in press). Older adults who improve their cognitive performance do not necessarily improve their beliefs about control which may limit long-term benefits of intervention. Although for younger adults performance experience may be sufficient for changes in self-efficacy, this does not appear to be the case for the elderly (Bandura, 1997). Thus, an intervention that is directly focused on changing beliefs is recommended in conjunction with teaching strategies for improving cognitive performance (Lachman, in press). This multifaceted approach has been successfully applied in two domains: memory enhancement (Lachman et al., 1992) and exercise programs for sedentary adults (Jette et al., in press; Lachman et al., 1997).

SUMMARY AND CONCLUSIONS

The research reviewed in this chapter shows consistently that there is a significant relationship between control beliefs and cognitive performance in later life. Clearly, there is evidence that control beliefs predict changes in cognitive functioning. However, the nature of this relationship is not fully understood. Much of the research has been cross-sectional and correlational in design, limiting the conclusions that can be made about process. Also, when background factors (i.e., health activity, exercise, and gender) are accounted for, the nature of the relationship between control beliefs and performance changes. Thus, future research is needed to investigate which domains of cognitive functioning are most closely linked to both background factors and control beliefs and why.

The findings reviewed in this chapter also indicate that cognitive performance leads to changes in control beliefs, consistent with findings in Bandura's theoretical work (e.g., Bandura, 1997) describing the reciprocal nature of control beliefs and performance. We presented one model linking beliefs and cognitive performance to illustrate the complexity of the relationship and to guide questions for future research. However, more research on the mediational factors linking control beliefs and cognitive aging is needed. For example, it is important to consider the role of biomedical and other psychosocial and behavioral factors as potential mediational processes (cf. Elliott & Lachman, 1989; Lachman, 1991; Lachman, et al., 1992; see also Fillit & Butler, 1997). Additionally, although time (Berry, 1987) and strategy (Stine et al., 1993) have been implicated as factors reflecting effort and performance, we know relatively little about how effort is manifested in cognitive performance. Research of this nature could be used to identify which factors are more or less modifiable and thus could lend themselves to interventions designed to improve the quality of life among older adults.

ACKNOWLEDGMENTS

Support for this chapter was provided by National Institute on Aging (NIA) training grant T32 AG00204 and by the John D. and Catherine T. MacArthur Foundation Network on Successful Midlife Development (MIDMAC). Address correspondence to the Department of Psychology, Brandeis University, Waltham, MA 02454–9110.

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