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Stress and Cognitive Performance in Older Adults

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Stress and Cognitive Performance in Older Adults

by

Christopher B. Rosnick

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
School of Aging Studies
College of Arts and Sciences
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ABSTRACT

The current dissertation sought to examine stress in three different, but overlapping, ways. The first study examined how self-reported negative life events, in the aggregate and individually, are associated with cognitive performance. The results suggested that there was no significant relationship between the aggregate measures of self-reported negative life events and cognitive performance. On the other hand, several individual negative life events were associated with cognitive functioning. The findings support previous research indicating that using estimates of individual stressors rather than aggregate measures of stressors increases the predictive validity of stress measurement.

The second study assessed the cross-sectional and longitudinal effects of bereavement on cognitive functioning. The cross-sectional results revealed that bereavement status alone was not associated with cognitive performance. On the other hand, there were several significant interactions between bereavement status and the background characteristics. The longitudinal results revealed that the bereaved individuals declined on the delayed naming recall task and there was a significant interaction between gender and bereavement on the delayed story recall task. Our results

support the finding that bereavement is associated with poorer cognitive performance within certain subgroups (i.e., males and the young-old participants).

The third and final study examined the effects of allostatic load (AL) on cognitive performance in bereaved and non-bereaved individuals over a twelve-month period post-bereavement. The cross-sectional findings suggested that the overall AL measure, the syndrome X (a collection of cardiovascular risk factors) and non-syndrome X measures (stress hormones), and the individual AL markers were associated with cognitive performance. Longitudinally, we were unable to find an association between the overall AL measure and cognitive performance.

Taken together, the current findings suggest that there is an association between the multiple stress factors under investigation and cognitive performance. The cross-sectional results revealed that the individual negative life events (i.e., having less money to live on), bereavement, and the AL markers were associated with poorer cognitive performance. Furthermore, the results suggest that utilizing the individual life events and AL markers may be more informative when assessing cognitive functioning in the current samples compared to using the sum scores.

Chapter One: Introduction

Over the last few decades a substantial amount of research has been focused on
how the aging process affects cognitive functioning (for review see Bäckman, Small, &
Wahlin, 2001). Based on this research, it is well known that deficits in multiple domains
of cognitive functioning are associated with the normal aging process (Bäckman et al.,
2001; Zacks, Hasher, & Li, 2000). Although mean-level deficits are presented,
considerable variability exists in terms of the magnitude of age-related differences in
cognitive performance. As such, many researchers have adopted an individual
differences perspective in an attempt to predict or better understand these age-related
differences. For example, relationships between age-related differences in cognition and
lifestyle factors (Albert et al., 1995; Yaffe, Barnes, Nevitt, Lui, & Covinsky, 2001),
genetics (Bretsky, Guralnik, Launer, Albert, & Seeman, 2003; Farrer et al., 1997; Small,
Rosnick, Fratiglioni, & Bäckman, 2004), health (Anstey, Lord, & Williams, 1997;
Rosnick, Small, Borenstein, & Mortimer, 2004), and demographics (Herlitz, Nilsson &
Bäckman, 1997; Zelinski & Burnight, 1997) have been reported. In the current
dissertation, another class of individual differences variables, namely stress, will be
examined in relation to cognitive performance in the elderly.   Specifically, the
dissertation will examine how stress, in the form of subjective reports of negative life
events and bereavement (a significant stressor), is associated with those age related
differences/ declines in cognitive functioning. In addition, the physiological correlates of

stress will be examined in an attempt to describe the mechanism of the stress-cognition relationship.

Stress is an unavoidable part of life. Furthermore, the effect of stress on cognitive functioning appears to depend on the length of time we endure the stressor. Transient or acute stress may be beneficial (Kim & Diamond, 2002), whereas chronic stress can have detrimental effects on cognitive performance (for reviews see McEwen & Sapolsky, 1995; Sapolsky, 2000a,b). On the other hand, the results of the effect of life events/ daily hassles on cognitive functioning are mixed. For example, Sands (1981-82) observed that, in a sample of community-dwelling elderly women, there was greater cognitive decline for women who experienced more stress over a two-year period. In contrast, Saczynski, Rebok, & Holtzman (2002) found that the more stressful life events participants reported, the better they performed on a delayed recall task.

Losing a loved one is one of the most stressful events a person can experience. The current research suggests that bereavement may have a time limited effect on cognitive functioning (Saczynski et al., 2002) but there is very little information on the association between bereavement and cognitive performance.

One of the more recent areas of stress research is examining the effect of allostatic load (AL; the wear and tear on the body due to environmental demands) on physical and cognitive functioning (Karlamangla, Singer, McEwen, Rowe, & Seeman, 2002; Seeman, McEwen, Rowe, & Singer, 2001). Karlamanga and colleagues (2002) and Seeman and colleagues (2001) revealed that AL was associated with a summary measure of cognitive functioning but there has been very little research since this investigation with regard to AL and its association with specific cognitive domains. Furthermore, there is no

information on whether the AL measures are actually associated with individual's reported stress levels.

In an attempt to further the research in the areas previously mentioned, the present doctoral dissertation will focus on how stress affects cognitive performance in a specific population, the elderly. This is important because, as mentioned earlier, the elderly suffer declines in cognition as part of the normal aging process, the elderly may be more susceptible to the types of stressors currently under investigation, and the elderly may be more vulnerable to the effects of the stressors. The current dissertation will examine stress in three different, but overlapping, ways. The first study will examine how self-reported negative life events, in the aggregate and individually, are associated with cognitive performance. If an individual reports experiencing an event over the last year, there is also a follow up question that asks the individuals to rate the severity of the event. We will also examine the perceived severity of the events and their effect on cognitive performance. The second study will assess the longitudinal effects of bereavement on cognitive functioning. We will utilize two measurement points in this study: six months post-bereavement and eighteen months post-bereavement. The third and final study will examine the effects of AL on cognitive performance in bereaved and non-bereaved individuals over a twelve-month period. We will utilize the original AL measure proposed by Seeman and colleagues (2001). Therefore, the AL measure will consist of ten items: systolic and diastolic blood pressure (SBP and DBP, respectively), waist-to-hip ratio (WHR), HDL and total cholesterol, glycosylated hemoglobin, dehydroepiandrosterone-sulfate (DHEA-S), cortisol, epinephrine, and norepinephrine. All three studies will examine multiple domains of cognitive performance. The

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dependent measures for the first study will be episodic memory, attention, and perceptual speed. The second and third study will utilize episodic memory, verbal ability, and visuospatial skills as the cognitive outcome measures.

The following chapter will discuss the general research findings in the multiple areas of stress research.

Chapter 2: Literature Review

Age has consistently shown to be negatively related to multiple cognitive tasks (for reviews see Bäckman et al., 2001; Zacks et al., 2000). For example, Wilson and colleagues (2002) found that performance on 19 neuropsychological tests, ranging from episodic memory to visuospatial abilities, declined over a six-year period. They also found that the rate of decline varied within age groups. There was very little decline in the 65-70 years olds, whereas the 80-85 year olds had substantial declines. Zelinski & Burnight (1997) reported similar results but only for list recall. Interestingly, when Wilson and colleagues (2002) examined the individual growth curves across the multiple cognitive tasks, there was substantial heterogeneity, with some individuals declining substantially but most of them remaining the same or increasing or decreasing slightly, suggesting individual differences in these trajectories.

Having fewer years of education has been the most consistent independent predictor of cognitive decline (Albert et al. 1995). Albert and colleagues (1995) reported that their strongest predictor of cognitive change was educational level, apart from the initial baseline measure of cognition. Education was also related to other factors such as higher income, being female, and being Caucasian. Furthermore, Caucasians showed greater maintenance of functioning over the test period.

There is evidence that women tend to outperform men on tasks of episodic memory, although the effects tend to be very small. For example, Herlitz and colleagues

(1997) reported that women performed better on two verbal fluency tasks, recall of newly acquired facts, activities, and name recognition. The latter three findings were still significant when controlling for verbal fluency performance. On the other hand, the authors were unable to find any gender differences on tasks of general word knowledge, word comprehension, primary memory, or priming. These findings were consistent across age groups ranging from 35 to 80 years of age. Similar findings were reported by van Exel and colleagues (2001) on tasks of attention, despite the fact that the women in their sample were less educated than the men. The authors suggest that biological underpinnings could explain the gender differences (i.e., lower rates of cardiovascular disease in women).

In light of the previous findings, many researchers have adopted an individual differences perspective in an attempt to predict or better understand these age-related differences. As mentioned in Chapter 1, the current dissertation will examine another class of individual differences variables, namely stress, in relation to cognitive performance in the elderly. The dissertation will begin by explaining the stress response and will go on to cover the literature on each type of stress under investigation: life events, bereavement, and allostatic load (AL).

THE STRESS RESPONSE

In order to understand how stress affects cognitive performance we must first understand how the body reacts to stress. In the current project, the biology of the stress reaction may be more relevant because it suggests a potential mechanism of action in terms of the effect of stress on cognitive performance. When a person encounters a stressor the catecholamines, epinephrine and norepinephrine, are secreted by the

sympathetic nervous system, and the glucocorticoids, namely cortisol, by the adrenal gland (McEwen & Sapolsky, 1995). The hypothalamic-pituitary-adrenal (HPA) axis releases two other important hormones- corticotrophin-releasing hormone (CRH) and adrenocorticotropin hormone (ACTH), which help regulate the levels of glucocorticoids. When the CRH receptor is activated it induces the release of ACTH from the pituitary and ultimately the release of cortisol. When the "system" is functioning correctly, cortisol feeds back and inhibits the release of additional CRH and ACTH (Patel & Finch, 2002). If this negative feedback loop is malfunctioning, the end result is excessive amounts of glucocorticoids (Miller & O'Callaghan, 2002).

The hippocampus has one of the highest concentrations of receptors for glucocorticoids (Kim & Diamond, 2002) and plays an important role in learning and memory (Sapolsky, 2000a,b). Further, the hippocampus is one of the most important areas that mediates, and in turn is affected by, the stress response (McEwen, 1999). Corticosteroid receptors within the hippocampus include Type I (mineralocorticoid) and Type II (glucocorticoid) receptors. Type II receptors have a low affinity for glucocorticoids and tissues with Type I receptors contain an enzyme which metabolizes cortisol so that the receptor is not exposed to high concentrations of cortisol for an extended amount of time (Bremner, 1999). The glucocorticoid receptors (Type II receptors) become heavily occupied during stress (Kim & Diamond, 2002) and during circadian peaks in plasma glucocorticoids (Greenberg, Carr, & Summers, 2002). Most importantly, the two receptors appear to perform different roles in memory consolidation and retrieval. The Type II receptors appear to be related to memory consolidation (de Kloet, Oitzl, & Joels, 1999; Patel & Finch, 2002; Roozendaal, 2002) and the Type I

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receptors appear to be responsible for interpreting environmental stimuli and behavioral reactivity to novel situations (de Kloet, Grootendorst, Karssen, & Oitzl, 2002; de Kloet et al., 1999).

TYPES OF STRESS UNDER INVESTIGATION

For the current project, the stressors being examined are assumed to evoke the stress response just described. In addition, it is assumed that the duration of the stress response is variable depending on the type of stressor.

Life Events/ Daily Hassles

It appears as if there is a difference in how individuals are affected by life events/ daily hassles and the perceived stressfulness of the events. For instance, Nacoste & Wise (1991), when examining three generational families, found that younger and older adults are more affected by negative life events when compared to middle-aged adults. In addition, personality characteristics, such as neuroticism, are related to the frequency and the severity rating of daily hassles as well. Furthermore, Russell & Davey (1993) observed that, in a sample of college students, those who scored higher in trait anxiety and worrying reported more daily hassles and rated the hassles as more severe. Also, acute stressors appear to affect males and females differently. Previous research indicates that women are more likely to report major life crises (Willis, Thomas, Garry, & Goodwin, 1987), more frequent hassles (Flannery, 1986), and more psychological maladjustment compared to men (McIntosh, Kaplan, Kubena, & Landman, 1993).

The association between negative life events, daily hassles, and major life events and physical and mental health is well established (Beasley, Thompson, & Davidson, 2003; Brilman & Johan, 2001; Carmack, Boudreaux, Amaral-Melendez, Brantley, & de

Moor, 1999; de Jong, Sonderen, & Emmelkamp, 1999; Leserman, Zhiming, Yuming, & Drossman, 1998; Lutgendorf, Reimer, Schlechte, & Rubenstein, 2001). In contrast, there is very little information on how negative life events may affect cognitive performance.

The literature that has examined self-reported stress and cognitive performance reveals mixed results. Amster & Krauss (1974) found that women who declined mentally over a five-year period experienced many more crises and higher levels of stress as indexed by the Geriatric Social Readjustment Questionnaire. Similarly, Sands (1981-82) observed that, in a sample of 112 women over 65 living independently in the community, there was greater intellectual decline for women who experienced more stress over a two-year period. The advantage of the Sands (1981-82) analysis compared to that of Amster & Krauss (1974) is that the author examined the individual life events and their association with cognitive functioning. At the individual stressor level, individuals who reported positive events during the last two years showed increased intellectual performance, whereas individuals who reported negative changes over the last two years experienced greater intellectual decline. In contrast to the previous two findings, Grimby & Berg (1995) did not find an association between the number of stressful events reported and cognitive decline. Although they did find an association between men who were bereaved during the previous six years and cognitive decline compared to men who did not experience any life events.

In a more recent article utilizing subjects from the Baltimore Epidemiologic Catchment Area study (Saczynski et al., 2002), the authors found that the more stressful life events participants experienced, the better they performed on a delayed recall task. There was no association between stressful life events and MMSE scores, or immediate

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and recognition memory. Similar to the study by Sands (1981-82), the authors also examined the relationship between the individual stressors and cognitive performance. They found that bereavement in the past year was associated with poorer performance on a delayed recall task; having lost a significant other in the past ten years was related to better delayed recall performance and MMSE scores; retirement was related to better immediate, delayed, and recognition memory performance; having experienced an injury/ illness over the past year was related to more words being recalled on the recognition memory task but the opposite effect was found for experiencing an injury/ illness over the last ten years. When examining the reaction to the events, having better planned for retirement and more activity following retirement were related to better cognitive functioning.   Based on the previous findings, researchers can see the importance of not only examining the sum of stressors but also examining the individual stressors themselves and their association with cognitive functioning. The total scores may obscure the relationship between the individual stressors and cognitive performance (Sands, 1981-82).

Overall, self-reported life events can have both a negative and positive effect on cognitive performance. One possible reason for the opposing relationships is that some individuals may have higher base rates of arousal compared to other individuals. The Yerkes-Dodson Law (Yerkes & Dodson, 1908) states that there is an inverted-U function of stress and performance. Hence, when individuals with a higher base rate of arousal encounter a stressful event they begin to go down the far side of the Yerkes-Dodson curve (Yerkes & Dodson, 1908) and perform poorly compared to individuals with a lower base rate of arousal. When individuals with a lower base rate of arousal encounter

a stressor they may be coming up the left side of the curve to the optimal level of arousal. This is probably why we see the decrease in performance shortly after bereavement, at extreme levels of stress, and then better performance years later, returning to the optimal level. With regard to experiencing the injury/ illness in the past, individuals may begin to adopt healthier lifestyles shortly after the experience, increasing performance, but not maintaining these habits for an extended amount of time, decreasing performance.

One important limitation of the previous area of research is the lack of information on how severe the individual perceives the events under investigation and whether there is a relationship between the perceptions of stress levels to biological markers of stress in the elderly. Lazarus (1999; p.72) states "…the main source of variation in the arousal of stress and how it affects human functioning is the way an individual evaluates subjectively the personal significance of what is happening." In addition, in a recent study of 58 pre-menopausal women between the ages of 25-50 researchers found that perceived stress levels were associated with shorter telomeres, higher oxidative stress levels, and lower telomerase activity, all markers of a cell's biological age (Epel et al., 2004). These findings suggest that there may be detrimental effects of perceived stress on cognitive health. On the other hand, in a sample of college students, Kelley, Hayslip, & Servaty (1996) found no association between students' perception of stress levels and the biomarkers of stress but there is no such research for the elderly population. If individuals endure many life events but do not see them as meaningful or stressful, we would not expect the aggregate score of stressors to affect cognitive functioning. On the other hand, if an individual experiences many life events

and all of them are very meaningful to them, we would expect to see an association between the sum score of stressors and cognitive performance.

Another possible limitation is that the authors did not assess how many times an event occurred over the time period in question. By limiting responses to "yes"- the event occurred or "no"- the event did not occur obscures the relationship between the event and performance. For example, experiencing the injury or illness of a friend or oneself can happen multiple times over the course of a year and especially over the course of ten years. Adding this dimension to the current measurement tools would increase the power of the aggregate life event measure allowing for better assessment of the association between stressors and cognitive performance.

In summary, there is strong evidence that chronic stress has long lasting negative effects on cognitive performance for both younger and older adults. Long-term exposure to glucocorticoids is related to decreased hippocampal volume and poorer performance on cognitive tasks (Bremner et al., 1995; Bremner et al., 1997; Steffens et al., 2000). Negative life events and daily hassles are related to higher rates of physical and mental health problems. On the other hand, there is very little known about the effects of self-reported life events on cognitive performance.

One of the most stressful life events a person can experience is the loss of a loved one. The following section will address the limited literature on the effects of bereavement on cognitive functioning.

Bereavement

Even though this is an important area of research because "…it allows researchers to do natural experiments of chronic stress that could not otherwise be done ethically with

human populations" (Vitaliano, 1997) there is very little information on the effects of bereavement and how it affects cognitive functioning. The limited research on the association between bereavement and cognitive performance suggests that the loss of a loved one does have an effect on cognitive performance in the elderly. For example, Xavier, Ferraz, Trentini, Freitas, & Moriguchi (2002) examined whether or not the stress associated with grief was related to cognitive performance in a group of elderly over the age of 80. In order for an individual to be characterized as experiencing grief they have to: 1) report being emotionally affected by the loss; and 2) the caretaker had to report observable differences in the individual's day-to-day behavior. The results revealed that individuals who were experiencing grief demonstrated poorer performance in episodic memory, attention and on the MMSE. The authors also examined the differences between the group of individuals who experienced a loss and were with grief to individuals who experienced a loss but were without grief. They found that individuals who were with grief scored worse on both subjective and objective cognitive measures compared to the group without grief. They went on to assess any differences between two "no-grief" groups (individuals who experienced a loss with no grief and individuals who did not experience a loss and without grief). The authors found that those individuals who experienced a loss, even though they were not displaying any grief, scored worse on a verbal fluency task. Recently, Aartsen and colleagues (2005) reported that bereaved individuals had greater memory decline over a 6-year period compared to non-bereaved individuals. In addition, memory decline was observed more often in bereaved men compared to bereaved women and there was a statistically significant

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difference in memory decline in bereaved men compared to non-bereaved men but this was not true for the bereaved and non-bereaved women.

The results assessing the impact of bereavement on cognitive functioning by using self reports, either by life event scales or listing stressful events over the past year have been mixed. For example, Sands (1981-82) was unable to find a relationship between the death of a spouse and cognitive performance in a sample of 112 women between the ages of 65-92. On the other hand, some researchers do report cross-sectional differences and longitudinal changes in cognitive functioning among individuals who have reported losing their loved one. Grimby and Berg (1985) reported that bereaved subjects declined on a spatial ability task (block design) over a six-year period compared to individuals who reported experiencing no negative life events. More specifically, the authors found that the bereaved men experienced greater cognitive decline on tests of verbal meaning, spatial ability, and digit span backwards compared to individuals reporting no negative life events, whereas there were no significant differences for the women. Furthermore, Saczynski and colleagues (2002) revealed that being bereaved by someone other than your spouse over the past year had a negative impact on delayed recall performance but there were no significant associations for being bereaved by your spouse. The authors go on to report that individuals who reported being bereaved by someone other than their spouse over the past ten years performed better on a delayed recall task and on the Mini Mental State Examination (Folstein, Folstein, & McHugh, 1975).

Up to this point, there has been no discussion of association between the biological markers of stress and cognitive performance. The next section will cover

multiple measures of biological stress. More specifically, the project will examine the effects of the cumulative AL measure and each independent component and how they are associated with cognitive performance.

Allostatic Load (AL)

A more recent area of investigation is the association between allostatic load (the wear and tear on the body associated with adapting to stressful situations) and cognitive performance (Karlamangla et al., 2002; Seeman et al., 2001). Originally, the allostatic load score was a summary score consisting of systolic and diastolic blood pressure (SBP and DBP, respectively), waist-to-hip ratio (WHR), high density lipoproteins (HDL), total cholesterol, glycosylated hemoglobin, dehydroepiandrosterone sulfate (DHEA-S), cortisol, epinephrine, and norepinephrine. Researchers found that individuals with higher allostatic load "scores" had an increased risk of mortality, cardiovascular disease, and cognitive impairment after controlling for age, sex, ethnicity, education, income, and baseline morbidity (Seeman et al., 2001). Of the ten measures that make up the allostatic load score, it has been reported that urinary epinephrine, waist-to-hip ratio, and urinary cortisol make the largest contributions to physical decline and diastolic blood pressure, urinary epinephrine, and glycosylated hemoglobin make the largest contributions to predicting cognitive decline (Karlamangla et al., 2002).

The following sections will cover the effects of each independent measure of AL and its effect on cognitive performance.

Systolic and Diastolic Blood Pressure (SBP and DBP)

The literature assessing the effects of high blood pressure (HBP) on cognitive functioning is mixed. Some researchers find a negative association; others find a positive

association, while others find no association at all. For example, Zelinski, Crimmins, Reynolds, and Seeman (1998) found that individuals who reported having high blood pressure scored lower on the Telephone Interview of Cognitive Status (TICS). In a more recent study, Saxby, Harrington, McKeith, Wesnes, and Ford (2003) found that hypertensives performed worse in multiple cognitive domains including speed of processing, executive functioning, episodic memory, and working memory. In contrast, Paran, Anson, and Reuveni (2003) found that individuals who remained hypertensive despite treatment performed better than normotensives on four out of five cognitive tasks. On the other hand, in a current growth curve analysis researchers concluded that hypertension was not associated with changes on the Mini-Mental Status Exam (MMSE; Hassing et al., 2004). Furthermore, other researchers have been unable to find an association between HBP and multiple domains of cognitive functioning (e.g., Rosnick et al., 2004). There are several possibilities as to the discrepant findings in past research including the composition of the samples, the way hypertension is defined, and the different cognitive outcomes that are measured.

The results of the independent effects of systolic and diastolic blood pressure (SBP and DBP, respectively) on cognitive functioning are relatively consistent. In a Swedish longitudinal study, researchers found that men who had higher DBP at baseline performed worse on a digit span test, Trailmaking tests A and C, and in verbal fluency 20 years later (Kilander, Nyman, Boberg, & Lithell, 2000). The group in the lowest category (</= 70 mmHg) performed the best on these tests. They found similar results when assessing the effects of SBP. The men in the lowest group (</= 115 mmHg) performed better on the digit span and verbal fluency. Similar results were revealed by

Budge, de Jager, Hogervorst, & Smith (2002) when assessing the effects of SBP on global cognitive performance while controlling for DBP. Furthermore, Swan, Carmelli, & Larue (1998) found that individuals whose SBP remained high over a 25-30 year period were more likely to have reduced verbal learning and memory function. In contrast, they found that individuals whose SBP decreased over the time interval were more likely to have impaired psychomotor speed. On the other hand, in a comparison of Indian and American samples, Indian individuals with higher SBP and DBP were less likely to be cognitively impaired (<= 21 on the Hindi Mental State Examination), whereas there was no association in the American sample.

There also appears to be a detrimental effect to the hippocampal area in individuals with untreated HBP. Korf, White, Scheltens, and Launer (2004) recently found an association between untreated high DBP and SBP and hippocampal atrophy. Individuals who were not taking antihypertensive medication were more likely to have hippocampal atrophy compared to individuals who were taking antihypertensive medication. Although the aforementioned results are informative, the authors did not perform analyses examining this relationship to cognitive functioning. Other researchers have been unable to find an association between antihypertensive medication use and cognitive functioning (Swan et al., 1998).

Obesity

For the current dissertation, waist-to-hip ratio (WHR) is utilized as an index of obesity. The literature that examines the effect of obesity on cognitive performance primarily uses body mass index (BMI) as the index for obesity. Hence, this is the literature that will be covered in the following section.

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BMI is calculated by dividing the individual's weight in kilograms by their height in meters squared. Individuals are classified as non-obese if their BMI is less than 25; overweight if their BMI is between 25 and 29.9; and obese if their BMI is greater than 30. The results vary depending on the sample that is used for examination. The results are mixed when community dwelling individuals are examined. For example, Trakas, Oh, Singh, Risebrough, and Shear (2001) examined a sample of over 38,000 Canadians between the ages of 20 and 64 and found that individuals with higher BMI scores reported more cognitive problems than individuals with lower BMI scores. In contrast, Dechamps, Astier, Ferry, Rainfray, Emeriau, & Barberger-Gateau (2002) found that individuals with BMI scores greater than or equal to 23 were less likely to decline on the MMSE compared to individuals with BMI scores less than 23. This risk was amplified when in the elderly over the age of 75. The discrepant results can be explained by the age of the participants in each study: 20-64 in the previous study and 69-89 in the latter. Also, in the study by Deschamps and colleagues (2002) they used a BMI cutoff of 23, which is still in the normal range for this age group.

Similar to the research with community dwelling elderly, the results are also mixed when the Alzheimer Disease (AD) population is examined. In a logistic regression analysis, Bedard, Molloy, Bell, and Lever (2000) revealed that individuals with poor cognitive functioning and females were more likely to have low BMI scores (< 21). Faxen-Irving, Andren-Olsson, Geijerstam, Basun, and Cederholm (2002) performed a nutritional intervention in a group of demented patients to determine the effects of the nutritional supplementation on cognitive functioning. The authors found that BMI was positively correlated with MMSE and negatively associated with the Clinical Dementia

Rating scores. The association between BMI and MMSE scores was no longer significant in multivariate analyses accounting for ADL function. Despite the fact that the individuals in the nutritional intervention gained weight over the six-month period, both CDR and MMSE scores deteriorated. Furthermore, Grundman, Corey-Bloom, Jennigan, Archibald, and Thal (1996) revealed that AD patients with low BMI have smaller mesial temporal cortices (MTC), which included the amygdala and hippocampus but BMI was not associated with cognitive performance.

To make things more complicated, in a sample of post-menopausal Down Syndrome patients, obese women (BMI >/= 30) performed better on measures of episodic memory when compared to non-obese and overweight women (Patel et al., 2004). On the other hand, in a group of women with anorexia nervosa, BMI was not associated with a neuropsychological battery (Moser et al., 2003).

HDL Cholesterol and Total Cholesterol

Similar to the other independent AL measures, the association between cholesterol and cognitive performance is mixed. Some authors find a negative association (Kalmijn et al., 2004), while others find no association (Morris, Evans, Bienias, Tangney, & Wilson, 2004). Kalmijn and colleagues (2004) assessed multiple domains of cognition in a sample of over 1,600 elderly participating in the Doetinchem Cohort Study and found that individuals who reported higher cholesterol levels had an increased risk of cognitive impairment compared to individuals reporting lower levels of cholesterol. Another group found that postmenopausal women with higher total and LDL cholesterol were at an increased risk of impairment (<84 on the 3MS; Yaffe, Barrett-Connor, Lin, & Grady, 2002). In addition, women who had reductions in both total and

LDL cholesterol levels over four years demonstrated better cognitive functioning compared to those women who had increased levels. On the other hand, investigators were unable to find an association between HDL cholesterol levels and cognitive performance. It has been suggested that there is a "graded association" between total cholesterol levels and cognitive performance. Kivipelto and colleagues (2001) found that individuals with dementia had higher levels of cholesterol compared to individuals with mild cognitive impairment (MCI), and the individuals with MCI had higher levels of cholesterol compared to controls. Furthermore, individuals with elevated cholesterol levels at midlife were at an increased risk of developing MCI compared to individuals with lower cholesterol levels. In a more advanced statistical analysis and using another large population-based sample, Engelhart and colleagues (2002) were unable to find an association between elevated cholesterol levels and dementia, AD, or vascular dementia.

The majority of the literature has been unable to find an association between total and HDL cholesterol levels and cognitive functioning. These results have been found cross-sectionally in middle-aged women (Henderson, Guthrie, & Dennerstein, 2003) and the healthy elderly (Rondanelli, Solerte, & Ferrari, 1998). In addition, this lack of association is consistent with longitudinal studies middle-aged individuals from the Maastricht Aging Study (Teunissen et al., 2003), in a cohort of elderly over the age of 65 in the Chicago Health and Aging Project (Morris et al., 2004), and in a sample of over 350 elderly men in the Zutphen Elderly Study (Kalmijn, Feskens, Launer, & Kromhout, 1996). Although it appears as if total and HDL cholesterol do not have an independent effect on cognitive functioning, Kalmijn and colleagues (1996) found that individuals with the apolipoprotein ε 4 (APOE ε4) allele and high cholesterol had an increased risk of

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cognitive decline compared to individuals without the ε 4 allele. Based on these findings and those of Kivipelto and colleagues (2001), it appears as though total and HDL cholesterol do not have a direct effect on cognitive performance but rather an interactive effect with the APOE ε 4 allele, which has been shown to have an independent association with cognitive performance in multiple domains (Small et al., 2004).

Glycosylated Hemoglobin

Glycosylated hemoglobin (GH) is a measure of blood sugar control over the past three months (Worrall, Chaulk, & Moulton, 1996) and an indicator of glycaemic control in diabetics (Chandalia & Krishnaswamy, 2002). In the current literature review, only one study found a univariate association between glycosylated hemoglobin levels and cognitive functioning (Helkala, Niskanen, Viinamaki, Partanen, & Uusitupa, 1995). Elevated baseline GH levels were correlated with poorer performance on a verbal fluency task. The other papers under review were unable to find an association between GH and cognitive performance (Cosway, Strachan, Dougall, Frier, & Deary, 2001; Scott, Kritz-Silverstein, Barrett-Connor, & Wiederholt, 1998; Worrall et al., 1996). Based on the limited information on the independent effects of GH, it is hard to draw any strong conclusions as to what kind of effect GH has on cognitive performance.

DHEA-S

DHEA-S is a glucocorticoid antagonist and should have the opposite effects of cortisol. The results assessing the association between DHEA-S and cognitive performance are mixed. Kalmijn and colleagues (1998) reported that individuals from the Rotterdam study who had lower DHEA-S concentrations and higher cortisol to DHEA-S ratios, indeed, were more likely to be cognitively impaired. On the other hand,

Wolf, Kudielka, Hellhammer, Hellhammer, & Kirschbaum (1998) administered DHEA to 42 older adults for two weeks. After that, the subjects returned and performed a speech and mental arithmetic in front of an audience (the Trier Social Stress Test). Individuals who were treated with DHEA had a four-fold increase in DHEA-S levels and had a higher cortisol response to the stressor compared to the control group. Further, the individuals who were treated with DHEA recalled fewer words on an episodic memory task but performed better on an attention task compared to the controls. All the participants recalled fewer items after the stressor compared to before the stressor. Again, similar to the cortisol research, if hormone levels are increased artificially we do not see the expected effect. On the other hand, if hormone levels are naturally high or low we typically see what is expected.

Cortisol

There has been a considerable amount of research examining the effects of cortisol on cognitive functioning. The results suggest an association between increased cortisol levels and both cognitive impairment and hippocampal atrophy (HA). For example, Lupien and colleagues (1998) performed a longitudinal study examining cortisol levels over a five-year period in 11 aged subjects. They found that the individuals in the high/ increasing cortisol group had significant impairments on a delayed memory task and took longer to recall and follow both a simple and complex maze task compared to individuals in the decreasing/ moderate group. With regard to HA, the investigators found that subjects in the increasing/ high group had total hippocampal volumes (HV) that were reduced by 14% compared to the elderly in the decreasing/ moderate group. This atrophy was specific to the hippocampus (there were

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no differences in the volume of the parahippocampal gyrus, fusiform gyrus, nor the temporal lobe). In further analyses, the authors found that the change in cortisol levels and the current levels of cortisol were both related to HV. In an earlier study by the same group (Lupien, Lecours, Lussier, Schwartz, Nair, & Meaney,1994), they found that the strongest predictor of cognitive impairment was current elevated cortisol level. Seeman, McEwen, Singer, Albert, & Rowe (1997) found similar results to the previous two studies but the findings were specific to females. Women with higher cortisol levels recalled fewer words on the delayed recall of story task. Moreover, women who had increases in cortisol levels over the three-year period exhibited poorer memory performance (see also Carlson & Sherwin, 1999). The opposite was true for women who had a decline in cortisol levels: 76% of the women who had a decline in cortisol showed an improvement in story recall. On the other hand, Carlson & Sherwin (1999) were unable to find an association between longitudinal changes in stress hormones and cognitive performance. This may be due to the shorter duration of the follow-up period in the latter study.

Rather than measuring naturally occurring levels of stress hormones, other researchers have examined stress hormone levels after a planned stressful event or administration of hydrocortisone. For example, a sample of community-dwelling elderly was given an intellectually challenging task (the stressor) and blood was drawn immediately after the task to determine cortisol levels. The results revealed that the individuals with increased cortisol levels exhibited poorer performance on tasks of fluid intelligence (Kelly, Hayslip, Hobdy, Servaty, Ennis, & Pavur, 1998). Contrary to these findings, Porter, Barnett, Idey, McGuckin, & O'Brien (2002) had 16 older adults take hydrocortisone the night before and the morning of cognitive testing. Although there was

a 10-fold increase in cortisol levels after hydrocortisone administration, there was no association between hydrocortisone and cognitive functioning. The discrepant findings may be due to the way stress levels were elevated (subjectively versus induced). In the first study, the increased cortisol levels were probably due to the individual perceiving the situation as stressful. In the second study, cortisol levels were simply increased by taking a pill, which is not very stressful to most individuals. It may be that if the increase in cortisol does not "match" a perceived stressor, then there may not be a decrease in performance. Some other possible explanations for the differences in the two findings are the samples utilized and the way cognition was assessed.

Epinephrine/ Norepinephrine

There are very few empirical studies assessing the effects of epinephrine and norepinephrine on cognitive functioning. The two studies reviewed here used the same method to assess recall. The subjects would watch a series of 21 slides after which they were injected with either epinephrine or norepinephrine. The subjects would return a week later for a "surprise" memory test. The group that was injected with epinephrine showed enhanced long-term memory compared to the control subjects (Cahill & Alkire, 2003). The individuals who were injected with norepinephrine performed worse on a recognition task compared to the controls (Papps, Shajahan, Ebmeier, & O'Carroll, 2002). The authors had hypothesized that the treatment group would outperform the controls. One explanation for the unexpected findings was that the dose of norepinephrine that was administered was too high. They believe that at a lower dose the treatment group will outperform the controls. Another explanation given by the authors is that the control group was in the same state at encoding and retrieval, whereas the

treatment group was not. Interestingly, the authors never measured the level of epinephrine or norepinephrine in their subjects. Did the hormone levels increase after the injections? What were the hormonal levels pre- and post-treatment? Further research should address these issues.

In summary, the current dissertation will examine stress in three ways: subjective reports of negative life events, experiencing the loss of a loved one, and the physiological correlates of stress, namely AL. The literature in all three areas is limited and the findings are mixed which makes it difficult to draw any hard conclusions as to how these different types of stress may affect cognitive performance. The first study (Chapter 3) will examine how self-reported negative life events, in the aggregate and individually, are associated with cognitive performance. The effect of the perceived severity of the life events on cognitive functioning will also be examined. The second study (Chapter 4) will assess the cross-sectional and longitudinal effects of bereavement on cognitive functioning. Lastly, the third study (Chapter 5) will examine the cross-sectional and longitudinal effects of AL, and its component parts, on cognitive performance in bereaved and non-bereaved individuals. Finally, a discussion and synthesis of the conclusions, limitations and future directions of the current dissertation will be provided (Chapter 6).

Chapter 3: Study I

Negative Life Events and Cognitive Performance in a Population of Older Adults.

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ABSTRACT

Objectives: This study examined the association between negative life events in the past year and cognitive performance in a population of older adults.

Methods: Secondary data analysis was conducted on 430 participants from the Charlotte County Healthy Aging Study. Participants completed tests of episodic memory, attention, and psychomotor speed and endorsed the presence and severity of 24 life events. Life events were examined in the aggregate, as well as individually.

Results: Hierarchical multiple regression results suggested no significant relationship between the aggregate frequency and severity measures of negative life events and cognitive performance. At the individual level, individuals who experienced the injury or illness of a friend during the past year and rated it as having more of an effect on their lives performed better on all three cognitive tasks. On the other hand, individuals who reported having less money to live on over the past year and rated the event as having more of an effect on their lives performed more poorly on the psychomotor speed tasks.

Discussion: Our findings support previous research indicating that using estimates of individual stressors rather than aggregate stress measures increase the predictive validity of stress measurement. Further, some of the individual negative life events appear to be associated with better cognitive performance, whereas the experience of other negative life events appear to be associated with poorer performance which nullify one another when using the sum score of events.

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INTRODUCTION

Over the last few decades a substantial amount of research has been focused on age-related differences in cognitive functioning (for review see Bäckman, Small, & Wahlin, 2001). Based on this research, it is well known that deficits in multiple domains of cognitive functioning are associated with the normal aging process (Bäckman et al., 2001; Zacks, Hasher, & Li, 2000). Although mean-level deficits are presented, considerable variability exists in terms of the magnitude of age-related differences in cognitive performance. As such, many researchers have adopted an individual differences perspective in an attempt to better understand these age-related differences. For example, associations between age-related differences in cognition and leisure activities (Albert et al., 1995; Yaffe, Barnes, Nevitt, Lui, & Covinsky, 2001), genetics (Bretsky, Guralnik, Launer, Albert, & Seeman, 2003; Farrer et al., 1997; Small, Rosnick, Fratiglioni, & Bäckman, 2004), health (Anstey, Lord, & Williams, 1997; Rosnick, Small, Borenstein, & Mortimer, 2004), and demographics (Herlitz, Nilsson & Bäckman, 1997; Zelinski & Burnight, 1997) have been reported. In the current study, another class of individual differences variables, negative life events, was examined in relation to cognitive performance in the elderly.

Acute stressors are typically measured by examining daily hassles, negative life events or major life events; past research suggests that several background characteristics are associated with each type of acute stressor. Nacoste and Wise (1991) reported that younger and older adults are more affected by negative life events compared to middle-aged adults. In addition, personality characteristics, such as neuroticism, appear to be related to the frequency and the severity rating of daily hassles. In a sample of 358

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subjects ranging in age from 20-62, De Jong, van Sonderen, and Emmelkamp (1999)

found that individuals scoring higher in neuroticism reported experiencing more stress.

Further, Russell and Davey (1993) observed that, in a sample of college students, those

who scored higher in trait anxiety and worrying reported more daily hassles and rated the

hassles as more severe. Also, acute stressors affect males and females differently.

Women are more likely to report major life crises (Willis, Thomas, Garry, & Goodwin,

1987) and more frequent hassles compared to men (Flannery, 1986). Lastly, research

suggests that reporting more acute stressors is related to poor psychological well-being

(Beasley, Thompson, & Davidson, 2003; Brilman & Johan, 2001; Carmack, Boudreaux,

Armal-Melendez, Brantley, & de Moor, 1999; De Jong et al., 1999) and physical health

(Brand, Hanson, & Godaert, 2000; Leserman, Zhiming, Yuming, & Drossman, 1998;

Lutgendorf, Reimer, Schlechte, & Rubenstein, 2001).

Relatively little information is available on how negative life events may impact

cognitive performance in the elderly. The literature that has examined self-reported

stressors and cognitive performance reveals mixed results. One study examined whether

the amount of stress, measured by the Schedule of Recent Events, predicts intellectual

decline (Sands, 1981-82). Differences between the sum score of stressors and the

individual stressors also were examined. The sample was comprised of 112 women over

65 (mean age=76.8; range=65-92) living independently in the community. Intelligence

was measured by four subtests from the Weschler Adult Intelligence Scale (WAIS):

vocabulary, comprehension, block design, and object assembly. A ratio was developed

by dividing the sum of vocabulary and comprehension (crystallized intelligence) by the

sum of block design and object assembly (fluid intelligence) to estimate intellectual

decline. The results revealed that the stress sum score that was created with values assigned to the events (i.e., turning sixty-five being assigned a stress value of 400) was not associated with the WAIS subtests or the intelligence ratio. However, the stress sum score that was based on self-reported stressfulness of the events was negatively associated with block design and positively associated with the intelligence ratio (indicating more decline). At the individual stressor level, individuals who reported "positive" events (i.e., vacations) during the last two years showed increased intellectual performance, whereas individuals who reported negative changes (i.e., changes in the health of a family member or personal health) over the last two years experienced greater intellectual decline. Similarly, Amster and Krauss (1974) found that women who declined mentally over a five-year period experienced many more crises and higher levels of stress as indexed by the Geriatric Social Readjustment Questionnaire. However, Grimby and Berg (1995) did not find an association between the number of stressful events reported and cognitive decline, although they did find an association between men who were bereaved during the previous six years and cognitive decline compared to men who did not experience any major life events.

In recent work from the Baltimore Epidemiologic Catchment Area study (Saczynski, Rebok, & Holtzman, 2002), the authors found that participants who reported more stressful life events performed better on a task of delayed recall. There was no association between stressful life events and MMSE scores, or immediate and recognition memory. The authors also examined the relation between individual life events and cognitive performance and reported that retirement and having experienced an injury/ illness over the past year was related to better memory performance. On the other hand,

experiencing the loss of a loved one in the past year was associated with poorer memory performance. The previous findings suggest the utility of not only examining the sum of stressors but also the individual stressors themselves and their associations with cognitive functioning. Total scores may obscure the relationship between individual stressors and cognitive performance (Sands, 1981-82).

In summary, individual life events appear to be both beneficial and detrimental to cognitive performance. In addition, the effect of stressful events on cognitive functioning appears to depend on the length of time the stressor is endured. Transient or acute stress may be beneficial (Kim & Diamond, 2002), whereas chronic stress can have detrimental effects on cognitive performance (for reviews see McEwen & Sapolsky, 1995; Sapolsky, 2000a,b). Based on these findings, we hypothesized that chronic negative life events will be associated with poorer performance, whereas acute stressors will be associated with better performance. In the present study, we examined the association between negative life events and cognitive performance in a population-based sample of older adults. The literature examining the effects of negative life events on cognitive performance is limited, especially within elderly populations. The current literature focuses on the effects of negative life events on physical and emotional health. Further, when assessing negative life events typically an aggregate measure is used as the predictor variable. In the current analyses, the occurrence and severity rating of negative life events were examined in the aggregate and individually. Because previous research has indicated that individual life events can be both positively and negatively associated with cognitive performance, the use of the aggregate measures may obscure potential relationships to

cognitive performance due to opposing effects. Finally, the analysis was derived from a population-based study of older adults, increasing the generalizability of the results.

METHODS

Participants

Data from the Charlotte County Healthy Aging Study (CCHAS), a population-based sample of older adults, were utilized (for more information on the data collection see Small et al., 2000). Briefly, two census tracts were selected for study. The goal was to recruit 504 persons aged 60 to 84 years. In each census tract, 126 persons were to be between the ages of 60 and 74 and the other 126 between the ages of 75 and 84. Congregate living and long-term care facilities were not included in the sampling frame. The total number of persons completing the study was 466. For the current analysis, 430 (213 men and 217 women) persons were examined for whom complete data on the measures of relevance were available.

Measures

Cognitive Performance

The measures of cognitive performance were chosen to examine several broad domains of functioning, including episodic memory, psychomotor speed, and attention.

Episodic Memory. This domain was indexed by a modified Hopkins Verbal Learning Test (Benedict, Schretlen, Groninger, & Brandt, 1998; Brandt, 1991). There were four measures of memory performance derived from this test: immediate recall from the first three learning trials, delayed free recall, cued recall, and a discrimination score corrected for guessing.

Psychomotor Speed. This domain was assessed by the Trailmaking Test, Parts A and B (Reitan & Wolfson, 1985). This test was administered according to standard procedures. The primary outcome measure was time taken to complete each part. Higher scores indicate poorer performance.

Attention. This domain was indexed with the Stroop Test (Stroop, 1935) including color, word, and discrimination trials. This task was administered according to standard procedures. The primary outcome measure was the number of items correctly identified for each task.

Due to the lack of information regarding the association between negative life events and cognitive performance in the elderly, we standardized all of the cognitive tasks and combined them to create three standardized cognitive variables: episodic memory, psychomotor speed, and attention.

Negative Life Events

Negative life events were measured by a subset of items from the Louisville Older Persons Events Schedule (LOPES; Murrell & Norris, 1984; Murrell, Norris, & Hutchins, 1984). The full measure assesses 54 negative life events and participants were asked if each event was positive or negative. The individual events utilized in the present study were rated as negative by 90% of the participants. This is a similar method to that of Owen et al. (2002), although they used an 80% threshold. Based on a 90% threshold, we utilized 24 items from the overall measure.

The LOPES was specifically designed for use with an older population and includes such questions as: 1) Did a good friend die in the past year?; 2) Do you have less money to live on in the past year?; and 3) Did any of your children have money problems

during the last year? (Murrell & Norris, 1984; Murrell et al., 1984). Participants are asked to indicate which of the 24 items occurred during the past 12 months (1=no; 2= yes) and rate the effect the event had on their life (1= no effect; 2= slight effect; 3= moderate effect; 4= strong effect). Two aggregate variables were created from the LOPES: (1) frequency, number of negative life events experienced; and (2) cumulative effect, created by summing the severity of the events and dividing by 24. If the event did not occur, it was coded as having no effect.

Background Characteristics

Demographic information included age (in years), gender (0=male, 1=female), education (in years), marital status (1=not married, 2=married), and neuroticism. Neuroticism was measured with the NEO-Five Factor Inventory (NEO-FFI; Costa & McCrae, 1989). The neuroticism scale was utilized because it is associated with the frequency and severity of daily hassles and stress (De Jong et al., 1999; Russell & Davey, 1993).

Statistical Analysis

Correlation analyses were performed to examine the bivariate associations among demographic characteristics, the aggregate frequency and severity of life event measures and cognitive performance. These analyses were followed by hierarchical multiple regressions to control for possible covariates. The background characteristics were entered in the first block and the second block consisted of the aggregate life event measure. Separate models were run for the aggregate frequency and severity measures and each of the cognitive outcomes.

For the individual negative life event analyses, correlation analyses were performed among the 24 LOPES items and the cognitive variables to determine associations among the independent and cognitive variables. The results of these analyses were used for the selection of predictor variables in the individual regression analyses (see Dixon & Hultsch, 1983; Rosnick & Reynolds, 2003). Similar to the analyses with the aggregate measures, hierarchical multiple regressions were performed with the background characteristics in the first block and the significant individual life events entered in the second block. Separate models were run for the individual frequency and severity measures. Because of the large number of predictor variables used in the analyses, a conservative alpha level of .01 was chosen to reduce Type I error.

RESULTS

Background Characteristics

Table 1.1 provides the means and standard deviations for the demographic characteristics and cognitive performance. On average, respondents were in their early 70's, had almost two years of college education and experienced approximately four negative life events over the past year with an average severity rating of 1.26, which indicates that the majority of the events had little to no effect on the participants' lives.

Frequency and Cumulative Effects

The correlation analyses between the aggregate frequency score and cognitive performance revealed that individuals who reported more negative life events recalled a greater number of words on the episodic memory tasks. Similarly, individuals who had a higher average severity rating performed better on the attention tasks. These associations

were no longer significant in the regression analyses after controlling for age, gender, education, marital status and neuroticism (results not shown).

Individual Events and Effects

Correlation analyses were performed with the three cognitive outcome measures and the 24 individual LOPES items to determine whether individual items were associated with cognitive performance. Because of the small sample, those LOPES items that were significantly correlated with cognitive performance were the ones included in the regression models (see Table 1.2). This allowed us to maintain an acceptable predictor variable to subject ratio. Hierarchical multiple regressions were conducted for the three cognitive variables independently with the demographic and personality covariates (age, gender, education, marital status, and neuroticism) entered in the first step and the individual frequency measures entered as the second block. The same analyses were performed with the severity measures.

Episodic Memory

The results of the regression for the associations between individual events and severity measures and episodic memory are presented in Table 1.3. The demographic characteristics contributed a statistically significant amount of variance to cognitive performance in both models (17.0%). At the individual variable level, higher age, being male, having fewer years of education, and higher neuroticism scores were associated with recalling fewer words. Further, both the blocks for frequency and severity measures were statistically significant, accounting for approximately 3% of the variance in episodic memory performance. More specifically, experiencing the injury/ illness of a friend over the past year was associated with recalling a greater number of words. Rating the

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experience as having more of an effect on one's life approached significance (p=.017) and was also associated with recalling a greater number of words.

Psychomotor Speed

Table 1.4 provides the results of the regression for the association between the frequency and severity measures and psychomotor speed. The demographic characteristics contributed 22.5% of the variance in cognitive performance. At the individual variable level, higher age, having fewer years of education and higher neuroticism scores were associated with increased times to finish the task. Again, both the blocks for frequency and severity measures were significant (accounting for 2.7% and 5.0% of variance, respectively). Experiencing the injury/ illness of a friend over the past year approached significance (p=.017) and was associated with faster times on the psychomotor speed tasks. Similarly, rating the injury/illness of a friend over the past year as having more of an effect on one's life was associated with faster times on the psychomotor speed tasks, whereas having less money to live on over the past year and rating it as having more of an effect on one's life was associated with slower times on these tasks. In addition, individuals who rated having a crime committed against them as having more of an effect on their lives took more time to complete the psychomotor speed tasks.

Attention

The results of the regression for the association between the frequency and severity measures and performance on the attention tasks are shown in Table 1.5. The demographic characteristics contributed a statistically significant amount of variance to performance (30.7%). At the individual variable level, higher age, being male, having

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fewer years of education and higher neuroticism scores were associated with fewer correct answers. The block of frequency measures was not statistically significant, whereas the block of severity measures was statistically significant accounting for 3.5% of the variance in cognitive functioning. Rating the injury/illness of a friend over the past year as having more of an effect on one's life was associated with more correct answers compared to individuals who rated it as having less of an effect. On the other hand, rating having less money to live on over the past year as having more of an effect on one's life approached significance and was associated with fewer correct answers (p=.014).

DISCUSSION

The goal of the present analysis was to examine the associations between negative life events, in the aggregate and individually, and cognitive performance in a population-based sample of older adults. The strengths of the current study were the use of multiple measures of cognitive performance (attention, psychomotor speed, and episodic memory), use of a measure of negative life events that was created for an elderly population, as well as the ability to examine the differences between the occurrence of events and the perceived effect the events had on participants' lives in relation to cognitive performance.

Similar to past research (Grimby & Berg, 1995), we were unable to find an association between the aggregate frequency and severity measures and cognitive performance after controlling for multiple background characteristics. On the other hand, there were multiple individual negative life events and effect ratings associated with all three cognitive domains under investigation. The most robust finding was that

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individuals who experienced the injury or illness of a friend during the past year and rated it as having more of an effect on their lives performed better on all three cognitive tasks. One possible explanation is that individuals who experienced an injury or illness for self or of a friend during the last year may change their lifestyle and may be motivated to increase physical activity in order to maintain their own physical/ cognitive health. In support of a relationship between health and cognitive performance, Anstey and Christensen (2000) have suggested that exercise might have an indirect effect on cognition through lowering blood pressure. Further, Yaffe et al. (2001) observed that women who reported more physical activity and expended more calories over a 6 to 8 year period experienced less cognitive decline.

In contrast to the findings pertaining to experiencing the injury or illness of a friend, individuals who reported having less money to live on over the past year and rated the event as having more of an effect on their lives performed more poorly on the psychomotor speed tasks compared to individuals who rated the event as having less of an effect. Furthermore, rating having less money to live on over the past year as having more of an effect on one's life approached significance on the attention tasks. Similarly, individuals who rated having a crime committed against them as having more of an effect on their lives took more time to complete the psychomotor speed tasks. One possible explanation for these findings is Wegner's (1994) theory of mental control. The basic premise is that individuals wish to control their mental activities by suppressing unwanted thoughts. By suppressing unwanted thoughts, individuals are thereby utilizing attention resources that could be used for the cognitive tasks at hand. This theory appears

to fit well with the current findings since the negative effects were restricted to the psychomotor speed and attention tasks (see also Klein & Boals, 2001).

Alternatively, the opposing effects of experiencing the injury or illness of a friend and rating it as having more of an effect on one's life (being associated with better cognitive functioning) and having less money to live on over the last year (being associated with poorer performance) could be explained by the inverted-U function of stress/ arousal and performance proposed by Yerkes and Dodson (1908). The Yerkes-Dodson law posits that there is an optimal level of stress or arousal where individuals perform their best. If there is a lack of arousal or too much arousal individuals perform poorly. With regard to the current results, experiencing and perceiving the injury or illness of a friend as having more of an effect on one's life may be sufficient stress for individuals to perform optimally. On the other hand, having less money to live on may be too much stress and that is why individuals are performing worse.

Our findings support the statement by Sands (1981-82) that using estimates of individual stressors rather than aggregate stress measures increases the predictive validity of stress measurement. We found that none of the aggregate life event measures was significantly associated with cognitive performance, whereas multiple individual life event measures were significantly related to cognitive functioning in older adults. This may be due to the fact that the sum scores are comprised of many different life events that impact people's lives differently. Also, some of the life events can be associated with better performance and others can be associated with poorer performance which nullify one another when using the sum score of events.

Several limitations to this study should be noted. First, the sample under investigation is comprised of relatively healthy, Caucasian older adults which may limit the generalizability of the current results. Furthermore, the current sample of older adults only reported experiencing approximately four negative life events over the past year out of a possible 24. However, despite the limited variability in life events reported, there were significant amounts of variance explained by multiple life events. Second, self-reports of experiencing negative life events over a year may be subject to recall bias. In addition, these life events may occur multiple times throughout a year but the LOPES responses are in a "Yes/No" format. For example, experiencing the injury or illness of a friend may occur multiple times to multiple friends. It may be the accumulation of single events instead of the accumulation of multiple events that is driving the effect on cognitive performance. Also, we were unable to assess whether the events were chronic or acute episodes. Future research needs to address these issues. Finally, the data used in this analysis are cross-sectional and we are therefore unable to determine the direction of the associations between the variables under study. Longitudinal follow-up of participants from the CCHAS should prove to be valuable as participants begin to experience decrements in cognitive functioning.

AUTHOR'S NOTE

Table 1.1 Means and Standard Deviations for the Background Characteristics, Cognition, and Negative Life Events.

	Mean (%)	SD	Range
Background Characteristics			
Age	72.97	6.22	60.2-84.8
Female	(50.5)		
Education	13.97	2.94	3-21
Married	(77.9)		
Neuroticism	15.20	6.95	0-44
Cognitive Performance			
Immediate Recall	6.74	1.78	1.33-10.67
Delayed Recall	7.57	2.76	0-12
Cued Recall	8.50	2.42	1-12
Discrimination Index	9.59	1.97	2-12
Trailmaking A	43.33	16.97	16.16-149
Trailmaking B	117.91	65.38	1.32-439
Stroop Color	58.29	12.77	20-97
Stroop Word	87.78	15.43	20-140
Stroop Discrimination	28.24	9.40	0-60
Life Events			
Frequency	3.69	2.34	0-12
Severity[a]	1.26	0.23	1-2.3

[a] 1= no effect; 2= slight effect; 3= moderate effect; 4= strong effect

Table 1.2 Correlation Coefficients Between Individual Negative Life Events and Cognitive Measures.

	Episodic Memory	Psychomotor Speed	Attention
Good friend died			
Occurrence	.028	-.070	.057
Severity Rating[a]	.013	.006	.068
Injury/ illness of friend			
Occurrence	.146**	-.121*	.121*
Severity Rating	.152**	-.139**	.166**
New injury			
Occurrence	-.014	-.015	-.046
Severity Rating	-.033	.006	-.063
Major home problem			
Occurrence	.016	-.066	.060
Severity Rating	-.044	-.001	.055
Less money to live on			
Occurrence	-.026	.144**	-.078
Severity Rating	-.065	.160**	-.107*
Spouse had injury			
Occurrence	.065	-.072	.097*
Severity Rating	.078	-.069	.115*
Kids w/ money problems			
Occurrence	-.067	-.020	.018
Severity Rating	-.052	.014	-.006
Go to hospital			
Occurrence	.119*	-.091	.055
Severity Rating	.123*	-.073	.092
Conflict with family			
Occurrence	.114*	-.034	.094
Severity Rating	.117*	-.072	.140**
Parents injury			
Occurrence	.055	-.142**	.176**
Severity Rating	.044	-.132**	.165**
Sibling injury			
Occurrence	.045	-.021	.025
Severity Rating	-.008	-.012	.022
Crime committed on you			
Occurrence	.086	.059	-.013
Severity Rating	.045	.133**	-.041
Lost your pet			
Occurrence	.042	-.042	.065
Severity Rating	.012	-.024	.055
Problem in marriage			
Occurrence	-.029	.032	-.033
Severity Rating	-.012	.026	-.019

(Table 1.2 continued)

	Episodic Memory	Psychomotor Speed	Attention
Kids w/ new injury			
Occurrence	.085	.013	-.031
Severity Rating	.086	.030	-.010
Friend relocated			
Occurrence	-.031	.098*	-.080
Severity Rating	-.008	.092	-.077
Someone committed suicide			
Occurrence	.002	-.029	.011
Severity Rating	.023	-.038	.011
Brother/ sister died			
Occurrence	-.091	.002	.014
Severity Rating	-.070	-.026	.075
Child died			
Occurrence	-.040	.049	-.053
Severity Rating	-.040	.049	-.053
Parent died			
Occurrence	.000	-.087	.038
Severity Rating	-.005	-.087	.038
Spouse died			
Occurrence	.016	.059	-.036
Severity Rating	.025	.041	-.026
More responsibility			
Occurrence	.002	-.037	.063
Severity Rating	.002	-.028	.071
Stop all church activities			
Occurrence	.015	.074	-.058
Severity Rating	.003	.058	-.090
Stop recreation activities			
Occurrence	.104*	-.024	.018
Severity Rating	.113*	-.046	.033

*$p<.05$, **$p<.01$
[a] 1= no effect; 2= slight effect; 3= moderate effect; 4= strong effect

Table 1.3 Hierarchical Multiple Regression on the Association Between the Individual Negative Life Events and Severity Measures and Episodic Memory.

	Model 1	Model 2	
Independent Variables	Background Characteristics	Frequency	Severity
Age	-.187**		
Gender	.310**		
Education	.204**		
Marital Status	-.014		
Neuroticism Score	-.141**		
Injury/Illness of Friend		.116*	.107
Hospitalization		.069	.044
Conflict with Family		.073	.064
Stopped Recreational Activities		.075	.081
R^2	.170	.205	.200
R^2 Change	.170	.034	.030
Significant R^2 Change	$p < .001$	$p < .001$	$p < .01$

*$p<.010$; **$p<.001$

Table 1.4 Hierarchical Multiple Regression on the Association Between the Individual Negative Life Events and Severity Measures and Psychomotor Speed.

Independent Variables	Model 1	Model 2	
	Background Characteristics	Frequency	Severity
Age	.269**		
Gender	-.107		
Education	-.256**		
Marital Status	-.095		
Neuroticism Score	.178**		
Injury/Illness of Friend		-.102	-.117*
Less Money to Live On		.119*	.120*
Parents Injured		-.031	-.038
Friend Relocated		.063	---
Crime committed on you		---	.138**
R^2	.225	.252	.275
R^2 Change	.225	.027	.050
Significant R^2 Change	$p < .001$	$p < .01$	$p < .001$

*$p<.010$; **$p<.001$

Table 1.5 Hierarchical Multiple Regression on the Association Between the Individual Negative Life Events and Severity Measures and Attention.

	Model 1	Model 2	
Independent Variables	Background Characteristics	Frequency	Severity
Age	-.384**		
Gender	.158**		
Education	.252**		
Marital Status	.100		
Neuroticism Score	-.170**		
Injury/Illness of Friend		.094	.123*
Less money to live on		---	-.101
Spouse injured		.046	.050
Conflict with family		---	.080
Parents Injured		.035	.044
R^2	.307	.320	.342
R^2 Change	.307	.012	.035
Significant R^2 Change	$p< .001$	$p = .054$	$p< .001$

*$p<.010$; **$p<.001$

Chapter 4: Study II

Bereavement and Cognitive Functioning:

A Cross-Sectional and Longitudinal Examination.

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ABSTRACT

Objectives: This study examined the association between bereavement and cross-sectional differences and longitudinal changes in cognitive performance in a sample of older adults.

Methods: Secondary cross-sectional data analysis was conducted on 209 participants from the MacArthur Battery dataset, a subset of the Changing Lives of Older Couples dataset. The longitudinal analysis consisted of 127 participants. Participants completed tests of episodic memory, verbal ability, and visuospatial skills six and eighteen months post-loss.

Results: Hierarchical multiple regression results suggested that bereavement status alone was not associated with cognitive performance. On the other hand, there were several significant interactions between bereavement status and the background characteristics. For example, there was an interaction between age and bereavement status: the young-old bereaved group performed worse in multiple cognitive domains compared to the young-old non-bereaved group and the old-old bereaved group performed better on five of the eight cognitive measures compared to the old-old non-bereaved individuals. In addition, bereaved males performed worse on four of the eight cognitive measures compared to non-bereaved males and the bereaved females performed better than the non-bereaved females on multiple cognitive measures. The hierarchical residualized regressions revealed that the bereaved individuals declined on the delayed naming recall task over the twelve-month period. Furthermore, there was a significant interaction between gender and bereavement status on the delayed story recall task: bereaved males experienced greater declines over the twelve-month period compared to non-bereaved males and the

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bereaved females exhibited improvements over the study period compared to non-bereaved females.

Discussion: Our results support the finding that bereavement is associated with poorer cognitive performance within certain subgroups (i.e., males and the young-old participants). Possible explanations for the current findings are that the bereaved individuals may have much higher stress levels compared to the non-bereaved individuals and that the bereaved group may have intrusive thoughts about the loss of their spouse that utilizes important attention resources necessary for the cognitive tasks.

INTRODUCTION

Losing a loved one is one of the most stressful events a person can experience and appears to have an impact on cognitive functioning (Aartsen, van Tilburg, Smits, Comijs, & Knipscheer, 2005). Even though this is an important area of research because "…it allows researchers to do natural experiments of chronic stress that could not otherwise be done ethically with human populations" (Vitaliano, 1997; pg. 75), there is little information on the effects of bereavement and how it impacts cognitive functioning.

The limited research that has been conducted on the association between bereavement and cognitive performance suggests that the loss of a loved one does impact cognitive performance. For example, Xavier, Ferraz, Trentini, Freitas, and Moriguchi (2002) examined whether or not the stress associated with grief was related to cognitive performance in a group of elderly over the age of 80. In order for an individual to be characterized as experiencing grief they had to: 1) report being emotionally affected by the loss; and 2) the caretaker had to report observable differences in the individual's day-to-day behavior. The results revealed that individuals who were experiencing grief demonstrated poorer performance on tests of episodic memory, attention and on the MMSE. The authors also examined the differences between the group of individuals who experienced a loss and were with grief to individuals who experienced a loss but were without grief. They found that individuals who were with grief scored worse on both subjective and objective cognitive measures compared to the group without grief. They went on to assess any differences between two "no-grief" groups (individuals who experienced a loss with no grief and individuals who did not experience a loss and without grief). The authors found that those individuals who experienced a loss, even

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though they were not displaying any grief, scored worse on a verbal fluency task. Recently, Aartsen and colleagues (2005) reported that bereaved individuals had greater memory decline over a 6-year period compared to non-bereaved individuals. In addition, memory decline was observed more often in bereaved men compared to bereaved women and there was a statistically significant difference in memory decline in bereaved men compared to non-bereaved men but this was not true for the bereaved and non-bereaved women.

The results assessing the impact of bereavement on cognitive functioning by using self reports of bereavement, either by life event scales or listing stressful events over the past year, have been mixed. For example, in a population-based sample of 430 older adults (213 men and 217 women), Rosnick, Small, McEvoy, Borenstein, and Mortimer (2005) were unable to find an association between bereavement and cognitive performance across multiple domains of cognitive functioning. Similarly, Sands (1981-82) was unable to find a relationship between the death of a spouse and cognitive performance in a sample of 112 women between the ages of 65-92. On the other hand, some researchers do report cross-sectional differences and longitudinal changes in cognitive functioning among individuals who have reported losing their loved one. Grimby and Berg (1985) reported that bereaved subjects declined on a spatial ability task (block design) over a six-year period compared to individuals who reported experiencing no negative life events. More specifically, the authors found that the bereaved men experienced greater cognitive decline on tests of verbal meaning, spatial ability, and digit span backwards compared to individuals reporting no negative life events, whereas there were no significant differences for the women. Furthermore, Saczynski, Rebok, &

Holtzman (2002) revealed that the death of someone other than your spouse over the past year had a negative impact on delayed recall performance but there were no significant associations for the death of one's spouse. The authors go on to report that individuals who reported being the death of someone other than their spouse over the past ten years performed better on a delayed recall task and on the Mini Mental State Examination (Folstein, Folstein, & McHugh, 1975).

In the present study, we examined the cross-sectional and longitudinal associations between bereavement and cognitive performance in a sample of older adults. All of the analyses will be controlled for age, education, and gender. We will also examine the interactions between the background characteristics (e.g., age, education, and gender) and bereavement status.

METHODS

Participants

Data from the MacArthur Battery (MacBat) dataset, a subset of the Changing Lives of Older Couples (CLOC) dataset were utilized (for more information on data collection see Carr & Utz, 2002). Briefly, the CLOC study was a prospective study of 1532 married individuals from the Detroit area. In order to be eligible for the study, individuals had to meet the following criteria: English-speaking, married, residing in a household in which the husband was at least 65 years of age, non-institutionalized, and able to participate in a two hour face-to-face initial interview. Baseline data was collected between June 1987 and April 1988, and approximately 68% of the individuals who were contacted participated in the initial interview. The three follow-up interviews were conducted at six months, 18 months, and 48 months after the spouse's death. Age

and sex matched non-bereaved individuals were also interviewed at all three follow-up points. The MacBat study was conducted for the first three measurement points: baseline, 6 months post-loss, and 18 months post-loss. The dataset consisted of 432 respondents at the baseline interview. Deaths were monitored by reading the obituaries in the three Detroit newspapers, using monthly death record tapes from the State of Michigan, and confirmed by the National Death Index. The current cross-sectional analysis consisted of 211 participants for whom complete data on the measures of relevance were available at the six-month follow-up and there were 127 participants included in the longitudinal analysis. At the six-month follow-up period, sixty percent (n=127) of the participants were bereaved. The primary reasons for missing data were ill health, death, or refusal to participate (for additional information see the University of Michigan's CLOC website, www.cloc.isr.umich.edu).

Measures

Cognitive Performance

The measures of cognitive performance were chosen to examine several broad domains of functioning, including episodic memory, verbal ability, and visuospatial skills.

Episodic memory was indexed by immediate and delayed story recall (Moss, Albert, Butter, & Payne, 1986). The subjects were read a short story and then asked to tell the researcher as much of the story as they could remember. After a few minutes had passed and another test had been performed, the subjects were again instructed to recall as much of the story as possible. There are six possible points for each task. Another domain examined in the current analysis was that of spatial memory (Moss et al., 1986).

A disc is paced on a board and the subject is given time to study the position of the disc. The board is then removed and another disc is added. When the subject is shown the board again, they are to point out the new disc. This process continued until there were up to 17 discs on the board.

Verbal ability was assessed using two measures. The first was taken from the Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1983). The subjects were shown a series of pictures and asked to name each picture (18 possible points). After several intervening tasks, the subjects are asked to recall as many of the pictures as they can. The second verbal ability measure was the Similarities task from the Wechsler Adult Intelligence Scale- Revised (Wechsler, 1981). The subjects are told two words that are alike in some way and asked "how" they are alike. One point was given for abstract responses and two points were given for concrete responses. These items were recoded so higher scores reflected more abstraction.

Visuospatial ability was indexed by copying four objects: 1) a diamond; 2) a circle; 3) a diamond with a square inside; and 4) a cube (Rosen, Mohs, & Davis, 1984). Lastly, we created an overall cognitive score by standardizing the individual test scores and summing them together. The overall cognitive measure was created to provide a summary statistic for global cognitive performance.

Statistical Analysis

Hierarchical multiple regressions were performed to control for possible covariates (i.e., age, education, and gender) and examine the association between bereavement and cognitive performance six months post-loss. Similarly, hierarchical residualized regressions (Cohen, Cohen, West, & Aiken, 2003; Menard, 1991) were

performed to control for the same covariates and examine the association between bereavement status and cognitive change from the six to eighteen month follow-up. At the first step the demographic characteristics (age, education, and gender) were entered. Bereavement status was entered as the second block. The interactions between bereavement status and the background characteristics were entered in the final step.

RESULTS

Background Characteristics

Demographic information included age (in years), gender (1=male, 2=female), and education (in years). Table 2.1 provides the means and standard deviations for the demographic characteristics and cognitive performance. At the six-month follow-up, respondents were, on average, approximately 70 years old, had a high school education, 85% of the participants were female, and 60% were bereaved. The participants who were lost to follow-up at the eighteen month measurement point had fewer years of education, and lower scores on the delayed story recall task, design copy task, and overall cognitive functioning measure. There were no age or gender differences between the two groups.

Cross-Sectional Analyses

The results of the hierarchical multiple regressions for the associations between the background characteristics, bereavement, and cognitive performance are presented in Table 2.2. The first block was significant in all of the models, accounting for approximately 14-36% of the variance across the cognitive tasks. Among the background characteristics, increasing age was associated with poorer performance on all but two (immediate and delayed story recall) of the cognitive measures; having fewer years of education was associated with poorer performance on all the cognitive tasks,

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with the exception of the spatial memory task; and males recalled fewer words on the delayed naming recall task and females recalled fewer discs on the spatial memory task.

In terms of the relationship between bereavement and cognitive function, bereavement status alone was not related to any of the cognitive outcomes. On the other hand, there were several significant interactions between bereavement status and the background characteristics, accounting for between 3%-5% of the variance in performance. There were significant Age X Bereavement interactions for immediate (β = 2.44, p < .01) and delayed story recall (β = 1.93, p < .01), naming (β = 2.27, p < .01), design copy (β = 1.77, p < .05), and overall cognitive performance (β = 2.07, p < .01). In addition, there were significant Gender X Bereavement interactions for immediate story recall (β = 0.83, p < .05), spatial memory (β = 0.90, p < .05), naming (β = 0.78, p < .05), and overall performance (β = 0.75, p < .05).

In order to better understand these interactions, we computed the correlations between bereavement and performance separately for gender and two age groups (created by using a median split), as shown in the top portion of Table 2.3. The pairs of correlations were tested to determine if they were statistically different using Fisher's *r* to *z* transformation (see Steiger, 1980). The correlations suggest that the young-old bereaved participants performed worse on the immediate and delayed story recall, design copy, and overall cognitive measures compared to the younger non-bereaved participants, although the only significant correlation was with bereavement and delayed story recall (r = -.22; p < .05). On the other hand, the old-old bereaved group performed better on the same four tasks compared to the old-old non-bereaved participants. Two of the correlations were significant: the old-old bereaved participants performed better on the

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design copy and overall cognitive measures compared to the old-old non-bereaved participants ($r = .26$, $p < .05$; $r = .22$, $p < .05$, respectively). Furthermore, all of the pairs of correlations between the young-old and old-old participants were statistically different from one another [immediate story recall: $t(91) = 2.48$, $p < .05$; delayed story recall: $t(91) = 2.70$, $p < .01$; design copy: $t(91) = 2.29$, $p < .05$; overall cognition: $t(91) = 2.20$, $p < .05$], with the exception of the naming task. For the Gender X Bereavement results, none of the correlations between bereavement and performance were statistically significant. On the other hand, the bereaved males performed worse on all four tasks compared to the non-bereaved males and the bereaved females performed better on the naming, spatial memory, and overall cognitive measures compared to the non-bereaved females. For the spatial memory task, the correlation for the males and females were significantly different from one another [$t(27) = 2.31$, $p < .05$].

Longitudinal Analyses

Table 2.4 presents the results of the hierarchical residualized regressions for the associations between the background characteristics and bereavement and cognitive change from the six-month to the eighteen-month follow-up post-loss. The first step was significant in all of the models accounting for between 21% and 68% of the variance in cognitive functioning. Increasing age was associated with declines in performance in spatial memory and delayed naming recall. Having fewer years of education was associated with a decline in performance on the similarities task and males declined on the immediate story recall task. More importantly, the results suggest that the bereaved individuals experienced greater declines on the delayed naming recall tasks compared to the non-bereaved individuals.

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In addition, there was a significant Gender X Bereavement interaction on the delayed story recall task. Similar to the cross-sectional analysis, we computed the correlations between bereavement and delayed story recall performance separately for the males and females and tested if the pair of correlations was statistically different (bottom portion of Table 2.3). Although the correlations between bereavement and delayed story recall performance were not statistically significant, they do suggest that the bereaved females improved on the delayed story recall task compared to the non-bereaved females and the bereaved males experienced greater declines compared to the non-bereaved males. More importantly, the correlation for the males and females were significantly different from one another [t(18) = 2.18, p < .05].

DISCUSSION

The goal of the present analysis was to examine the association between bereavement and cognitive functioning in a sample of older adults. The strengths of the current study were the use of multiple measures of cognitive performance (episodic memory, verbal ability, and visuospatial skills) and the ability to assess both cross-sectional differences and longitudinal changes in cognitive performance after individuals have lost a spouse.

The cross-sectional results revealed that the main effect of bereavement was not significant but there were several statistically significant interactions. Interestingly, the significant interactions indicated that the young-old bereaved group performed worse than the young-old non-bereaved group. In addition, the old-old non-bereaved individuals performed worse on five of the eight possible cognitive measures compared to the old-old bereaved participants. Although the majority of the correlations were not

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significant, the correlations between the younger and older adults were significantly different from one another. Furthermore, the bereaved females performed better on the naming, spatial memory, and overall cognitive measures compared to the non-bereaved females, whereas the bereaved males performed worse on the immediate story recall task, spatial memory, naming, and overall cognitive performance. The only significantly different correlation between the males and females was for performance on the spatial memory task.

The longitudinal results suggest that bereavement is only associated with cognitive decline on the delayed naming recall task. The one significant interaction revealed that the bereaved females improved over the twelve-month period on the delayed story recall task compared to non-bereaved females, whereas the bereaved males experienced greater decline on this task compared to the non-bereaved males. Also, the correlation between the males and females was statistically significant.

Our findings are consistent with previous longitudinal investigations examining the effect of bereavement on cognitive performance. Aartsen et al. (2005) recently examined the effects of widowhood on memory performance in a sample of older adults over the age of 60 and reported that both the bereaved and non-bereaved group declined over the study period (six-years). The authors go on to report that the widowed men demonstrated greater memory decline compared to the widowed women. In addition, there was a significant difference in memory decline between the bereaved and non-bereaved men but not in the two groups of women. Grimby & Berg (1995) also found that there was greater cognitive decline in bereaved men compared to non-bereaved men but were unable to find a difference in the bereaved and non-bereaved women. These

findings would support the current observation of bereaved men declining on an episodic memory task.

Although this study was descriptive in nature, one possible explanation for the current findings is that the bereaved males and young-old participants may have higher stress levels compared to their non-bereaved counterparts. There is strong evidence that chronic stress has long lasting negative effects on cognitive performance. The hippocampus has one of the highest concentrations of receptors for the stress hormone cortisol (Kim & Diamond, 2002) and plays an important role in learning and memory (Sapolsky, 2000a,b). Long-term exposure to cortisol is related to decreased hippocampal volume and poorer performance on cognitive tasks (Bremner et al., 1995; Bremner et al., 1997; Steffens et al., 2000). Further research is needed to address whether there is an actual increase in stress hormones after the loss of a loved one and how this fluctuation in hormones affects cognitive functioning.

Another possible explanation for the current findings is that the bereaved individuals are continually thinking about their loved one who has passed on. In support of this hypothesis, Byrne & Raphael (1994) observed that bereaved men reported intrusive thoughts about their deceased loved one 13 months post-bereavement. Over 90% of the participants reported intrusive thoughts of their loved one 6-weeks post-bereavement. Six-months post-bereavement approximately 84% of the participants still reported intrusive thoughts and over 75% of the participants reported having intrusive thoughts 13-months post-bereavement. If this were the case for the current sample, the results would support Wegner's (1994) theory of mental control. The basic premise is that individuals wish to control their mental activities by suppressing unwanted thoughts

and, in doing so, individuals utilize attention resources that could be used for the cognitive tasks at hand.

Several limitations to this study should be noted. First, we were only able to examine approximately 60% of the respondents due to missing data (primarily baseline cognitive performance). Subsequently, we were unable to examine the longitudinal effects pre- and post-loss.   In addition, we do not know how stressful the loss was for the participants. If the death of the spouse were a relief (due to suffering or marital conflict), we would expect the individual to view the death as not stressful. On the other hand, if the death were unexpected, we would expect for the individual to view the death as very stressful. Lazarus (1999; p.72) states "…the main source of variation in the arousal of stress and how it affects human functioning is the way an individual evaluates subjectively the personal significance of what is happening." Moreover, the perceived severity of life events has recently been shown to be related to cognitive performance (Rosnick et al., 2005). Future research needs to address the difference between the effects of experiencing a stressful event, the perceived stressfulness of the event, and the physiological markers of stress and how they affect cognitive performance.

In summary, the current cross-sectional results suggest that the men and young-old individuals in the current sample who lost a loved one performed worse in multiple cognitive domains. The longitudinal results revealed that decrements in cognitive functioning for the bereaved participants was strictly in the domain of episodic memory which suggests increased stress hormone levels. Future research needs to address this issue.

Table 2.1 Means and Standard Deviations for all Study Variables.

	Mean (%)	SD	Range
Background Characteristics			
Age	69.97	6.33	51-86
Female	(85.3)		
Education	11.84	2.73	2-17
Bereaved	(60.2)		
Cognitive Performance			
Immediate Story Recall			0-6
Wave 1	4.02	1.29	
Wave 2	4.16	1.37	
Delayed Story Recall			0-6
Wave 1	3.83	1.43	
Wave 2	3.95	1.46	
Naming			0-18
Wave 1	17.23	1.25	
Wave 2	17.37	1.14	
Delayed Naming Recall			0-18
Wave 1	5.95	2.66	
Wave 2	6.50	2.83	
Similarities			0-8
Wave 1	5.47	2.53	
Wave 2	5.78	2.29	
Copying			0-20
Wave 1	15.48	2.73	
Wave 2	15.78	2.90	
Spatial Memory			0-17
Wave 1	10.18	3.64	
Wave 2	10.89	3.55	
Total Cognition			0-93
Wave 1	62.45	9.86	
Wave 2	64.71	10.13	

Table 2.2 Hierarchical Multiple Regressions on the Association Between Bereavement Status and Cognitive Functioning.

Independent Variables	ISR	DSR	SM	Naming	DNR	Similarities	DC	OC
Step One								
Age	-0.13	-0.10	-0.34***	-0.27***	-0.14*	-0.26***	-0.15*	-0.32***
Education	0.30***	0.39***	0.07	0.32***	0.22***	0.34***	0.40***	0.42***
Gender[a]	0.02	0.08	-0.17*	0.13	0.24***	0.06	-0.03	0.05
R^2	0.12***	0.18***	0.11***	0.23***	0.15***	0.22***	0.19***	.32***
Step Two								
Bereavement Status[b]	-0.02	-0.07	0.03	0.08	0.00	0.02	0.08	0.04
R^2 Change	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Step Three								
Age*Bereavement	2.44**	1.93**	---	2.27**	---	---	1.77*	2.07**
Education*Bereavement	---	---	---	---	---	---	---	---
Gender*Bereavement	0.83*	---	0.90*	0.78*	---	---	---	0.75*
R^2 Change	0.05**	0.03**	0.03*	0.04**			0.04*	0.04**

*p<.050; **p<.010; ***p<.001; [a]1=male; 2=female; [b]0=non-bereaved; 1=bereaved

ISR-immediate story recall; DSR-delayed story recall; SM-spatial memory; DNR-delayed naming recall; DC-design copy; OC-overall cognition

Note: Standardized regression coefficients are shown for ease of interpretation.

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Table 2.3 Correlations of Bereavement with Selected Cognitive Variables by Age and Gender.

Cross-Sectional Analysis

	Age Group	
	51-70 Years	71-86
Correlation with Bereavement	(n = 110)	(n = 94)
Immediate Story Recall[t]	-.18	.17
Delayed Story Recall[tt]	-.22*	.16
Design Copy[t]	-.06	.26*
Naming	.03	.19
Overall Cognition[t]	-.09	.22*

	Gender	
	Male	Female
	(n = 30)	(n = 174)
Immediate Story Recall	-.17	-.00
Naming	-.03	.14
Spatial Memory[t]	-.37	.09
Overall Cognition	-.17	.08

Longitudinal Analysis (refer to Table 2.4)

	Gender	
	Male	Female
Correlation with Bereavement	(n = 21)	(n = 106)
Delayed Story Recall[t]	-.35	.19

* $p<.05$; **$p<.01$; ***$p<.001$

[t] $p<.05$; [tt]$p<.01$; indicates a significant difference between the correlations

Table 2.4 Hierarchical Residualized Regressions on the Association Between Bereavement Status and Cognitive Functioning.

Independent Variables	ISR	DSR	SM	Naming	DNR	Similarities	DC	OC
Step One								
Baseline Cognition	0.49***	0.42***	0.30***	0.77***	0.52***	0.58***	0.58***	0.78***
Age	-0.03	-0.12	-0.28**	0.05	-0.19*	-0.08	-0.07	-0.09
Education	0.07	0.07	0.04	-0.07	0.13	0.16*	0.13	-0.02
Gender[a]	0.16*	0.08	-0.17	0.04	0.07	0.12	0.05	0.04
R^2	0.31***	0.25***	0.21***	0.55***	0.42***	0.51***	0.42***	0.68***
Step Two								
Bereavement Status[b]	-0.03	0.08	-0.12	-0.04	-0.15*	0.01	0.10	-0.04
R^2 Change	0.00	0.01	0.01	0.00	0.02*	0.00	0.01	0.00
Step Three								
Age*Bereavement	---	---	---	---	---	---	---	---
Education*Bereavement	---	---	---	---	---	---	---	---
Gender*Bereavement	---	1.12**	---	---	---	---	---	---
R^2 Change		0.05**						

*p<.050; **p<.010; ***p<.001; [a]1=male; 2=female; [b]0=non-bereaved; 1=bereaved
ISR-immediate story recall; DSR-delayed story recall; SM-spatial memory; DNR-delayed naming recall; DC-design copy; OC-overall cognition

Note: Standardized regression coefficients are shown for ease of interpretation.

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Chapter 5: Study III

Allostatic Load and Cognitive Performance in Bereaved and Non-Bereaved Individuals:

A Cross-Sectional and Longitudinal Examination.

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ABSTRACT

Objectives: This study examined the cross-sectional and longitudinal associations between allostatic load and cognitive performance in a sample of bereaved and non-bereaved older adults.

Methods: Participants consisted of bereaved and non-bereaved older adults from the MacArthur Battery dataset, a subset of the Changing Lives of Older Couples dataset. Participants completed tests of episodic memory, verbal ability, and visuospatial skills six and eighteen months after the loss of their spouse. We utilized the original ten items of allostatic load (AL) to assess overall physiological dysregulation.

Results: Cross-sectional results suggested that individuals with higher AL and syndrome X scores performed worse on multiple measures of cognitive performance and individuals with higher non-syndrome X scores performed better on the similarities and design copy tasks. At the individual AL marker level, individuals in the highest systolic blood pressure and waist-to-hip ratio quartile performed worse on multiple cognitive outcomes and individuals in the highest epinephrine quartile performed better on the delayed story recall, design copy, and overall cognition measures. Longitudinal results revealed that the overall and individual AL measures were not associated with cognitive performance. On the other hand, the syndrome X scores were associated with decreases in performance and the non-syndrome X scores were associated with increases in performance.

Discussion: Our cross-sectional findings suggest that the overall AL measure, the syndrome X and non-syndrome X measures, and the individual AL markers are associated with cognitive performance. On the other hand, we were unable to find an

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association between the overall AL measure and cognitive performance longitudinally which is in contrast to prior research. Possible reasons for the discrepant findings are discussed.

INTRODUCTION

When a person encounters a stressor the catecholamines, epinephrine and norepinephrine, are secreted by the sympathetic nervous system, and the glucocorticoids, namely cortisol, by the adrenal gland (McEwen & Sapolsky, 1995). The hippocampus is a target of stress hormones, having one of the highest concentrations of receptors for glucocorticoids (Kim & Diamond, 2002). Further, the hippocampus is one of the most important areas that mediates, and in turn is affected by, the stress response (McEwen, 1999). The effects of stress on the hippocampus are exacerbated because the hippocampus modulates the glucocorticoid release through the HPA axis (Bremner, 1999; Porter & Landfield, 1998). Consequently, the important effects of the stress hormones on the hippocampus are consistent with the hypothesis that the hippocampus likely plays a role in stress-related psychiatric disorders and the cognitive impairments associated with the disorders. For example, patients diagnosed with posttraumatic stress disorder (PTSD) demonstrate a variety of memory problems including deficits in declarative memory (remembering facts or lists) and fragmentation of memories (both autobiographical and trauma-related; Bremner, 1999). The literature examining the effects of stress on hippocampal volume (HV) and memory performance have primarily used subjects with combat-related PTSD or individuals who had a traumatic experience in early life (i.e., were abused as a child). In general, individuals with PTSD have sufficient memory deficits, in addition to recurrent nightmares, amnesia for war experiences, and flashbacks. The memory problems exhibited by PTSD patients appear to be in verbal memory tasks versus spatial learning tasks (Bremner et al., 1995), which is consistent with hippocampal damage.

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Cortisol is the primary glucocorticoid released during the stress response and there has been a considerable amount of research examining the effects of cortisol on cognitive functioning. The results suggest an association between increased cortisol levels and both cognitive impairment and hippocampal atrophy (HA; Lupien et al., 1998). Seeman, McEwen, Singer, Albert, & Rowe (1997) found similar results but their findings were specific to females. Women with higher cortisol levels recalled fewer words on the delayed recall of story task. Moreover, women who had increases in cortisol levels over the three-year period exhibited poorer memory performance (see also Carlson & Sherwin, 1999). The opposite was true for women who had a decline in cortisol levels: 76% of the women who had a decline in cortisol showed an improvement in story recall. On the other hand, Carlson & Sherwin (1999) were unable to find an association between longitudinal changes in stress hormones and cognitive performance.

Losing a loved one is one of the most stressful events a person can experience and the results assessing the impact of bereavement on cognitive functioning by using self reports, either by life event scales or listing stressful events over the past year have been mixed. Several authors have been unable to find an association (Rosnick, Small, McEvoy, Borenstein, and Mortimer, 2005; Sands, 1981-82), while others have found that bereavement negatively impacts cognitive functioning (Grimby & Berg, 1985; Saczynski, Rebok, & Holtzman, 2002). It has been suggested that the observed declines in cognitive performance in bereaved individuals may be due to increased levels of stress and the corresponding stress hormones (Aartsen, van Tilburg, Smits, Comijs, & Knipscheer, 2005; Rosnick & Small, 2005). Based on these suggestions, we wanted to examine the

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association between allostatic load (AL; an indicator of physiological dysregulation) and cognitive performance in a sample of bereaved and non-bereaved individuals.

On the other hand, the literature that examines the association between the bereavement process and cognitive performance suggests that bereaved individuals perform worse than non-bereaved individuals in multiple cognitive domains (i.e., Aartsen et al., 2005). For example, Aartsen and colleagues (2005) examined the effect of widowhood on memory functioning in a sample of over 1100 older adults. The authors reported that bereaved individuals had greater memory decline over the 6-year study period compared to non-bereaved individuals. In addition, memory decline was observed more often in bereaved men compared to bereaved women and there was a statistically significant difference in memory decline in bereaved men compared to non-bereaved men but this was not true for the bereaved and non-bereaved women. Furthermore, Xavier, Ferraz, Trentini, Freitas, and Moriguchi (2002) reported that individuals who were experiencing grief due to the loss of a close friend or relative demonstrated poorer performance on tests of episodic memory, attention and on the MMSE. The authors also report that individuals who experienced a loss and were not displaying any grief scored worse on a verbal fluency task compared to individuals who did not experience a loss.

Recently, Rosnick and Small (2005) examined the association between bereavement and cognitive performance in a sample of older adults. Participants completed tests of episodic memory, verbal ability, and visuospatial skills six and eighteen months post-loss. The cross-sectional and longitudinal results suggested that there was a negative association between bereavement and cognitive performance, but that these effects were moderated by several background characteristics. Cross-

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sectionally, the young-old bereaved individuals performed worse in multiple cognitive domains compared to the young-old non-bereaved individuals and the old-old bereaved individuals performed better on five of the eight cognitive measures compared to old-old non-bereaved individuals. In addition, bereaved males performed worse on four of the eight cognitive measures compared to non-bereaved males and the bereaved females performed better than the non-bereaved females on multiple cognitive measures. Longitudinally, there was a significant interaction between gender and bereavement status on the delayed story recall task: bereaved males experienced greater declines over the twelve-month period compared to non-bereaved males and the bereaved females exhibited improvements over the study period compared to non-bereaved females.

In the current study, we examined the impact of multiple biological markers, including cortisol, on cognitive functioning in a sample of bereaved and non-bereaved individuals. Recently, AL was proposed to examine the cumulative physiological effect of adapting to stressful situations by assessing the functioning of multiple biological systems including the hypothalamic-pituitary-adrenal (HPA) axis, metabolic processes, cardiovascular system, and sympathetic nervous system (Karlamangla, Singer, McEwen, Rowe, & Seeman, 2002; Seeman, McEwen, Rowe, & Singer, 2001). The original AL measure was a summary score consisting of systolic and diastolic blood pressure (SBP and DBP, respectively), waist-to-hip ratio (WHR), high-density lipoproteins (HDL), total cholesterol, glycosylated hemoglobin (GH), dehydroepiandrosterone sulfate (DHEA-S), cortisol, epinephrine (EPI), and norepinephrine (NOR). Researchers found that individuals with higher AL scores had an increased risk of mortality, cardiovascular disease, and cognitive impairment after controlling for age, sex, ethnicity, education,

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income, and baseline morbidity (Seeman et al., 2001). Of the ten measures that make up the allostatic load score, it has been reported that urinary epinephrine, waist-to-hip ratio, and urinary cortisol make the largest contributions to physical decline and diastolic blood pressure, urinary epinephrine, and glycosylated hemoglobin make the largest contributions to predicting cognitive decline (Karlamangla et al., 2002).

METHODS

Participants

Data from the MacArthur Battery (MacBat) dataset, a subset of the Changing Lives of Older Couples (CLOC) dataset were utilized (for more information on data collection see Carr & Utz, 2002). Briefly, the CLOC study was a prospective study of 1532 married individuals from the Detroit area. In order to be eligible for the study, individuals had to meet the following criteria: English-speaking, married, residing in a household in which the husband was at least 65 years of age, non-institutionalized, and able to participate in a two hour face-to-face initial interview. Baseline data was collected between June 1987 and April 1988, and approximately 68% of the individuals who were contacted participated in the initial interview. The three follow-up interviews were conducted at six months, 18 months, and 48 months after the spouse's death. Age and sex matched non-bereaved individuals were also interviewed at all three follow-up points. The primary reasons for missing data in the CLOC dataset were ill health, death, or refusal to participate (for additional information see the University of Michigan's CLOC website, www.cloc.isr.umich.edu). The MacBat study was conducted for the first three measurement points: baseline, 6 months post-loss, and 18 months post-loss. The dataset consisted of 432 respondents at the baseline interview. Deaths were monitored by

reading the obituaries in the three Detroit newspapers, using monthly death record tapes from the State of Michigan, and confirmed by the National Death Index.

Measures

Cognitive Performance

The measures of cognitive performance were chosen to examine several broad domains of functioning, including episodic memory, verbal ability, and visuospatial skills.

Episodic memory was indexed by immediate and delayed story recall (Moss, Albert, Butter, & Payne, 1986). The subjects were read a short story and then asked to tell the researcher as much of the story as they could remember. After a few minutes had passed and another test had been performed, the subjects were instructed to recall as much of the story as possible. There are six possible points for each task. Another domain examined in the current analysis was that of spatial memory (Moss et al., 1986). A disc is paced on a board and the subject is given time to study the position of the disc. The board is then removed and another disc is added. When the subject is shown the board again, they are to point out the new disc. This process continued until there were up to 17 discs on the board.

Verbal ability was assessed using two measures. The first was taken from the Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1983). The subjects were shown a series of pictures and asked to name each picture (18 possible points). After several intervening tasks, the subjects are asked to recall as many of the pictures as they can. The second verbal ability measure was the Similarities task from the Wechsler Adult Intelligence Scale- Revised (Wechsler, 1981). The subjects are told two words that are

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alike in some way and asked "how" they are alike. One point was given for abstract

responses and two points were given for concrete responses.

Visuospatial ability was indexed by copying four objects: 1) a diamond; 2) a

circle; 3) a diamond with a square inside; and 4) a cube (Rosen, Mohs, & Davis, 1984).

Lastly, standardizing the individual test scores and summing them together created an

overall cognitive score. The overall cognitive measure was created to provide a summary

statistic for global cognitive performance.

Allostatic Load

AL was based on conventions described by Seeman et al. (2001), and included ten

items: systolic and diastolic blood pressure (SBP and DBP, respectively), waist-to-hip

ratio (WHR), serum HDL, total cholesterol, glycosylated hemoglobin,

dehydroepiandrosterone-sulfate (DHEA-S), cortisol, epinephrine, and norepinephrine.

SBP and DBP were calculated as the average of three seated blood pressure

readings. WHR was calculated based on the minimal waist circumference and maximal

hip circumference. Blood samples were collected at the individuals' homes the morning

after the home interview to assess HDL cholesterol, total cholesterol, gylcosylated

hemoglobin, and DHEA-S levels. Subjects also completed an overnight (8 p.m. to 8

a.m.) urine sample after their home interview to assess basal rates of cortisol,

epinephrine, and norepinephrine. Furthermore, these three measures were corrected for

creatinine clearance to adjust for body size (for more information see Seeman et al.,

2001).

Subjects were classified into quartiles based on the baseline (6-months post-loss)

distribution of scores and a summary measure was created based on the number of

markers the subject was in the highest quartile (except for HDL and DHEA-S for which the lowest quartile was used). This is consistent with the literature assessing the effects of AL on functioning in older populations (e.g., Seeman et al., 2004; Seeman, Glei, Goldman, Weinstein, Singer, & Lin, 2004; Seeman et al., 2001). Table 1 provides the cutoff points utilized for the current analysis. We also wanted to assess the effect of the components of AL by decomposing the overall score. We did this in two ways: 1) we created a sum score of the syndrome X components (i.e., SBP, DBP, WHR, GH, HDL cholesterol, and the ratio of total cholesterol to HDL cholesterol) and non-syndrome X components (i.e., cortisol, epinephrine, norepinephrine, and DHEA-S; Reaven, 1988); and 2) we assessed the effects of the individual AL markers.

Statistical Analysis

Multiple regressions were performed to control for possible covariates (i.e., age, education, and gender) and examine the association between the overall AL measure, syndrome X, non-syndrome X, the individual AL markers and cognitive performance six months post-loss. Due to the small sample sizes, we performed correlation analyses to determine which of the possible covariates were associated with each of the cognitive outcomes. The regression models include only those covariates that were significantly associated with performance at the bivariate level. The same procedure was used when assessing the effect of the individual AL markers on cognitive performance. Residualized regressions (Cohen, Cohen, West, & Aiken, 2003; Menard, 1991) were performed to control for the same covariates and examine the association between the 6-month overall AL measure, syndrome X, non-syndrome X, the individual AL markers, and cognitive change from the six to eighteen month follow-up. We included

bereavement as a covariate in all analyses due to a recent report that bereavement was associated with cognitive performance in this population (Rosnick & Small, 2005).

<div align="center">RESULTS</div>

Background Characteristics

Demographic information included age (in years), gender, and education (in years). Table 2 provides the means and standard deviations for the demographic characteristics and cognitive performance. At the six-month follow-up, respondents were, on average, approximately 70 years old, had a high school education, a little more than 85% of the participants were female, and over 60% were bereaved.

Cross-Sectional Analyses

Table 3 provides the means, standard deviations, and the percent of participants who were above the cutoff point by bereavement status for each of the independent AL measures. Although the means and percentages were not statistically different from one another, the non-bereaved older adults have a larger percentage of individuals over the cutoff points for the syndrome X factors, whereas the bereaved individuals have a larger percentage of individuals over the cutoff points for the non-syndrome X factors. This would suggest that the bereaved individuals have elevated stress hormones compared to the non-bereaved individuals.

As previously mentioned, the background characteristics were correlated with the cognitive outcomes to determine which variables would be included in each analysis. Based on these results, age was included in all of the models; education was included in all of the models, with the exception of the spatial memory analysis; and gender was included in the naming, delayed naming recall, and overall cognition analyses.

Allostatic Load

Table 4 presents all of the models examining the relationship between the overall AL measure and cognitive performance. All of the models were statistically significant, accounting for 9-39% of the variance across the cognitive tasks. Among the background characteristics, increasing age was associated with poorer performance on the immediate story recall, spatial memory, naming, similarities, and overall cognitive performance measure; having fewer years of education was associated with poorer performance on all the cognitive tasks in which it was included in the model; and males demonstrated poorer performance on the naming, delayed naming recall, and overall performance measures. The bereaved participants performed better on the design copy task compared to the non-bereaved individuals. Furthermore, the results suggest that individuals with higher AL scores performed worse on the immediate story recall task ($\beta = -.19$, $p < .05$) and approached significance on the spatial memory task ($\beta = -.18$, $p = .053$).

Syndrome X versus Non-Syndrome X

All of the models were significant, accounting for between 10-43% of the variance across the cognitive tasks (see Table 5). The results for the background characteristics were comparable to the previous analysis. Together with the syndrome X and non-syndrome X factors, bereavement status was not related to any of the cognitive outcomes.

In terms of the relationship between the syndrome X and non-syndrome X measures and cognitive functioning, the results suggest that individuals with higher syndrome X scores performed worse on the immediate story recall ($\beta = -.30$, $p < .001$), spatial memory ($\beta = -.21$, $p < .05$), and overall cognitive performance ($\beta = -.17$, $p < .05$)

measures. On the other hand, individuals with higher non-syndrome X scores performed better on the similarities (β = .20, p < .05) and design copy tasks (β = .19, p < .05).

Individual AL Markers

Table 6 presents the results of the multiple regression analysis assessing the association between the individual AL measures and cognitive functioning. All of the models were significant, accounting for between 13-45% of the variance across the cognitive tasks. Again, the results for the background characteristics were comparable to the previous analyses. Taken together with the individual AL markers, bereavement status was not related to any of the cognitive outcomes.

The results suggest that individuals in the highest SBP quartile performed worse on the delayed story recall (β = -.16, p < .01), spatial memory (β = -.23, p < .001), similarities (β = -.18, p < .05), and overall cognition (β = -.17, p < .05) measures compared to individuals in the lower three quartile. Individuals in the highest WHR quartile performed worse on the naming task (β = -.20, p < .05) compared to individuals not in the upper quartile. Lastly, individuals in the highest epinephrine quartile performed better on the delayed story recall (β = .20, p < .05), design copy (β = .24, p < .01), and overall cognition (β = .15, p < .05) measures compared to individuals in the lower three quartiles.

Longitudinal Analyses

Allostatic Load

All of the models were significant, accounting for between 15-62% of the variance across the cognitive tasks (results not shown). Among the background characteristics, increasing age was associated with greater declines on the delayed

naming recall task over the twelve-month period. Education, gender, bereavement status, and the overall AL measure were not associated with cognitive performance.

Syndrome X versus Non-Syndrome X

All of the models were significant, accounting for between 16-62% of the variance across the cognitive tasks (see Table 7). The results for the background characteristics were comparable to the previous analysis. Individuals with higher syndrome X scores demonstrated greater declines on the delayed story recall task ($\beta = -.24$, $p < .05$) and individuals with higher non-syndrome X scores showed increases on the design copy task ($\beta = .23$, $p < .01$) and a trend towards improvements on the similarities tasks ($\beta = .19$, $p = .053$).

Individual AL Markers

All of the models were significant, accounting for between 17-61% of the variance across the cognitive tasks (results not shown). The results for the background characteristics were as follows: increasing age was associated with greater declines on the spatial memory and delayed naming recall tasks. Education, gender, bereavement status and the individual AL markers were not associated with cognitive performance.

DISCUSSION

The goal of the present analysis was to examine the association between AL, its component parts, and cognitive functioning in a sample of bereaved and non-bereaved older adults. The strengths of the current study were the use of multiple measures of cognitive performance (episodic memory, verbal ability, and visuospatial skills), the ability to assess both cross-sectional differences and longitudinal changes in cognitive performance, and the presence of biological markers of health.

The cross-sectional results revealed that individuals with higher overall AL scores performed worse on the immediate story recall task; individuals with higher syndrome X scores performed worse on the immediate story recall, spatial memory, and overall cognition measures; individuals with higher non-syndrome X scores performed better on the similarities and design copy tasks. In terms of the relationship between the individual AL markers and cognitive functioning, being in the upper SBP and WHR quartiles were associated with poorer cognitive performance, whereas being in the upper epinephrine quartile was associated with better performance on multiple tasks. Due to the cross-sectional nature of the data used in this analysis, we are unable to determine the direction of the relationship between cognitive functioning and the physiological measures under investigation. The longitudinal results suggested that the overall AL measure was not associated with cognitive change. On the other hand, individuals with higher syndrome X scores demonstrated greater declines on the delayed story recall task and individuals with higher non-syndrome X scores showed improvements on the design copy task.

Although we were able to find cross-sectional differences between the overall AL measure and immediate story recall performance, our longitudinal findings contradict the findings of other authors (i.e., Seeman et al., 2001) investigating the effect of AL on cognitive change. For example, Seeman et al. (2001) examined the association between AL and multiple health outcomes including cognitive performance. The authors reported that individuals with the highest AL scores showed the greatest declines on a measure of overall cognitive performance. In the current analysis, we were unable to find an association between the overall AL measure and cognitive change. There are several possible reasons for the discrepant findings. First, our sample size was relatively small

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(n=80) when assessing cognitive change and we had a limited follow-up period (12 months), whereas the sample utilized in the Seeman et al. (2001) analysis consisted of more than 700 participants and were followed for six-years. It is possible that the deleterious effects of AL take longer to exert their effect on cognitive performance. Second, in the current analysis, we analyzed the effect of the overall AL measure as a continuous variable due to the lack of people with a "0" score. Previous research has analyzed the overall AL measure as a dummy variable in order to examine the dose response of the AL composite score. Lastly, our cutoff points are based on the 6-month post-loss follow-up versus having a true baseline measure to create the cutoff points.

Our findings for the association between the syndrome X and non-syndrome X factors are partially in accordance with the Seeman et al. (2001) findings. They found an association between the syndrome X factor and cognitive decline but were unable to find an association between the non-syndrome X factor and cognitive performance. The current findings revealed that there were both cross-sectional and longitudinal associations between the syndrome X and non-syndrome X factors. These differences could also be explained by the samples utilized, analyzing the syndrome X and non-syndrome X factors as dummy variables versus continuous, and we were unable to assess these factors pre-loss.

The most robust findings when assessing the effect of the individual AL markers on cognitive functioning were the negative impact of being in the SBP upper quartile and the positive impact of being in the epinephrine upper quartile. These findings are consistent with previous research (i.e, SBP; Budge, de Jager, Hogervorst, & Smith, 2002; Kilander, Nyman, Boberg, & Lithell, 2000; epinephrine; Cahill & Alkire, 2003). Similar

to our research assessing the effect of life event sum scores and individual life events on cognitive performance (Rosnick et al., 2005), the current findings suggest that the overall sum score may not be sensitive enough to detect cognitive changes in this population but the decomposition of the AL measure may be more informative when assessing cognitive performance.

Several limitations to this study should be noted. First, we were only able to examine approximately 27% of the respondents due to missing data. Most of the blood and urine data were missing at baseline. This is truly unfortunate because we were unable to examine the longitudinal effects pre- and post-loss. In comparing our cutoff points to the cutoff points from the Seeman et al. (2001) study, it appears that we have a highly stressed sample (cortisol: 40.5 vs. 25.7; epinephrine: 7.8 vs. 5; norepinephrine: 54.8 vs. 48; and DHEA-S: 31 vs. 35. respectively). This is probably due to the fact that our cutoff points are based on the 6-month post-loss follow-up when the majority of the participants have experienced the loss of their loved one versus the pre-loss measurement time point. This could explain why were unable to find many longitudinal changes.

There are also several limitations to the measurement of AL. One, we were able to assess the effect of basal cortisol rates on cognitive performance but, since we only had one blood sample, we were unable to assess the effect of the diurnal variations in cortisol levels and its association with cognitive functioning. Secondly, the way researchers assess the affects of AL on health outcomes has changed dramatically since the original operationalization of AL proposed by Seeman and colleagues in 2001. AL is currently comprised of sixteen items (see Seeman et al., 2004a). The additional six items include albumin, IL-6, C-reactive protein, peak flow, fibrinogen, and creatinine clearance. What

are we really measuring when we try to assess the affects of AL? The current results suggest that the overall sum score is not very informative but the individual measures can shed more light on the associations between physiological dysregulation and cognitive performance. Researchers should determine the utility of adding measures to what comprises AL. Lastly, we do not know how stressful the loss was for the participants. Future research needs to address the difference between the effects of experiencing a stressful event, the perceived stressfulness of the event, and the AL markers and how they affect cognitive performance.

Table 3.1 Cutoff Points for Each of the AL Markers.

Individual AL Markers	Quartiles
SBP	> = 154 mm Hg
DBP	> = 80 mm Hg
Glycosylated Hemoglobin	> = 7.1%
WHR	> = 0.89
Ratio total cholesterol/ HDL	> = 5.5
Urinary Cortisol	> = 40.45 µg/g creatinine
Urinary Epinephrine	> = 7.84 µg/g creatinine
Urinary Norepinephrine	> = 54.76 µg/g creatinine
HDL cholesterol	< = 41 mg/dl
DHEA-S	< = 31 µg/dl

Table 3.2 Descriptives of the Background Characteristics and Cognitive Performance.

	Mean (%)	SD	Range
Background Characteristics			
Age	69.97	6.61	51-86
Female	(85.3)		
Education	11.84	2.71	2-17
Bereaved	(60.2)		
Cognitive Performance			
Immediate Story Recall			0-6
Wave 1	4.02	1.29	
Wave 2	4.18	1.35	
Delayed Story Recall			0-6
Wave 1	3.83	1.43	
Wave 2	3.93	1.49	
Naming			0-18
Wave 1	17.23	1.25	
Wave 2	17.28	1.38	
Delayed Naming Recall			0-18
Wave 1	5.95	2.66	
Wave 2	6.08	2.89	
Similarities			0-8
Wave 1	5.47	2.53	
Wave 2	5.75	2.30	
Copying			0-20
Wave 1	15.48	2.73	
Wave 2	15.73	2.77	
Spatial Memory			0-17
Wave 1	10.18	3.64	
Wave 2	10.71	3.53	
Total Cognition			0-93
Wave 1	62.45	9.86	
Wave 2	63.77	10.20	

Table 3.3 Means, Standard Deviations, and Percentages Over the Six-Month Post-Loss Cutoff Points for Each of the AL Components by Bereavement Status.*

Measures	Bereaved		Non-Bereaved		F-value	χ^2
	Mean (SD)	%	Mean (SD)	%		
Allostatic Load	2.7 (1.7)		2.6 (1.4)		0.08	
Syndrome X	1.5 (1.5)		1.8 (1.3)		2.12	
SBP	138.9 (22.1)	26.2%	139.2 (20.1)	23.8%	0.01	0.15
DBP	74.5 (9.5)	26.2%	73.8 (9.8)	31.0%	0.31	0.57
GH	6.8 (1.7)	19.6%	6.8 (1.0)	32.0%	0.10	2.75
Waist-to-Hip Ratio	0.84 (0.08)	23.6%	0.84 (0.10)	28.6%	0.02	0.65
Cholesterol/ HDL	4.6 (1.4)	21.7%	4.9 (1.6)	32.0%	1.28	1.80
HDL cholesterol	52.9 (16.2)	22.8%	51.4 (15.6)	30.0%	0.31	0.88
Non-Syndrome X	1.2 (1.0)		0.9 (1.1)		2.34	
Urinary Cortisol	36.5 (34.8)	26.2%	28.1 (17.4)	23.4%	2.36	0.12
Urinary Epi	6.2 (3.4)	28.9%	6.2 (5.6)	21.7%	0.00	0.79
Urinary Nor	48.6 (38.1)	28.9%	41.6 (27.2)	19.6%	1.21	1.36
DHEA-S	60.1 (42.5)	29.4%	64.1 (48.1)	19.2%	0.25	1.67

*The means and percentages over the cutoff points were not statistically different from one another

Table 3.4 Multiple Regressions on the Association Between Allostatic Load and Cognitive Functioning (n = 115).

Independent Variables	ISR	DSR	SM	Naming	DNR	Similarities	DC	OC
Age	-.23*	-.15	-.24**	-.29**	-.13	-.24**	-.13	-.28***
Education	.24**	.36***	---	.33***	.21*	.32***	.45***	.47***
Gender[a]	---	---	---	.21*	.30**	---	---	.21*
Bereavement Status[b]	-.05	-.03	-.01	-.02	-.01	.02	.20*	.03
AL	-.19*	.00	-.18	.03	-.10	.09	.02	-.07
R^2	.16***	.17***	.09*	.28***	.18***	.18***	.22***	.39***

*p<.050; **p<.010; ***p<.001; ISR-immediate story recall; DSR-delayed story recall; SM-spatial memory; DNR-delayed naming recall; DC-design copy; OC-overall cognition

Note: Standardized regression coefficients are shown for ease of interpretation.

Table 3.5 Multiple Regressions on the Association Between Syndrome X and Non-Syndrome X Factors and Cognitive Functioning (n = 115).

Independent Variables	ISR	DSR	SM	Naming	DNR	Similarities	DC	OC
Age	-.21*	-.15	-.24**	-.30**	-.14	-.23**	-.12	-.30***
Education	.20*	.34***	---	.32***	.19*	.30**	.41***	.43***
Gender[a]	---	---	---	.20*	.27**	---	---	.15
Bereavement Status[b]	-.10	-.06	-.02	-.03	-.03	-.01	.17	-.01
Syndrome X	-.30***	-.07	-.21*	.01	-.14	.00	-.08	-.17*
Non-Syndrome X	.09	.13	-.03	.05	.02	.20*	.19*	.13
R^2	.23***	.19***	.10*	.29***	.19***	.21***	.27***	.43***

*p<.050; **p<.010; ***p<.001; ISR-immediate story recall; DSR-delayed story recall; SM-spatial memory; DNR-delayed naming recall; DC-design copy; OC-overall cognition

Note: Standardized regression coefficients are shown for ease of interpretation.

Table 3.6 Multiple Regressions on the Association Between the Individual AL Markers and Cognitive Functioning.

Independent Variables	ISR (n=208)	DSR (n=129)	SM (n=207)	Naming (n=131)	DNR (n=129)	Similarities (n=129)	DC (n=128)	OC (n=128)
Age	-.13*	-.12	-.25***	-.22**	-.13	-.18*	-.09	-.24**
Education	.28***	.31***	---	.34***	.17	.30***	.38***	.40***
Gender[a]	---	---	---	.14	.21*	---	---	.10
Bereavement Status[b]	-.02	-.05	.03	.03	-.04	.05	.14	.01
SBP	-.10	-.16*	-.23***	---	---	-.18*	-.02	-.17*
DBP	-.11	---	---	---	---	---	---	---
WHR	---	---	---	-.20*	-.10	---	---	-.09
Cortisol	---	---	---	.08	---	.11	---	.14
Epinephrine	---	.20*	---	---	.09	.10	.24**	.15*
Norepinephrine	---	---	---	---	---	.13	---	---
R^2	.15***	.24***	.13***	.32***	.17***	.28***	.26***	.45***

*p<.050; **p<.010; ***p<.001; ISR-immediate story recall; DSR-delayed story recall; SM-spatial memory; DNR-delayed naming recall; DC-design copy; OC-overall cognition

Note: Standardized regression coefficients are shown for ease of interpretation.

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Table 3.7 Residualized Regressions on the Association Between Syndrome X and Non-Syndrome X Factors and Cognitive Functioning (n = 80).

Independent Variables	ISR	DSR	SM	Naming	DNR	Similarities	DC (78)	OC (78)
Baseline Cognition	.41***	.26*	.23	.64***	.50***	.50***	.52***	.62***
Age	-.08	-.14	-.15	-.13	-.21*	-.15	-.12	-.14
Education	.16	.14	---	.05	.08	.11	-.03	.08
Gender[a]	---	---	---	.07	.15	---	---	.15
Bereavement Status[b]	-.01	.03	-.14	.02	-.15	-.01	-.11	-.05
Syndrome X	-.06	-.24*	-.16	.06	-.01	-.02	-.08	.02
Non-Syndrome X	.08	.09	-.01	.01	-.12	.19	.23*	.05
R^2	.28***	.25**	.16*	.51***	.50***	.40***	.44***	.62***

*p<.050; **p<.010; ***p<.001; ISR-immediate story recall; DSR-delayed story recall; SM-spatial memory; DNR-delayed naming recall; DC-design copy; OC-overall cognition

Note: Standardized regression coefficients are shown for ease of interpretation.

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Chapter 6: Concluding Remarks

The purpose of the current dissertation was to examine how stress impacted cognitive performance in older adults. More specifically, we examined how subjective reports of negative life events (study I), bereavement (study II), and the physiological correlates of stress (study III) were associated with age-related differences as well as age-related changes in cognitive functioning. This is important because, as mentioned earlier, older adults suffer declines in cognition as part of the normal aging process. In addition, the elderly may be more susceptible to the types of stressors currently under investigation, and the elderly may be more vulnerable to the effects of the stressors.

There is relatively little information on the association between the effect of negative life events, bereavement, and their association with cognitive performance. The results that are available show both positive and negative associations with reporting negative life events and cognitive performance. Similarly, the results examining bereavement as a self-reported life event reveals mixed results. On the other hand, the results are relative consistent when assessing cognitive differences/ changes between bereaved and non-bereaved individuals. With regard to the AL measure and its association with cognitive performance, the AL summary measure has been shown to be related to overall cognitive performance but there has been very little research on its association with specific cognitive domains. In an attempt to further the research in all these areas, we conducted three studies examining how these different stress

measurements affect cognitive functioning in older adults. In this section, I will recapitulate the main findings and limitations from the three studies.

The first study examined the association between negative life events in the past year and cognitive performance in a population of older adults. The results suggested no significant relationship between the aggregate frequency and severity measures of negative life events and cognitive performance. At the individual level, individuals who experienced the injury or illness of a friend during the past year and rated it as having more of an effect on their lives performed better on all three cognitive tasks. On the other hand, individuals who reported having less money to live on over the past year and rated the event as having more of an effect on their lives performed more poorly on the psychomotor speed tasks. These findings support previous research indicating that using estimates of individual stressors rather than aggregate stress measures increases the predictive validity of stress measurement. Further, the individual negative life events can have both a positive and negative effect which nullify one another when using the sum score of events.

The second study examined the cross-sectional and longitudinal associations between bereavement and cognitive performance in a sample of older adults. The results revealed that bereaved individuals performed worse in multiple cognitive domains compared to the non-bereaved individuals. More importantly, several of the background characteristics moderated the relationship between bereavement and cognitive performance. Young-old bereaved individuals performed worse in multiple cognitive domains compared to the young-old non-bereaved individuals and the old-old bereaved individuals performed better on five of the eight cognitive measures compared to the old-

old non-bereaved individuals. In addition, bereaved males performed worse on four of the eight cognitive measures compared to non-bereaved males and the bereaved females performed better than the non-bereaved females on multiple cognitive measures. The longitudinal analyses revealed that the bereaved individuals declined on two of the episodic memory tasks: delayed story recall and delayed naming recall. Furthermore, there was a significant interaction between gender and bereavement status on the delayed story recall task: bereaved males experienced greater declines over the twelve-month period compared to non-bereaved males and the bereaved females exhibited improvements over the study period compared to non-bereaved females. The current findings support past research reporting a negative association between bereavement and cognitive performance.

The final study assessed the cross-sectional and longitudinal associations between allostatic load, its component parts, and cognitive performance in a sample of bereaved and non-bereaved older adults. The cross-sectional results suggest that individuals with higher AL scores performed worse on the immediate story recall task and approached significance on the spatial memory task. Furthermore, individuals with higher syndrome X scores performed worse on multiple measures of cognitive performance and individuals with higher non-syndrome X scores performed better on the similarities and design copy tasks. At the individual AL marker level, individuals in the highest SBP quartile performed worse on the delayed story recall, spatial memory, similarities, and overall cognition measures; individuals in the highest WHR quartile performed worse on the naming task; and individuals in the epinephrine upper quartile performed better on the delayed story recall, design copy, and overall cognition measures. The only significant

longitudinal findings were that individuals with higher syndrome X scores demonstrated greater declines on the delayed story recall task and individuals with higher non-syndrome X scores showed increases on the design copy task and a trend towards improvements on the similarities tasks. The cross-sectional findings suggested that the overall AL measure, the syndrome X and non-syndrome X measures, and the individual AL markers are associated with cognitive performance. Longitudinally, we were unable to find an association between the overall AL measure and cognitive performance, which is in contrast to prior research (Seeman et al., 2001).

Taken together, the results of the current project suggest an association between the multiple stress factors and cognitive performance. Similar to the findings of Grimby & Berg (1985) we were unable to find an association between the sum of life events experienced and cognitive functioning. On the other hand, we did find an association between specific negative life events and cognitive functioning. Our findings support the statement by Sands (1981-82) that using estimates of individual stressors rather than aggregate stress measures increases the predictive validity of stress measurement. Furthermore, our findings from the second study are consistent with previous research suggesting an association between bereavement and cognitive functioning (Aartsen et al., 2005). Lastly, when assessing the possible physiological mechanisms of stress and cognitive performance, we were able to find cross-sectional differences between the overall AL measure and cognitive performance but we were unable to observe longitudinal associations between the overall AL measure and cognitive functioning. This is inconsistent with prior research (Seeman et al., 2001). These differences could be explained by the samples examined, how the overall AL measure was assessed (i.e.,

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continuous versus categorical), and the cutoff points utilized to determine individuals who were at risk in the study sample. On the other hand, we were able to find an association between the individual markers of AL and the syndrome X and non-syndrome X factors and cognitive performance. Lastly, it may be that the individual life events and AL markers may be more informative when assessing cognitive functioning in the current samples compared to using sum scores (Sands, 1981-82).

LIMITATIONS

Although the present findings are informative there are several limitations that should be mentioned. In study I, which utilized the Charlotte County Healthy Aging Study, the participants only reported experiencing approximately four negative life events over the past year out of a possible 24. More importantly, self-reports of experiencing negative life events over a year may be subject to recall bias. In addition, these life events may occur multiple times throughout a year but the LOPES responses are in a "Yes/No" format. Also, we were unable to assess whether the events under investigation were chronic or acute episodes. Finally, the data used in this analysis are cross-sectional and we are therefore unable to determine the direction of the associations between the variables under study.

For study II, we were only able to examine approximately 60% of the respondents due to missing data (primarily baseline cognitive performance). Subsequently, we were unable to examine the longitudinal effects pre- and post-loss. In addition, we do not know how stressful the loss was for the participants.

Similar to study II, we were only able to examine approximately 27% of the respondents due to missing data. Most of the blood and urine data were missing at

baseline. This is truly unfortunate because we were unable to examine the longitudinal effects pre- and post-loss. Furthermore, our cutoff points were much higher compared to the cutoff points from the Seeman et al. (2001) study; it appears that we had a highly stressed sample. This is probably due to the fact that our cutoff points are based on the 6-month post-loss follow-up when the majority of the participants have experienced the loss of their loved one versus the pre-loss measurement time point. This could explain why were unable to find many longitudinal changes. In addition, we do not know how stressful the loss was for the participants. Lastly, our sample size was relatively small (n=80) when assessing cognitive change and we had a limited follow-up period (12 months). It is possible that the deleterious effects of AL take longer to exert their effect on cognitive performance.

FUTURE DIRECTIONS

The primary area of research that is lacking when assessing the effect of life events on cognitive performance is determining whether or not the event is chronic or relatively acute. As mentioned earlier, acute stress appears to have a beneficial effect on cognitive performance, whereas chronic stress can have deleterious consequences. Another avenue for future research concerns whether older adults are making positive lifestyle changes after experiencing certain life events. These possible lifestyle changes could be the reason why we are seeing positive effects of experiencing the injury/ illness of friends. Furthermore, these lifestyle changes may be decreasing the possible biomarkers of stress (i.e., cortisol), which have been shown to be related to negative cognitive outcomes. Future research should also attempt to disentangle the relationship between experiencing an event, how stressful participants perceive the event, and the

underlying biomarkers of stress and their relative contribution to cognitive performance. Lastly, researchers should determine the impact intrusive thinking has on cognitive performance and the link between intrusive thoughts and the physiological markers of stress.

Similar to our research assessing the effect of life event sum scores and individual life events on cognitive performance (Rosnick et al., 2005), the findings from study III suggest that the overall AL sum score may not be sensitive enough to detect cognitive changes in this population but the decomposition of the AL measure may be more informative when assessing cognitive performance. The overall AL measure may need more time to exert its deleterious effects on cognitive performance, whereas the negative effect of the independent markers may take less time. AL has primarily been used to assess declines in health and is still being developed (i.e., there is more on metabolic/ endocrine function and inflammation markers). Future research should determine its importance in detecting cognitive declines in the older population.

Taken together, future research needs to make the connection between experiencing stressful life events, the perceived stressfulness of experiencing the events, the underlying physiological mechanisms associated with stress, intrusive thinking, and their relative contribution to cognitive performance.

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APPENDICES

Appendix A: Action Letter and Reviewer Comments

Dear Chris,

I am pleased to inform you that your manuscript, "Negative Life Events and Cognitive Performance in a Population of Older Adults", (05-051) has been accepted for publication pending minor revisions. Please consider the reviewers' comments and revise accordingly.

Please e-mail the revised manuscript along with a letter explaining changes made. We would also appreciate hard copies of each. This is a fine manuscript with interesting and important results. We look forward to receiving what I expect will be the final manuscript.

Sincerely,

Kyriakos S. Markides, Ph.D.
Annie & John Gnitzinger Distinguished Professor of Aging Studies
Editor of The Journal of Aging & Health
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(Appendix A: Continued)

Reviewer #1 Comments

Summary of Review and Recommendation:

Their study can be summarized as follows: "In community dwelling older adults, self-reports of adverse life events over 1-year period were associated with cognitive domains of psychomotor speed, memory and attention, independent of relevant demographic confounders. The direction of associations depends on whether the life events variables were analyzed as aggregate or individual predictor variable".

Overall, the topic is very relevant to cognitive aging research by showing associations between life stress and cognitive performance in a population-based sample of older adults. Their findings provided new information on the importance of examining life events not only as a summative measure but to also to look at individual stressors as, their study shows, adverse life events may have positive or negative effects on cognitive performance. The minor comments below do not take away from this well-conceptualized, well-written and hypothesis-driven study.

Introduction: excellent introduction. Maybe, the authors can add a statement or two about effects of depressive symptoms, social network/support, religiosity and income variables in moderating impact (and perceptions) of adverse life events. Of course, if these variables exist in CCHAS study database, I will suggest examining whether these variables (as well as race/ethnicity, a proxy for culture factors) affect the direction and strength of association between negative life events and cognition.

 Methodology: excellent with several excellent papers already published from the database. Appropriate use of hierarchical multiple regressions to explore individual and

(Appendix A: Continued)

aggregate effects of their predictors. Because presence of depressive symptoms affects both cognition and stressors perception, I suggest, if the depressive symptoms measure is available in the CCHAS, that the authors re-analyze the data presented in Tables 3-5 with adjustment for depressive symptoms. This may explain some of the differential effects of individual negative life events on the cognitive measures.

Results: Well presented and with very lucid explanations.

Discussion; Excellent discussion with a good summary of potential limitations.

In summary, this paper presented new findings based on cross-sectional analyses of a well-known database (the Charlotte County Healthy Aging Study). It is clear and well-written. Their findings advance cognitive aging research.

(Appendix A: Continued)

Reviewer #2 Comments

Thank you for the opportunity to review this manuscript. The authors have submitted a carefully prepared manuscript that is well written, thoughtful, and integrates results with current knowledge. I have several comments that I believe would strengthen the manuscript.

1. Please include a description of reliability and validity for all measures.

2. Please include the possible range for the cognitive performance scales in Table 1—this would help with interpretation.

3. Along these lines, were any analyses done to discern whether negative life events were associated with scores that fell outside standard ranges? In other words, it is interesting to note a negative life event is associated with a "lower" score, but it may be more interesting to note whether that same negative life event is associated with a score that denotes mild or moderate cognitive impairment.

4. The authors integrate their findings with current literature well and pposit several theories for associations found in the study. However, one possible theory is not addressed—is it possible that the low score on the cognitive performance measure was present prior to the negative life event, rather than the way in which it is hypothesized? For example, the authors found an association between having less money to live on over the past year and lower attention scores. Is it possible that participants with lower attention scores are predisposed to an employment status that would place them in a lower socioeconomic bracket?

Appendix B: Award Letter

July 6, 2005

Dear Colleague:

Congratulations on being a winner for the 2005 Laurence G. Branch Doctoral Student Research Award in honor of outstanding students for exceptional research during their training.

We are pleased to announce that the selection committee has selected the following winners:

Award Winner:
Christopher B. Rosnick, B.A. "Negative Life Events and Cognitive Performance in a Population of Older Adults"

The Award Winners will be presented with the award at the Gerontological Health Section awards session to be held Monday, November 7, 2005, in New Orleans, LA. The venue for the award program will be announced shortly.

In preparation for the awards program, we need the following from you by Wednesday

July 13, 2005:

1) **A narrative biographical sketch (see attached sample below),**
2) **An updated abstract, and**
3) **A 2"x 3" electronic photograph for the brochure.**

Please send all of these materials to Thomas Bow at Thomas.bow@vnsny.org.

We appreciate your submission and look forward to seeing you at the meetings in November.

Sincerely,

Penny H. Feldman

Penny Hollander Feldman, Ph.D.
Vice President & Director

Christopher B. Rosnick

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Education

Ph.D.	2000 - 2005 University of South Florida	Aging Studies
M.P.H.	2001 - 2005 (anticipated) University of South Florida	Biostatistics
B.A.	1994 - 1997 University of South Florida	Gerontology
B.A.	1994 - 1997 University of South Florida	Psychology

Honors/ Awards

2005   Laurence G. Branch Doctoral Student Research Award to be presented at the 133rd Annual American Public Health Association Meeting. **Rosnick, C. B.**, Small, B. J., McEvoy, C. L., Borenstein, A. R. & Mortimer, J. A., *Negative Life Events and Cognitive Performance in a Population of Older Adults*.

2005   Provost's Commendation for Outstanding teaching by a Graduate Teaching Assistant

2004   Provost's Commendation for Outstanding teaching by a Graduate Teaching Assistant

2003	Certificate for the Provost's Award for Outstanding Teaching by a Graduate Teaching Assistant
2002	Award for Excellence in Research at the 1st Annual Center for Hospice and Palliative Care Symposium, University of South Florida. **Rosnick, C. B.** & Reynolds, S. L., *Thinking Ahead: Factors Associated With Executing Advance Directives.*
2000	Institute on Aging Fellowship, University of South Florida

Professional Experience

2000 to present	Graduate Assistant, School of Aging Studies, University of South Florida.
2000 to present	Graduate Research Assistant, Dr. Brent J. Small, University of South Florida.
2000 to 2002	Graduate Research Assistant, Dr. Sandra Reynolds, University of South Florida.
1999 to 2000	Research Assistant, Department of Gerontology, University of South Florida.
1998 to 1999	Staff Coordinator, Home Instead Senior Care, Tampa, FL.
1997 to 1998	Research Assistant, Dr. Kathryn Hyer, Hartford Foundation, New York University.

Professional Activities

2005   Gerontological Society of America reviewer for the 2005 Annual Meeting

2005   American Public Health Association reviewer for the 2005 Annual Meeting

2004   Elected Diversity Committee Graduate Student Representative, University of South Florida College of Arts and Sciences.

Ad Hoc Reviewer, *Journal of Mental Health and Aging*

Workshops Attended

Technical Assistance Workshop: Workshop for Minority and Emerging Scientists and Students Seeking Careers in Aging Research. The preconference workshop was presented by the National Institute of Aging at the 55th Annual Scientific Meeting of the Gerontological Society of America, Boston, MA, November, 2002.

Mixed Models and Hierarchical Models in Gerontological Research. The workshop was presented at the 54th Annual Scientific Meeting of the Gerontological Society of America, Chicago, IL., November, 2001

University Instruction

Summer 2005	GEY 4612, Psychology of Aging - Instructor, University of South Florida, School of Aging Studies
Spring 2005	GEY 4612, Psychology of Aging - Instructor, University of South Florida, School of Aging Studies
Summer 2004	DEP 2004, Life Cycle - Instructor, University of South Florida, School of Aging Studies
	GEY 4612, Psychology of Aging - Instructor, University of South Florida, School of Aging Studies
Spring 2004	DEP 2004, Life Cycle - Instructor, University of South Florida, School of Aging Studies
Fall 2003	GEY 4612, Psychology of Aging - Instructor, University of South Florida, School of Aging Studies
Spring 2003	DEP 2004, Life Cycle - Instructor, University of South Florida, Department of Gerontology
Fall 2002	DEP 2004, Life Cycle - Instructor, University of South Florida, Department of Gerontology
Summer 2002	GEY 4612, Psychology of Aging – Co- Instructor, University of South Florida, Department of Gerontology

Professional Memberships

Gerontological Society of America

American Psychological Association

American Psychological Association, Division 20 (Adult Development and Aging)

American Public Health Association

Phi Kappa Phi Scholastic Honor Society

Publications

Small, B.J., **Rosnick, C.B.,** Fratiglioni, L. & Bäckman, L. (2004). Apolipoprotein E and Cognitive Performance: A Meta-Analysis. *Psychology and Aging, 19* (4), 592-600.

Rosnick, C.B., Small, B.J., Borenstein Graves, A, & Mortimer, J.A. (2004). The Association Between Health and Cognitive Performance in a Population-Based Study of Older Adults: The Charlotte County Healthy Aging Study (CCHAS). *Aging, Neuropsychology,and Cognition, 11* (1), 89-99.

Rosnick, C. B. & Reynolds, S. L. (2003). Thinking ahead: Factors associated with executing Advance Directives. *Journal of Aging and Health, 15* (2), 409-429.

Manuscripts Under Review/ In Progress

Rosnick, C. B., Small, B. J., McEvoy, C. L., Borenstein, A. R. & Mortimer, J. A. (under review). Negative Life Events and Cognitive Performance in a Population of Older Adults.

Rosnick, C. B. & Branch, L. G. (under review). Life Events and the Affect on 4-year Cognitive Change in Older Black and White Americans.

Rosnick, C. B. & Small, B. J. (in progress). Bereavement and Cognitive Functioning: A Cross-Sectional and Longitudinal Analysis.

Rosnick, C. B. & Small, B. J. (in progress). Allostatic Load and Cognitive Performance in Bereaved and Non-Bereaved Individuals: A Cross-Sectional and Longitudinal Examination.

Presentations at Professional Meetings

Rosnick, C. B., Small, B. J., McEvoy, C. L., Borenstein, A. R. & Mortimer, J. A. Negative Life Events and Cognitive Performance in a Population of Older Adults. Paper presentation at the 133rd Annual American Public Health Association Meeting, Philadelphia, PA, December, 2005.

Rosnick, C. B., & Branch, L. G. *Life Events and the Affect on 4-Year Cognitive Change in Older Black and White Americans.* Poster presentation at the 58th Annual Gerontological Society of America Scientific Meeting, Orlando, FL, November, 2005.

Rosnick, C. B., Small, B. J., & Popa, M. *The Effect of Bereavement and Allostatic Load on Cognitive Performance.* Poster presentation at the 57th Annual Gerontological Society of America Scientific Meeting, Washington, DC, November, 2004.

Small, B.J., **Rosnick, C.B.,** Fratiglioni, L., & Bäckman, L. *Apolipoprotein E and Cognitive Performance: A Quantitative Review.* Paper presented at the 31st Annual International Neuropsychological Society Conference, Honolulu, Hawaii, February, 2003.

Rosnick, C. B., Small, B. J., McEvoy, C. L., Borenstein Graves, A. & Mortimer, J. A. *Acute stressors and their effect on cognitive performance.* Poster presentation at the 55th Annual Gerontological Society of America Scientific Meeting, Boston, MA, November, 2002.

Reynolds, S. L. & **Rosnick, C. B.** *Unmet need for guardianship.* Paper presentation at the 55th Annual Gerontological Society of America Scientific Meeting, Boston, MA, November, 2002.

Rosnick, C. B., Small, B. J., Borenstein Graves, A., & Mortimer, J. A. *Health predictors of cognitive performance in the Charlotte County Healthy Aging Study.* Poster presentation at the 54th Annual Gerontological Society of America Scientific Meeting, Chicago, IL, November, 2001.

Rosnick, C. B. & Reynolds, S. L. *Thinking ahead: Factors associated with executing Advance Directives.* Poster presentation at the 54th Annual Gerontological Society of America Scientific Meeting, Chicago, IL, November, 2001.

Small, B. J., **Rosnick, C. B.,** von Strauss, E., & Fratiglioni, L. *Terminal decline and cognitive performance: Does cause of death matter?* Paper presented at the Cognitive Aging Conference, Atlanta, GA, April, 2000.

ABOUT THE AUTHOR

Christopher B. Rosnick received his Bachelor's of Arts Degree in Psychology and Gerontology from the University of South Florida in December of 1997. He entered the Ph.D. in Aging Studies program at the University of South Florida in the Fall of 2000 with an interest in cognitive functioning in older adults.

While in the Ph.D. program at the University of South Florida, Mr. Rosnick was employed as a Graduate Teaching Assistant in the School of Aging Studies, responsible for teaching the undergraduate Life Cycle and Psychology of Aging courses. Mr. Rosnick was the first author on two publications and a co-author on one publication in peer-reviewed journals while enrolled as a student, as well as presenting his research at multiple national conferences.