# DAILY STRESSORS AND MEMORY FAILURES IN A NATURALISTIC SETTING: FINDINGS FROM THE NORMATIVE AGING STUDY

by

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# DEDICATION

This dissertation is dedicated to my family: To my parents, Jan and Jerry Neupert, for their unconditional support and enthusiastic encouragement of my educational pursuits; to my brother, Erich, for his ability to make me laugh when I needed it; and to my grandparents (Hugo and Eleanor Neupert, Merwin and Marion Adams) for being such positive influences in my life that they unknowingly shaped the path of my career and research interests.

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# ABSTRACT

The role of stress in memory functioning has typically been examined in the laboratory with biological indicators of stress (i.e., stress hormones) and cognitive tests. These studies have generally found a negative association between stress and cognitive performance; that is, people who have higher levels of stress hormones tend to have poorer cognitive performance. The present investigation sought to test this relationship in a naturalistic setting by examining daily stressors and memory failures via a daily diary paradigm. Further, age differences in reactivity (the likelihood of reporting a memory failure when a stressor is experienced) were examined. The primary source of data was the most recent wave of the Normative Aging Study (NAS), a longitudinal study that began in 1961 to examine normal aging processes. One hundred twenty-one adults (69 men, 52 women, age range 44 – 89) participated in the present study and answered questions regarding their daily stressors and memory failures for eight consecutive evenings. Results from Hierarchical Linear Modeling (HLM) analyses indicated that on days when people experience stressors, they were more likely to also report memory failures compared to stressor-free days. Although age differences in reactivity were not apparent when examining the total frequency of stressors and memory failures, some age differences emerged when looking more specifically at stressor and memory failure type. This study did not directly test the underlying physiological processes of stressors and memory failures, but the results found in a naturalistic setting lend ecological validity to findings that have been previously restricted to the laboratory. Directions for future

research (e.g., combining laboratory and naturalistic measures, sampling a wider age range, implementing other sampling techniques, etc.) are discussed.

# CHAPTER I

## Introduction

### *Statement of the Issue*

A growing body of research suggests that cognitive ability is negatively associated with stress (e.g., Greendale, Kritz-Silverstein, Seeman, Barrett-Connor, 2000; Wolf, Schommer, Hellhammer, McEwen, & Kirschbaum, 2001). However, the majority of this work uses laboratory-based measures of stress and cognition in an artificial setting. Although laboratory studies are beneficial for understanding basic biological processes in a controlled environment, they do little to shed light on the relationship between naturally occurring stressors and more real-world memory tasks (e.g., remembering to take one's medication) that can be particularly important for the health and well-being of individuals on a daily basis (Hertzog & Hultsch, 2000). Research on naturally occurring stressors has rarely examined cognitive functioning as an outcome but has been typically been concerned with psychological outcomes (e.g., psychological distress, depression, and anxiety (Almeida, Wethington, & Kessler, 2002)). When cognition is acknowledged in previous lines of naturalistic research, it has typically been viewed as a mediator or a confound in the stress process.

The cognitive-behavioral view of the stress process puts heavy emphasis on the role that cognition plays in the appraisal of stressors (Lazarus, 1999), while the sociological view treats cognition as a source of reporting bias and instead tries to focus on an objective, external event and its effects on well-being (Pearlin & Mullan, 1992; Pearlin & Turner, 1987). Although both of these views acknowledge cognition (either as

a mediator or confound), perhaps a third possibility is that stressors can directly affect cognition. Indeed, research conducted in the laboratory suggests that individuals' stressful situations can affect memory tasks (e.g., Bremner et al., 1997). Is it possible that the frequency of stressors impacts memory? Given that most work assessing stressors and memory has been conducted in a laboratory setting, can this relationship be extrapolated to a naturalistic setting of daily stressors and memory failures?

*Naturalistic and Biological Traditions of Stress/Stressors*

There are two main views that attempt to assess the stress process in a naturalistic setting. The first is the cognitive-behavioral view that draws heavily upon cognitions and perceives them as mediators in the link between stressors and distress (See Figure 1), and the second is the sociological view that places more relevance on the objective event of the stressor itself (See Figure 2) and tends to view cognition as a confound. Those who subscribe to the cognitive-behavioral view believe that people differ greatly in their goals, beliefs about self and world, and personal resources, so an event that may be stressful for one person may not affect another person (Lazarus, 1999). Lazarus (1999; Lazarus & DeLongis, 1983) would argue that whether an individual experiences distress as a result of a stressor is directly linked to his or her appraisal of the situation. Specifically, he believes that the main source of variation in the manifestation of stress and how it affects human functioning is the way an individual evaluates subjectively (i.e. appraises) the personal significance of what is happening. Lazarus (1999) posits two kinds of appraisal: primary and secondary. Primary appraising involves the relevance of what is happening to one's values, goal commitments, beliefs about self and world, and

situational intentions. If the event is not relevant to the individual, then no distress will be experienced (Lazarus & Cohen, 1987). Secondary appraising refers to a cognitive-evaluative process that is focused on what can be done about a stressful person-environment relationship, especially when there has been a primary appraisal of harm, threat, or challenge (Lazarus, 1999). Therefore, individuals' cognitions (i.e., appraisal) are critically important in the cognitive-behavioral view of stress because they determine whether distress will be experienced.

In contrast to Lazarus (1999), Pearlin's sociological view (Pearlin & Mullan, 1992; Pearlin & Turner, 1987) suggests that people experience distress as a result of *exposure* to the stressors themselves and individual characteristics (e.g., SES, gender). He argues that if indicators of stressors are based on subjective evaluations or cognitions, they can easily become entangled with and indistinguishable from the emotional distress the stressors are supposed to create (Pearlin & Turner, 1987). The reliance on subjective reports raises reasonable questions as to whether the assessment of the stressors is too heavily dependent on the cognitive processes of individuals as they reflect upon their own lives (Pearlin, 1999). To the extent that this is true, interpreting research findings is difficult, and therefore many researchers who endorse the sociological view consider cognition to be confounded with the assessment of stressors (Pearlin, 1999). For example, the presence of psychological depression might influence the appraisal/cognition of the stressor, rather than the stressor leading to depression (Pearlin, 1999). One solution is to seek indicators of the stressors that are more objective (i.e., independent of cognition) (Pearlin & Turner, 1987). In addition to the objectivity of the

stressor, Pearlin believes that standings in the stratified orders of social and economic class, gender, race, and ethnicity have the potential to pervade the structure of daily existence and the experiences that flow from it (Pearlin & Turner, 1987). He believes the statuses of people are potentially connected to virtually every component of the stress process. For example, individuals with lower SES are exposed to more stressors (Taylor, Repetti, & Seeman, 1997). It is also important to note that people are exposed to different types of stressors that can be due to various factors. For example, middle aged and older adults experience more life events such as: (a) network stressors (misfortunes that happen to close others), (b) illness events, (c) changes in social roles, and (d) shifts in the patterns of everyday life events (Zautra, Affleck, & Tennen, 1994). Therefore, the sociological view puts less emphasis on cognition and instead focuses on individual differences as important indicators of stressor exposure.

Another way to view cognition in the stress process is as an outcome (See Figure 3). In contrast to the cognitive-behavioral view and the sociological view, the biological perspective treats cognition as an outcome variable rather than a mediator or confound. As will be discussed in greater detail in the next chapter, repeated exposure to stressors is associated with higher levels of stress hormones (i.e., cortisol and hydrocortisone) and hippocampal atrophy, and results have been similar when examining the biological effects of acute stressors. Additionally, because the hippocampus is linked to episodic memory (memory for events or everyday episodes), the relationship between stressors and everyday memory should be examined microanalytically, such that on days when individuals encounter stressors they may also experience more memory failures.

In addition to the number of stressors experienced, the type of stressor that one encounters may also impact well-being. Exposure to different types of stressors can be linked to person-level characteristics and surrounding contexts. For example, stressors stemming from the workplace are particularly important when predicting myocardial infarction (MI) in men (Neilson, Brown, & Marmot, 1989). More broadly, stressors that entail some sort of danger are associated with anxiety, whereas stressors that entail loss are associated with depression (Finlay-Jones, 1989). Although the link between types of stressors and types of memory failures has not been examined in previous studies, the differential impact of various stressors on physical and psychological well-being suggests that an exploratory analysis of the relationship between stressor type and memory failure type is warranted.

### *Biological Perspective of Aging, Stress, and Cognition*

One area of decline associated with aging that receives much attention is cognition. According to a speed of processing perspective, aging is accompanied by a general slowing in cognitive processing (Balota, Dolan, & Duchek, 2000), such that older adults process information at a slower rate than younger adults, resulting in age differences in memory (Salthouse, 1996). Anderson and Craik (2000) posit that these differences in processing speed have neurophysiological underpinnings. Various changes in brain structure and function occur with increasing age, including reductions in cerebral volume, decreased brain metabolism, reduced blood flow, and altered neurochemical systems (Anderson & Craik, 2000). Until recently the link between cognitive theories of aging and brain aging has remained hypothetical; however, the advent of neuroimaging

techniques (i.e., magnetic resonance imaging (MRI)) has permitted more direct investigation of this connection.

In order to provide a neurophysiological explanation for age differences in memory performance, Anderson and Craik (2000) suggest that neurological changes (e.g., volumetric reductions in areas such as the hippocampus) lead to reduced attentional resources and cognitive slowing. In turn, these deficits result in reduced cognitive control that then impacts memory performance. This process may have tremendous importance for potential age differences in the relationship between stressors and memory failures. Older adults have experienced more stressors throughout their lifetime compared to younger adults (Pearlin & Mullan, 1992), and as a result they may be more vulnerable to memory failures when faced with a stressor because they have fewer resources to combat the effects of the stressor. As will be discussed in greater detail in the next chapter, this idea is akin to the kindling effect, whereby repeated exposure to the same state alters the way people experience that given state and therefore may increase reactivity or vulnerability in older adults.

Just as the link between cognitive and brain theories of aging is relatively recent, the introduction of a microanalytic (i.e., daily) assessment of cognition is a novel component of the present study because it allows for the examination of factors that are related to memory performance in a naturalistic setting. Additionally, cognition (i.e., memory failures) was treated as an outcome variable in this study in contrast to other perspectives where it is seen as a mediator or confound. Although cognition can be an outcome variable in the biological perspective, the naturalistic self-report method used to

assess cognition in the present study was a unique contribution. The investigation regarding the impact of stressor type on memory failure type was also a unique aspect of the present study. Lastly, the cumulative impact of stressors may play a role in age differences in the relationship between stressors and memory failures, so an analysis of between-person differences in the within-person process of cognitive reactivity was assessed.

Although the cognitive-behavioral view and the sociological view attempt to explain the relationship between stressors and psychological and physical distress, the third view proposed in this investigation allowed for the possibility that stressors can affect and change cognition. Instead of examining the relationship between self-reported stressors and affect or physical symptoms (either with mediating or confounding effects of cognition), the present investigation sought to utilize cognitive functioning as the outcome variable. In this respect, cognition was given a new status because it was recognized as an interesting construct in its own right, rather than a mediating mechanism or a construct with little importance in the stress process. Additionally, the importance of different types of naturalistic stressors has yet to be examined with respect to cognition. As people age, they are exposed to different types of stressors that may differentially impact their cognitive performance. Therefore, the present study addressed the effects that various naturally occurring stressors may have on different types of everyday memory failures.

*Research Questions*

The present study investigated the possible links between age, stressors, and memory functioning (See Figure 4) in a naturalistic setting by addressing two general research questions:

1. What is the impact of more frequent stressors on everyday memory failures?
2. Does the relationship between stressors and memory failures differ with age?

A third, more exploratory analysis of the potential relationship between the types of stressors and their effects on different types of memory failures was addressed through the following research question:

3. Are certain types of stressors associated with certain memory failures?

# CHAPTER II

## Literature Review

The roles of stress and stressors in memory functioning have typically been examined in the laboratory with biological indicators of stress (i.e., stress hormones) and cognitive tests. The present investigation sought to describe the relationship between stressors and cognition in a naturalistic setting. This chapter begins with the identification of stress and stressors, as well as three common classifications of stressors. After describing the typical methods of previous work on stressors and cognition, the biological perspective surrounding the relationship between stressors and memory functioning is discussed. The roles of age and stressor type in exposure and reactivity to stressors are described before outlining the measurement issues of stressors and everyday memory. The biological perspective regarding the effects of stressors on memory as well as previous work examining age differences helped formulate specific research questions and hypotheses concerning this relationship outside the laboratory.

### *What is Stress/Stressors?*

"Stress" is a term that is used regularly in popular culture, the media, and daily life, but its meaning often differs from those used by social scientists. Within science, stress has been used in three different ways (Levi, 1996). Some researchers have defined stress in terms of extreme environmental conditions (e.g., noise, cold, heat) that affect an organism (Agrawal & Rai, 1988; Anisman, & Merali, 1999; Jelicic & Bonke, 2001; Lepore & Evans, 1996). Others have referred to stress as a physiological reaction of an organism to environmental strain (e.g., accelerated heart rate while running) (Hinkle,

1974; Jelicic & Bonke, 2001). Lastly, stress can be defined as an interaction between individuals and their environment (i.e., demands from the environment that exceed the organism's resources) (Jelicic & Bonke, 2001; Lazarus, 1999). In keeping with the latter definition, Wheaton (1999) identifies stress in terms of a biological state of the body (i.e., a generalized physical alert) in response to threatening agents and Selye (1956) defines stress as a "state of wear and tear on the body" (p. 55). From a psychological perspective, McCubbin and Patterson (1983) identify stress as a state that arises from an actual or perceived demand-capability imbalance in functioning that is characterized by a multidimensional demand for adjustment or adaptive behavior. Lazarus (1999) distinguishes between the stress response (reaction to a stressor) and the stress stimulus (stressor). The above definitions tend to characterize the stress response, so the following discussion will focus on the stress stimulus.

Numerous researchers have offered different definitions of stressors. Selye (1956) attempted to define a stressor as "that which produces stress" (p. 64). According to this definition, the indicator of a stressor is inextricably linked to whether it produces biological stress. There are two problems with this definition: (a) a stressor should not be defined retrospectively by its consequences, and (b) exposure to stressors can have other consequences that bypass the biologically defined occurrence of stress. For example, stressors can undermine educational performance and a variety of other non-biological factors, so it is not necessary that biological stress occur for stressors to have important consequences (Wheaton, 1999). Pearlin and Skaff (1998) believe that stressors refer to conditions that test the adaptive capacities of individuals, and in a similar vein, Sapolsky

(1992) defines a stressor in the physiological sense as any perturbation in the outside world that disrupts homeostasis. Additionally, Sapolsky (1992) classifies the stress-response as the set of neural and endocrine adaptations that help reestablish homeostasis.

*Types of Stressors*

Stressors can generally be incorporated into one of three categories. Specifically, stressors can take the form of life events/acute stressors, chronic stressors, or daily hassles. Lazarus (1999) and Wheaton (1999) distinguish event/acute stressors from chronic stressors by describing life event stressors as having discrete, observable events standing for significant changes with a relatively clear onset and offset. Additionally, once they are in motion, they are composed of a relatively well-defined set of subevents describing the normal progress of the event. Most life events involve a process (e.g., divorce); they do not typically emerge slowly but they usually begin with the announcement of unfortunate news that begins the life change (Wheaton, 1999). Life event stressors also tend to have a clear offset; a point when the stressor ends (e.g., court settlement of the divorce) (Wheaton, 1999).

In contrast, chronic stressors do not necessarily start as an event, but develop slowly as continuing and problematic conditions in social environments or roles (Lazarus, 1999; Wheaton, 1999). In fact, these problems or issues could be so regular in the enactment of daily roles and activities that they behave as if they are continuous for the individual (Lazarus, 1999). They also tend to last longer than life event stressors (from onset to resolution) and are usually less self-limiting than life events. Distinctions between event stressors and chronic stressors can be made by analyzing the time course

of the stressor, and the differences in the way the stressor develops, exists, and ends (Wheaton, 1999). However, it is inevitable that some life events will be more chronic than others and that some chronic stressors may act like more discrete problems. Some stressors will begin like an event with sudden news or a clear change, but then become open-ended and protracted (Lazarus, 1999; Wheaton, 1999). For example, the death of a spouse (major life event) affects morale, social functioning, and health by adding new demands and frustrations (i.e., a new source of daily hassles) (Lazarus, 1999). This situation describes what Wheaton (1999) calls a hybrid; that is, it is likely that not one but two stressors have occurred and in essence been spliced together. The distinction between event and chronic stressors allows researchers to distinguish, for example, the difference between *becoming* widowed and *being* widowed.

Wheaton (1997) outlines seven kinds of characteristics that underlie chronic stressors. The first is *threat*, which can itself be considered a stressor (e.g., the threat of regular physical abuse or the threat of living in a high-crime area). *Demands* occur when levels of expectation or duty cannot be met with current resources (including overload due to role expectations). *Structural constraints* include the lack of access or necessary means to achieve ends as well as any structured reduction in available alternatives. *Underreward* represents reduced outputs from a relationship relative to inputs (e.g., lower pay for a job compared to others with the same qualification). *Complexity* refers to the number of sources or demands, direct conflict of responsibilities across roles, constant instability of living arrangements, or complex content in role responsibilities.

*Uncertainty* is a problem when one desires or needs resolution of an ongoing issue, and *conflict* emerges over fundamental differences in goals or values.

It is important to note that chronic stressors are not necessarily linked with the concept of role strain (i.e., stressors associated with role membership) (Wheaton, 1999). For example, Pearlin (1989) uses the term chronic stress to include not only role-based or role-defined stressors but those which he calls "ambient stressors" that cannot be attached to any one role situation. Chronic stress cannot be tied exclusively to occupancy in major social roles (e.g., spouse, parent, worker) because role occupancy would become confounded conceptually with the experience of chronic stress; that is, role occupancy is not a necessary precursor to chronic stressor exposure (Wheaton, 1999). In light of this distinction, Wheaton (1999) urges researchers to be mindful when measuring chronic stressors. He advocates targeting stressors that accompany not only role occupancy (e.g., work overload, marital conflict), but role inoccupancy (e.g., not having children when one wants to, not having a partner when one wants to be in a relationship) and a range of ambient stressors that are not directly related to roles (e.g., time pressure, financial problems).

Daily hassles are defined as "the irritating, frustrating, distressing demands that to some degree characterize everyday transactions with the environment" (Kanner, Coyne, Schaefer, & Lazarus, 1981, p.3). In terms of Wheaton's (1999) stress continuum that ranges from most discrete (i.e. sudden traumas and life change events) to most continuous (i.e., chronic stressors), daily hassles are placed in the center of the continuum. Daily hassles represent a unique area of stress that is not tapped by the more

general conceptualization of chronic and event stressors (Wheaton, 1999) and can include events such as an argument, repairing things around the house, having to wait, filling out forms, and traffic problems. The uniqueness of the daily hassle concept is the focus on the "insidious aspects of the mundane; the specification of a level of social reality at which other stressors are not usually specified" (Wheaton, 1999, p. 186). In a study of both chronic stressors and daily hassles, Serido, Almeida, and Wethington (in press) found that chronic stressors and daily hassles are distinct types of stressors (i.e., not correlated with each other) with unique contributions to psychological distress. When daily hassles are experienced cumulatively, they may be annoying and stressful (Wheaton, 1999). Some aspects of daily hassles (e.g., troublesome neighbors, preparing meals) refer to more chronic forms of stressors, while others (e.g., having to wait, the weather) refer to more episodic or irregular events. Thus, daily hassles can span the realm of both chronic problems and discrete events (Wheaton, 1999). In general, daily hassles tap something that could be called "micro-events" at the border between quasi-regular events and continuous life conditions. Although daily hassles tend to be far less dramatic than major life events, Lazarus suggests that when they pile up or touch on special areas of vulnerability, they can be very stressful for some people and very important for their subjective well-being and physical health (Gruen, Folkman, & Lazarus, 1988; Kanner et al., 1981). Specifically, daily hassles have been identified as more salient predictors of negative health outcomes than major life events (Kanner et al., 1981) and therefore was the primary type of stressors examined in the present study.

*Typical Outcomes of Naturalistic and Laboratory-Based Studies*

Researchers in the past have typically studied the effects of self-reported stressors on self-reported negative affect or physical symptoms (e.g., Almeida et al., 2002; Cohen, Tyrrell, & Smith, 1991; Jandorf, Deblinger, Neale, & Stone, 1986). For example, Almeida et al. (2002) demonstrated the validity of their daily stressor measure by correlating stressors with negative affect and physical symptoms. They argued that the Daily Inventory of Stressful Events (DISE) is a valid indicator of stressors because the relationships were in the expected direction (i.e., more frequent stressors were associated with higher levels of negative affect and more physical symptoms).

The physiological and emotional effects of naturally occurring daily stressors on negative affect were examined by Smyth et al. (1998). One hundred twenty participants reported on stressors and affect six times per day in response to a preprogrammed wristwatch. Twenty minutes after each assessment, a sample of cortisol was taken. Stressors were associated with lower positive affect and higher negative affect. Additionally, negative affect was associated with higher cortisol levels. These results underscore the important link between stressors and negative affect.

Jandorf et al. (1986) compared the effects of daily life events and major life events on physical symptoms. Seventy-nine married men reported their daily experiences for 90 days. Results indicated that daily, undesirable events were better predictors of symptom frequencies than either major life events or daily desirable events. These results were further explored by comparing 45 healthy participants to 34 participants with prior medical conditions. Undesirable daily events were a stronger predictor of physical

symptoms in the healthy group than in the prior medical conditions group. Taken together, results from this investigation show that daily stressors can impact physical well-being.

Cohen et al. (1991) conducted an experiment to test the relationship between stressors and the common cold. Four hundred twenty participants were assessed for degree of psychological stress and then experimentally exposed to one of five cold viruses. Findings indicated that stress is associated with increased risk for acute respiratory infectious illness. Additionally, the relationship between stress and colds was independent of a variety of health practices, suggesting that stress is associated with suppression of immune functioning.

In addition to negative affect and physical symptoms, cognitive outcomes associated with stress can be examined. The effects of stress on memory failures have typically been examined in a laboratory setting (e.g., Greendale et al., 2000; Heffelfinger & Newcomer, 2001; Kirschbaum, Wolf, May, Wippich, & Hellhammer, 1996; Newcomer, Craft, Hershey, Askins, & Bardgett, 1994; Wolf et al., 2001), where objective stress measurements (e.g., cortisol) were correlated with objective memory assessments (e.g., cognitive tests). Attempts to measure memory performance in everyday life have been undertaken either with the aim of extending cognitive psychology beyond the laboratory (e.g., Baddeley, 1981) or of obtaining clinically relevant measures in the assessment of memory-impaired patients (Poon, 1980; Sunderland, Harris, & Gleave, 1984; Zelinski, Gilewski, & Thompson, 1980).

Incorporating the self-reported assessment of both stressors and memory failures was a unique aspect of the present investigation. Through laboratory-based studies, researchers have examined the stress process and its physiological impacts. Whether cortisol samples are taken (Wolf et al., 1999), blood pressure is monitored (Steptoe, 2000), or a urine enzyme-linked immunosorbent assay (ELISA) is tested (Todd et al., 1999), the negative effects of stress on the body are well-documented. Additionally, cognitive aging researchers in the laboratory have validated the widely accepted belief about the psychology of aging; that is, the belief that memory declines with age (Smith & Earles, 1996). In a typical laboratory study, the experimenter first presents material to be remembered (encoding). Second, some interval of time passes while the participants engage in a different activity (retention). Third, after the retention interval the experimenter asks the participant to remember the information presented earlier (retrieval). Laboratory studies of stress and memory typically have the benefit of precise control so that variables being studied can be isolated and independently manipulated or measured (e.g., Smith & Earles, 1996). However, one criticism of these studies is that they are artificial and thus do not adequately simulate the relationship between naturally occurring stressors and everyday memory performance. Therefore, there is a distinction between studying physiological stress and memory in the laboratory and studying stressors and memory failures in the context that they occur in everyday life. Each is important for different reasons, and both bodies of literature point to the complexities involved in describing stressors, memory changes, and memory stability throughout the lifecourse.

*Relationship Between Stressors and Memory Functioning*

Support for the finding that stressors are negatively related to memory functioning has typically come from laboratories examining the physiological underpinnings of various mechanisms. For example, researchers have consistently found that stressors can affect memory through the hippocampus. Additionally, the hippocampus has been posited as an important component in understanding stressor reactivity (Lupien & Lepage, 2001). Some researchers suggest the effects of stress on memory should be considered within a theoretical framework that recognizes the brain as an active participant in response to its environment (i.e., environmental stress) (e.g., Lupien & Lepage, 2001). The hippocampus is particularly important for episodic (or declarative) memory, but it is also important because it binds sites in the neocortex together that represent a whole memory (Squire, 1992). Therefore, literature representing the biological perspective of stressors and memory functioning and the link between the two is presented in subsequent sections.

Three arguments were presented by Lupien and Lepage (2001) to confirm the stressor-hippocampus link. The first concerns the fact that high levels of stress hormone are associated with significant impairments in episodic memory function. The second relates to the presence of the glucocorticoid receptor in the hippocampus. This is important because stress hormones can bind to sites in the hippocampus. Third, stress (and its related hormones) can impair neurogenesis in the hippocampus; that is, stress-related hormones can affect neuronal growth in the hippocampus. Studies that address the stressor-hippocampus link are outlined below.

*Episodic Memory*

Hippocampal volume is associated with episodic memory, such that a smaller hippocampus is related to impaired episodic memory abilities. Episodic memory is one component of long-term memory and typically involves retrieval by reconstructing an encoded experience (Smith & Earles, 1996). It has also been referred to as the internal diary (e.g., Smith & Earles, 1996) because the encoded experiences are often those that the participant encounters. Another hypothesis for age-related differences in episodic memory is that older adults do not pay attention to specific contextual details at encoding as well as younger adults do and therefore are deficient in their ability to use context to retrieve episodically (Rabinowitz & Ackerman, 1982; Smith & Earles, 1996). Additionally, one possible biological explanation for the large age differences usually observed in episodic memory abilities could be the cumulative effect of stressors and stress hormones on hippocampal volume.

It is generally accepted that the hippocampus mediates episodic memory in humans (Eichenbaum, 2001). Further, some researchers have proposed that the hippocampus plays a critical role when distinct personal experiences must be encoded (e.g., Eichenbaum, 2001). For example, Stewart (2002) asserts that the initial formation and retrieval of memories for the events of everyday life is dependent on the hippocampus. Additionally, emerging evidence from recordings of hippocampal neural activity shows that hippocampal networks encode episodic memories as sequences of events and the places where they occur (Fortin, Agster, & Eichenbaum, 2002). Other studies examining hippocampal volume have found a link between smaller hippocampi

and impaired episodic memory (e.g., Keenan et al., 1996; Spiers, Burgess, Hartley, Vargha-Khadem, & O'Keefe, 2001; Vargha-Khadem et al., 1997; Vargha-Khadem, Gadian, Watkins, & Connelly, 1997)

The hippocampus is largely responsible for episodic memory, so any effects that stressors may have on this region of the brain could directly impact how one recalls episodes or events. Specifically, stressors that a given individual experiences may impact his/her memory (within-person process), but it is also important to examine potential between-person differences in this process that may be linked to age or stressful life events, which can be considered proxies for related biological indicators (i.e., hippocampal volume). The next section will outline studies that address the relationship between glucocorticoids and cognition.

*Glucocorticoids (GC) and their Effects*

It was mentioned previously that Selye (1956) identified stress as a state of wear and tear on the body. Before arriving at this definition he conducted seminal research on the physiological effects of stress. Specifically, Selye is known for his work concerning the secretion of glucocorticoids during the stress-response period. Glucocorticoids (e.g., cortisol and hydrocortisone) are secreted by the adrenal gland in response to a wide variety of stressors (Heffelfinger & Newcomer, 2001; Sapolsky, 1992). These steroids are central to the metabolic stress-response; they reflect the capacity of *gluco*corticoids to mobilize glucose during stressors (Sapolsky, 1992). Additionally, glucocorticoids are known to regulate various brain functions including human cognitions (Heffelfinger & Newcomer, 2001). Excessive exposure to glucocorticoids can damage the brain and

make neurons more vulnerable to neurological insults (Sapolsky, 1992), and increased glucocorticoid exposure in humans at levels associated with stress could decrease memory and learning function (Heffelfinger & Newcomer, 2001).

In Selye's initial studies (e.g., Selye, 1936), he observed that a variety of chronic stressors caused disease (i.e., peptic ulcers, adrenal hypertrophy, and immune collapse). He further conceptualized the stress-response as having three components. In the initial alarm stage, the stressor is noted or experienced. The second stage, resistance, consisted of successfully dealing with the short-term physical insult. The third stage was where disease started, when the stressor became chronic. This final stage was termed exhaustion, because there are no longer sufficient glucocorticoids to combat the stressor. In Selye's view, then, stress-related disease was due to the stressor itself attacking the undefended body. However, there is little empirical evidence of such a global exhaustion of the hormones of the stress-response (Sapolsky, 1992). Chronic stress is not damaging because the body's defenses fail but because, with enough chronic stress, those defenses themselves (i.e., glucocorticoids) become damaging (Sapolsky, 1992; Sapolsky, 1996). During an acute/short-term stressor the costs of the stress-reponse can be contained, but with chronic activation they exact a toll on the body (Sapolsky, 1992; Sapolsky, 1996). Therefore, if an organism cannot appropriately initiate a stress-response during an acute physical stressor (i.e., fight or flight), the consequences can be extremely deleterious (Sapolsky, 1992; Sapolsky, 1996). Likewise, if an organism cannot appropriately terminate a stress-response at the end of stressor, or if it activates too much because of repeated or chronic stressors, numerous stress-related diseases can occur (Sapolsky,

1992). A few days of glucocorticoid overexposure endangers hippocampal neurons, and glucocorticoid secretion is also positively related with hippocampal atrophy (Rosch, 1997; Sapolsky, 1996). The stress-response is a vital set of responses on the part of the body, but also a dangerous one (Sapolsky, 1992). This point is also critical to understanding the biological explanation for the link between stressors and memory failures on a daily basis. Further studies that outline the importance of the temporal effects of stress hormones (i.e., cortisol) on cognitive functioning are highlighted below.

Newcomer et al. (1994) examined the effects of glucocorticoids on hippocampal neurons with a double-blind, placebo-controlled experiment. Participants in the treatment condition were given Dexamethasone (DEX; a synthetic glucocorticoid) at 11pm for four consecutive days. Plasma sampling and cognitive testing were performed at baseline and study days 1, 4, and 7. Participants in the treatment group had decreased paragraph recall on study day 4 compared to participants in the placebo group, suggesting that impairment of episodic memory performance in normal adults can be observed after relatively low doses of DEX.

A similar study was conducted by Newcomer et al. (1999) to investigate the relationship between glucocorticoid administration and memory performance. A randomized, double-blind, placebo-controlled comparison was made of two fixed oral doses of cortisol given for four days to matched groups of healthy subjects. Cognitive testing was completed at baseline, after one and four days of treatment, and after a six-day washout period. Results indicated that several days of exposure to cortisol at doses and plasma concentrations associated with physical and psychological stress can

reversibly decrease specific elements of memory performance in otherwise healthy individuals.

The effects of cortisol were hypothesized to be different for younger and older adults, so Wolf et al. (2001) examined nine young and 11 elderly men in a placebo-controlled, double-blind, crossover study. Participants in the treatment group were given 0.5 mg/kg of cortisol and those in the control group were given an intravenous placebo. All participants learned a word list before cortisol/placebo administration and then delayed recall was tested. ANOVAs were used with age as a grouping factor (young versus old) and treatment versus control administration as the within-subject factor. Surprisingly, cortisol impaired Digit Span (processing speed) performance in young but not elderly individuals. Although cortisol did reduce recall from the word list for both young and elderly participants, Wolf et al. (2001) suggested that differential age-associated brain changes might exist.

While Wolf et al. (2001) limited their investigation to male participants, Greendale et al. (2000) examined the relationship between cortisol levels and change in cognitive performance in a longitudinal study of postmenopausal women. Blood for basal morning cortisol was obtained along with pertinent medical, behavioral, and psychological covariates from 749 postmenopausal women who were not taking corticosteroids or postmenopausal hormones. Linear regression models (adjusted for age) suggested that higher baseline cortisol was a significant predictor of worsened category fluency. Additionally, subtle dysregulation of cortisol within people across time

was related to memory loss, suggesting that cognitive functioning can be affected by fluctuations in cortisol.

In another study examining the effects of glucocorticoids on memory, Young, Sahakian, Robbins, and Cowen (1999) administered hydrocortisone (a stress hormone) twice daily for 10 days to normal male volunteers in a random, placebo-controlled, crossover, within-subject design. Changes in urinary cortisol were assessed using t-tests and neuropsychological data were analyzed using two-way repeated measures MANOVA. Results indicate that administration of hydrocortisone leads to deficits in cognitive functioning that is sensitive to frontal lobe dysfunction and may contribute to cognitive impairment.

Kirschbaum et al. (1996) investigated the link between cortisol levels after an acute stressor and memory performance in healthy adults. Thirteen subjects were exposed to a brief psychological laboratory stressor with a subsequent test of declarative memory performance. Results indicated that participants with high cortisol response to the stressor showed poorer memory performance. Additionally, the brief social stressor did have a negative impact on memory performance.

The relationship between naturalistic stressors, memory, and cortisol was examined by Vedhara et al. (2000). Specifically, acute changes in cortisol and memory in the context of an acute naturalistic stressor was the focus of their investigation. Sixty students participated in an assessment of self-reported levels of stress, salivary cortisol, short-term memory, and working memory. Students were assessed before and after exam periods, and results indicated that the exam period was associated with an increase in

perceived levels of stress but a significant reduction in salivary cortisol. However, reduction in cortisol was associated with enhanced short-term memory. Results from this investigation support the view that cortisol can modulate cognitive processes and that the effects of corticosteroids on cognitive function are selective. It is important to note that although the stressor in this study was not laboratory-induced, measures of stress (i.e., cortisol) and memory (i.e., short-term memory and working memory) were laboratory-based.

In summary, laboratory studies have generally found a link between stress hormones, decreased hippocampal volume, and impaired cognitive functioning. Specifically, people who experience more acute stressors (and therefore acute changes in cortisol) tend to have poorer memory functioning compared to people with fewer acute stressors (e.g., Vedhara, Hyde, Gilchrist, Tytherleigh, & Plummer, 2000). These studies, however, do not explain the entire picture of the relationship between stressors and cognitive performance. For example, many studies focused solely on the relationship between physiological indicators of stress and cognition. When stressors were examined, participants were typically exposed to the same stressor and then given a cognitive test. Because previous researchers have found that people vary in their exposure to stressors (e.g., Pearlin, 1999), investigation of the effects of stressors as they naturally occur outside the laboratory will provide a more complete understanding of this complex relationship. Specifically, participants in the present investigation reported their own exposure to stressful events as they occurred, rather than being assigned to a condition where their exposure was controlled and equal to the exposure of other participants.

## *Role of Age in Stress and Memory Functioning*

### *Normal Aging*

A typical result of laboratory experiments is poorer memory performance in older participants compared to younger participants. For example, evidence suggests that older adults have poorer memory for activities (e.g., Earles & Coon, 1994; Kausler & Hakami, 1983), slower processing speeds (Salthouse, 1996; Madden, 1985), decreased working memory abilities (Salthouse, Babcock, & Shaw, 1991), and poorer episodic memory abilities (Foos & Sarno, 1998) than younger adults. Additionally, longitudinal studies have shown that, on average, cognition declines in old age (e.g., Colsher & Wallace, 1991; Evans et al., 1993; Wilson, Beckett, Bennett, Albert, & Evans, 1999). As people age, their hippocampi progressively atrophy (Rosch, 1997). Loss of recent memory, as well as impaired learning and concentrating skills in older adults are often attributed to smaller hippocampi (Rosch, 1997).

On an individual level, however, wide variability between persons is often observed (e.g., Christensen et al., 1999; Wilson et al., 1999). Cognition can decline severely in some people while in others it may decline only slightly or even improve (Wilson et al., 2002). Determining the factors that contribute to this variability requires detailed knowledge about individual differences in patterns of change in different cognitive abilities in old age (Wilson et al., 2002). Unfortunately, research to date is very limited in this area.

As has been discussed earlier, stressors and stress hormones are related to decreased cognitive abilities. Additionally, stressors and stress hormones may exert their

effects on memory by altering the hippocampus, an area of the brain essential for episodic memory. Although the present study did not include biological measures of stress, age was used as a proxy for hippocampal volume based on research that age is negatively related to hippocampal volume (Anderson & Craik, 2000). Researchers have also highlighted the association between acute stressor exposure and smaller hippocampi (e.g., Kirschbaum et al., 1996), so therefore a measure of stressful life events was included in the analyses. The next section will address the role of age in exposure and reactivity to different types of stressors.

*Age Differences in Exposure and Reactivity to Different Types of Stressors*

Age may plan an important role in the stress-memory relationship in terms of how age-related characteristics affect exposure and reactivity to stressors. Exposure is generally defined as the likelihood of encountering a stressful event, and people can be exposed to stressors for a variety of reasons. Kessler (1987) discusses the random exposure to life events and provides an example of a tornado touching down and destroying one particular block of homes but none on the adjoining blocks. Stressor exposure can also depend upon person-level characteristics and surrounding contexts. For example, individuals with lower SES may be exposed to more stressors involving natural disasters because they are more likely to live in an area vulnerable to such damage (Taylor et al., 1997). Additionally, neighborhood contexts may also heighten the risk of exposure to other stressors (Pearlin & Turner, 1987). As mentioned earlier, one distinct benefit of examining stressors as they naturally occur rather than in a controlled laboratory setting is that participants are able to report their differential exposure. The

present study was able to examine how individuals' own levels of stressor exposure correspond with everyday memory failures.

In contrast to exposure, emotional reactivity can be defined as the likelihood that an individual will report psychological distress when he or she encounters a stressor (Almeida, McGonagle, Cate, Kessler, & Wethington, in press; Bolger & Zuckerman, 1995). In addition, reactivity may vary depending on individual characteristics. The focus of the present investigation was not on emotional reactivity but rather cognitive reactivity to stressors. Therefore, cognitive reactivity was defined in the present study as the likelihood that an individual will experience a memory failure when he or she is exposed to a stressor.

*Age differences in exposure to stressors.* Historically, it has been assumed that there is a rough linear relationship between age and stress across the lifespan; that is, as people get older they increasingly encounter stressful life conditions (Pearlin & Mullan, 1992). Although current research examining different types of stressors tends to call this relationship into question, several common observations of the aging process seem to support it. First, bodies change with age; they do less than they once did and more effort is required to maintain them (Pearlin & Mullan, 1992). Additionally, displacement from roles and statuses accelerates with age (e.g., life events such as retirement and children leaving the home), so the aging process is often synonymous with loss (Pearlin & Mullan, 1992). Aldwin and Levenson (2001) suggest that the relationship between age and stress depends upon the type of stress (i.e., life events, chronic stressors, daily hassles) that is

examined. Therefore, a more detailed discussion of age differences in exposure and reactivity to different types of life events, chronic stressors, and daily hassles follows.

Although the frequency of life events may not increase with age, the type of life events experienced by middle aged and older adults are different than those experienced by younger adults. For example, middle aged and older adults experience more life events such as: (a) network stressors (misfortunes that happen to close others), (b) illness events, (c) changes in social roles, and (d) shifts in the patterns of everyday life events (Zautra et al., 1994). Aldwin and Levenson (2001) identified challenges that can occur at midlife that may cause individuals to make significant changes in their lives (e.g., death of a parent, divorce of a child), so they concluded that certain life events are especially relevant for middle aged and older adults. Younger individuals typically report more gains in social roles, while older individuals report more losses (Aldwin & Levenson, 2001), but more research is needed to determine whether the frequency of life events varies by age category. Additionally, health-related events are among the most common events experienced by older persons and, when they occur, tend to have a more depressive effect than many other types of events they experience (Ensel, 1991; Murrell, Himmelfarb, & Phifer, 1988). Death of a loved one may affect well-being through its impact on moderating resources; that is, the loss of a spouse or other person to whom the individual is attached may result in adverse outcomes because part of one's social network that provided support may be lost (Pearlin & Skaff, 1995). Stressor exposure has also been implicated in the etiology of hypertension as well as depressed immune functioning in adults (Chiriboga, 1989). Therefore, it is important to examine the specific

domains of stressors (e.g., health, network) that may be particularly salient for older adults.

Chronic stressors reflect another important area of research on adulthood. Older adults have a higher prevalence of chronic illnesses than any other age group (Zautra et al., 1994), so they are often forced to deal with their own ailing health and/or assume a caregiving role that can be a source of chronic stress (Pearlin & Mullan, 1992). Because of the increased longevity and the technological means to prolong the lives of the ill, caregiving in late life is on its way to becoming a statistically normative experience (Pearlin & Mullan, 1992) and is therefore a common source of stressors. Adult children often assume the caregiving role for their aging parents (Chiriboga, 1989), which can be a considerably distressing experience (Chiriboga, Yee, & Weiler, 1992; Gaugler, Davey, Pearlin, & Zarit, 2000; Parks & Pilisuk, 1991). The emergence of caregiving roles usually takes place during the middle or late-life years, and therefore surfaces within a context of preexisting multiple roles (Pearlin, 1999). Accommodating the new caregiving role demands some restructuring of the existing roles, which in itself can be a source of chronic stress (Pearlin, 1999).

Similar to life events, some research has shown that the frequency and type of daily stressors are also age-graded (Almeida & Horn, in press). For example, older adults tend to have fewer desirable and undesirable daily events (Zautra, Finch, Reich, & Guarnaccia, 1991). This decreased exposure may be due to a reduction in social roles and time commitments across the life course. With age, time spent on personal and physical care, sleep and personal activities increases, while time spent on work decreases

(Verbrugge, Gruber-Baldini, & Fozard, 1996). Further, Kanner et al. (1981) found that younger individuals experience more academic or social problems associated with their time of life and attending school (e.g., wasting time, meeting school expectations and demands), while older individuals experience more economic concerns, such as stress about rising prices, investments, and taxes.

In addition to age-graded differences in exposure to stressor type, certain stressors may also exert differential effects. For example, stressors stemming from the workplace are particularly important when predicting myocardial infarction (MI) in men (Neilson et al., 1989), suggesting that stressors specific to the workplace can have a specific physical impact. Leserman, Li, Hu, and Drossman (1998) investigated the health impact of four stressors (i.e., history of sexual and physical abuse, lifetime losses and traumas, turmoil in childhood family, and recent stressful life events). Each stressor type was related to specific aspects of health status (i.e., pain, physician visits, and functional disability), again supporting the notion that specific stressors can exert specific health effects. More broadly, stressors that entail some sort of danger are associated with anxiety, whereas stressors that entail loss are associated with depression (Finaly-Jones, 1989). Although the link between types of stressors and types of memory failures has not been examined in previous studies, the differential impact of various stressors on physical and psychological well-being suggests that an exploratory analysis of the relationship between stressor type and memory failure type is warranted.

*Age differences in reactivity to stressors.* The previous discussion highlights the importance of the various effects of stressor exposure, but age differences in reactivity to

stressors are also important to consider. The cumulative effects of stress hormones are associated with smaller hippocampi (e.g., Heffelfinger & Newcomer, 2001; Starkman, Gebarski, Berent, & Schteingart, 1992; Uddo, Vasterling, Braily, & Sutker, 1993; Vasterling et al., 2002). Therefore, older adults who have been exposed to more stressors throughout their lifetime compared to younger adults (Pearlin & Mullan, 1992) may have fewer resources (i.e., smaller hippocampi) to combat the negative effects of stressors, thereby resulting in heightened cognitive reactivity to stressors. Specifically, Anderson and Craik (2000) suggest that reductions in hippocampal volume lead to reduced attentional resources and cognitive slowing. Subsequently, these deficits result in reduced cognitive control that then negatively impacts memory performance. Thus, when faced with a stressor, older adults may be more likely to experience a memory failure (i.e., be more cognitively reactive) because they are unable to tap the same resources available to younger adults. Additionally, research on kindling effects (repeated activation of a given state) asserts that reactivity may increase with age. For example, researchers who examine emotional reactivity have demonstrated that changes in the aging brain may alter the way people experience emotion, especially negative affect. The structures in the brain that mediate the experience of negative affect, the amygdala and limbic system, become more sensitive with age (Adamec, 1990; Panksepp & Miller, 1996). Therefore, heightened sensitivity may lead to easier activation of negative affect when a stimulus such as stress is encountered. These neurophysiological changes make it conceivable that negative affect is more likely to become activated as a consequence of being frequently activated previously. Reactivity to stress may increase

with age due to a lifetime of repeated activations of the neural systems that mediate negative affect. The present investigation drew on the tenets of kindling effects and applied them to cognitive reactivity. Specifically, it was posited that changes is the aging brain (i.e., hippocampal volume) may also alter the way people experience memory failures such that older adults would exhibit heightened sensitivity that may lead to easier activation of memory failures when a stressful stimulus was encountered.

Although cognitive reactivity to stressors has not been examined outside the laboratory, previous research focusing on the biological mechanisms of the stressor-memory failure process indicates that this relationship should be investigated to see if it exists in a naturalistic setting. Specifically, the present study attempted to examine between person differences in within-person associations between daily stressors and daily memory failures in a naturalistic setting.

In summary, age differences in exposure and reactivity to stressors could depend on a variety of factors. Some researchers have concluded that exposure to certain types of stressors are age graded, such that acquiring new social roles at various points throughout the lifespan may increase one's chances of exposure to certain stressors. Additionally, reactivity to certain stressors may also be age graded. Older adults may be more psychologically reactive to stressors that happen to close friends or family members (i.e., network stressors) than younger adults. However, previous studies have not addressed the effects that certain types of naturalistic stressors may have on cognitive reactivity; that is, the extent to which individuals are likely to experience a memory

failure as the result of a stressor. The present investigation attempted to shed light on this issue.

## *Measurement Issues*

### *Stressors*

When examining stress in the laboratory, researchers typically extract blood or salivary samples to test cortisol levels, draw plasma to measure adrenocorticotropin (ACTH), and/or monitor blood pressure and heart rate. In order to induce stress, researchers create situations that would be considered stressful by most people (e.g., public speaking) (Larson, Ader, & Moynihan, 2001). Although these measures can be standardized and objective, the results are typically not generalizable beyond the controlled environment of the laboratory. For example, objective indicators of stress hormones are taken in an artificial environment (i.e., lab), usually after exposure to an artificial stressor (e.g., being assigned to the public speaking group). When strong associations are observed between stress hormones and various outcomes in the laboratory, it is difficult to know if the same association would be found for naturally occurring stressors. The present study examined the relationship between stressors and memory failures outside of the laboratory by utilizing a self-report daily diary design.

### *Daily Stressors*

As mentioned earlier, researchers have utilized the daily diary design to establish a link between daily stressors and psychological distress and physical symptoms. Despite considerable evidence for an association between daily stressors and well-being, controversy exists regarding potential confounding between reports of daily stressors and

well-being outcomes. This controversy is due to: (a) the inclusion of subjective internal states (e.g., "feeling blue") among the stressor events in some scales, such as the Daily Hassles Scale (Kanner et al., 1981), and (b) concern that a retrospective reporting bias is associated with preexisting emotional impairment that influences recall of daily stressors over a week or a month (Dohrenwend, Dohrenwend, Dodson, & Shrout, 1984; Kessler, Mroczek, & Belli, 1999; Lazarus, DeLongis, Folkman, & Gruen, 1985). To overcome these potential problems, several checklist measures of day-to-day stressors have been developed specifically for use on a daily basis (see review by Eckenrode & Bolger, 1995). These checklists typically focus exclusively on objective external events in an effort to minimize the confounding of predictors and outcomes. In addition, daily collection of information helps resolve the problem of emotional bias in retrospective recall by allowing respondents to report on experiences closer to their occurrence (Stone, Kessler, & Haythornthwaite, 1991). One of the best ways to examine the microprocesses of the stressor-distress relationship is to follow people on a daily basis and examine the fluctuations of and relationships between both events (Almeida & Kessler, 1998). Another important component of the daily diary design is that temporal covariation of daily stressors and distress can be examined (Larsen, Billings, & Cutler, 1996; Larsen & Kasimatis, 1990). By following individuals intensively over time, researchers are able to examine the extent to which stressors and distress co-occur within the same individual (Almeida & Kessler, 1998).

In an effort to combine the benefits of objective checklist measures with participants' subjective appraisals of those events, Almeida et al. (2002) developed the

Daily Inventory of Stressful Events (DISE), a telephone interview with an investigator-rated approach for assessing stressor severity. The DISE consists of a series of stem questions asking whether certain types of daily stressors have occurred in the past 24 hours, along with a set of interviewer guidelines for probing affirmative responses to rate stressor content, severity, and threat as well as a series of structured questions that measure respondents' primary appraisal of the stressors. The aim of this interviewing technique was to acquire a short narrative of each stressor that included descriptive information (e.g., topic or content of the stress, who was involved, how long the stressor lasted) as well as what was at stake for the respondent. Open-ended information for each reported stressor was tape recorded, then transcribed and coded for several characteristics. This interview-based approach allowed Almeida et al. (2002) to distinguish between a stressful event (e.g., conflict with spouse) and the affective response to the stressor (e.g., crying or feeling sad).

The daily diary paradigm has been extremely useful in examining the linkages between daily stressors and well-being (i.e., psychological distress and physical symptoms) (e.g., Almeida et al., 2002), but it has not yet been implemented in investigating the relationship between naturally occurring stressors and memory failures.

*Everyday Memory*

Measurement and identification of real-life memory problems have been the focus of discussion and debate by neuropsychologists over recent years (Hickox & Sunderland, 1992). Specifically, the debate has concentrated on the discrepancy between patients' performances in formal psychometric tests and their subjective reports of everyday

forgetting (Newcombe & Artiola i Fortuny, 1979; Pollina, Greene, Tunick, & Puckett, 1993). Although formal tests allow researchers to measure changes in patients' performances on highly structured and specific tasks (Sunderland, 1990), their lack of relevance to day-to-day memory reduces their clinical significance (Sunderland, Harris, & Baddeley, 1983). Therefore, it is important to use measures that can validly tap real-life memory problems.

The simplest way of attempting to investigate everyday memory is to use self-report questionnaires. In most cases, these questionnaires enable patients to describe their real-life experience of memory on scales that usually rate the frequency or severity of the problem (Hickox & Sunderland, 1992). The underlying issue with self-report questionnaires of everyday memory failures is that of validity; to what extent can a person accurately report on his or her own memory performance? Because of their subjective nature, it is generally believed that memory questionnaire responses are based on metamemory (Hickox & Sunderland, 1992); that is, a person's belief of his or her own mnemonic abilities (i.e., factual knowledge about memory tasks and processes, memory monitoring, and memory self-efficacy (Hultsch, Hertzog, & Dixon, 1987)). Berry and West (1993) found age-related increases in negative self-evaluation of memory performance; that is, as people get older, they tend to perceive their overall memory ability more negatively. Therefore, Hultsch, Dixon, and Hertzog (1985) have suggested that low validity findings between laboratory measures and self-report questionnaires may be due to peoples' inaccurate beliefs about their actual memory performance instead of poor questionnaire design.

In contrast, Sunderland, Watts, Baddeley, and Harris (1986) suggest that failures to find correlations between test performance and subjective measures of everyday memory should not be taken on their own as evidence of low validity of the subjective measures. The frequency with which memory lapses occur is not determined purely by cognitive ability, but by other important factors including the demands imposed by the participant's lifestyle and the effort a person is willing to expend to avoid memory failure (Sunderland et al., 1986). An absence of correlation with test performance, therefore, might indicate the importance of these other factors. In order to examine this possibility, Zelinski et al. (1980) gave participants a metamemory questionnaire that included questions on demand and effort as well as the frequency of memory failures. No simple bivariate relationships were apparent between performance on verbal memory tests and self-ratings of everyday memory, but canonical correlations did suggest a relationship between questionnaire responses and test performance for older but not younger adults (Zelinski et al., 1980). Therefore, it is possible that self-report questionnaires can be very useful for assessing memory failures in older adults.

Hickox and Sunderland (1992) proposed an additional reason why objective (laboratory-based) and subjective (self-report questionnaires) everyday memory assessments might differ. They believe that forgetting to record (i.e., forgetting to remember what was forgotten), which usually results when there is a greater interval between forgetting and recording, could account for some of the discrepancy. Wilkins and Baddeley (1978) also suggest that it may be compounded by the absence of a strategy or cue to remember failures. Although the retrospective nature of memory questionnaires

do not allow for such strategies, the problem of forgetting to record can be minimized by devising means of reminding the patient to record the memory failures as soon as they occur (i.e., prompting by a relative) (Wilkins & Baddeley, 1978). The present investigation did not utilize prompting strategies, but the data collection process (i.e., daily diary design) was such that participants were not asked to recall memory failures more than 24 hours after they had occurred. Reducing the interval between the occurrence of the memory failures and participants' reports of these failures is one way to increase the agreement between subjective and objective everyday memory assessments (Hickox & Sunderland, 1992).

*Content Classifications of Memory Failures*

The previous discussion centered on everyday memory failures as a whole, but Pollina et al. (1993) created categories based on factor analysis to divide this construct into more distinct units. Their first factor consists of *encoding failures*; that is, memory failures that result from inattention. For example, if one fails to direct attention to an individual's name when hearing it for the first time, it is unlikely to be encoded and thus unlikely to be available for future retrieval. Finding that one must reread material because one has been thinking about something else fits into this first category. Inability to remember whether one has turned off lights or locked a door may result from failure to encode a fairly trivial activity. Additionally, finding that one cannot quite remember something even though it's on the tip of his or her tongue has been interpreted to tap an individual's failure to devote full attention to the task at hand (Pollina, Greene, Tunick, & Puckett, 1992; Pollina et al., 1993).

The second factor proposed by Pollina et al. (1993) consisted of *misdirections of focal attention.* Examples of items that received high loadings include bumping into people, leaving important letters unanswered for days, and having trouble making up one's mind. In these cases, attentional focus shifts either to an internal preoccupation (e.g., worry over impending medical tests) or to an unexpected event (e.g., the arrival of uninvited guests) (Pollina et al., 1993). Failure to answer important letters could result from attentional focus and effort on other matters, while difficulty in making up one's mind could result from the inability to keep all variables relevant to the decision with attentional focus at one time.

The third factor involves *relationships with others*, with examples included items such as losing one's temper and regretting it and failing to hear people when one is doing something else (Pollina et al., 1993). Failure to hear people speak could be an instance of attention directed elsewhere, and losing one's temper and regretting it later is a common occurrence when one is interrupted in a performance or a preferred task or when attention is drawn to something unpleasant (Pollina et al., 1993). The above instances are classified by Pollina et al. (1993) as aspects of interpersonal intelligence, or memory failures that tend to involve other people.

The fourth factor was interpreted to tap *distractibility*, because it included such items as forgetting appointments and forgetting where one put something (Pollina et al., 1993). These items appear to reflect encoding failures that might result from distraction or interruption. Additionally, McDowd and Birren (1990) observed that older adults tend to be more easily distracted than younger adults, making this factor even more salient for

older populations. As will be discussed later, the present study included an item assessing distractibility by asking if participants forgot to take their medication as scheduled (a similar item to forgetting appointments used by Pollina et al., (1993)).

Finally, the fifth factor represented *spatial attention* (Pollina et al., 1993). For example, failure to notice signposts could result from attending to concurrent events such as a conversation with a passenger in the car. Additionally, confusing left and right when giving directions might result from failure to recognize another's perspective. One explanation for the age-related increase in these types of memory failures is the increase of spatial egocentrism (Bielby & Papalia, 1975) and decline in processing spatial information (Kirascic & Allen, 1985).

As will be discussed in greater detail in Chapter 3, Sunderland et al. (1983) tested five components of everyday memory grouped under the headings: "speech", "reading and writing", "faces and places", "actions", and "learning new things". Examples of these items include forgetting where one has put something (similar to the *distractibility* factor described by Pollina et al., 1993) and going back to check whether a task (e.g., turning off a light) had been completed (similar to the *encoding failure* factor described by Pollina et al., 1993).

### *The Present Study*

The central goal of the present study was to combine the naturalistic daily stressor approach with self-reported everyday memory failures. A daily diary design was chosen because it allows for the examination of between-person differences in the within-person association of daily stressors and memory failures. To date, research on self-reported or

naturally occurring stressors has examined negative affect or physical symptoms. When memory failures are included in studies of stress, they typically take place in the laboratory with physiological measures of stress and cognitive tests of memory failures.

*Strengths of the Daily Diary Design*

The daily experience paradigm allows researchers to examine within-person covariation between components of daily well-being and daily stressors over time, thereby establishing temporal links between daily stressors and well-being (Shiffman & Stone, 1998; Tennen, Suls, & Affleck, 1991). By studying within-person through-time covariation between daily stressors and well-being, one can more precisely establish the short-term effects of concrete daily experiences (Almeida & Kessler, 1998; Bolger, DeLongis, Kessler & Schilling, 1989; Larson & Almeida, 1999; Lewinsohn & Talkington, 1979; Stone, Reed, & Neale, 1987). Additionally, the daily diary design reduces retrospective recall bias because participants are asked to recall events that occurred over the previous 24-hour period as opposed to a week or even a year (Kessler et al., 1999). Therefore, a more accurate picture of individuals' daily lives can be captured with this design. Although the daily diary design has been implemented in studies of stressors and psychological or physical well-being, the present study marks the first time this paradigm was used in the study of stressors and everyday memory failures. Therefore, the method used in the present study allowed for the testing of temporal links between daily stressors and everyday memory failures.

As mentioned previously, many researchers have found a link between stress and memory in a laboratory setting. These findings are often couched in a biological

framework that asserts the importance of stress hormones (i.e., cortisol) and their impact on cognitive functioning. Additionally, many researchers have examined the cumulative effects of chronic stressor exposure and have found a link between decreased hippocampal volume and poorer cognitive functioning. Because older adults have been exposed to more stressors over the course of their lifetime compared to younger adults (Pearlin & Mullan, 1992) and hippocampal volume is not directly measured in the present investigation, age can be seen as a proxy for hippocampal volume.

To test for the association between stressors and memory failures in a naturalistic setting, a daily diary paradigm was implemented. This design allows for stronger conclusions about the temporal association between predictor variables and outcome variables compared to traditional between-subjects designs. When conclusions are drawn between people about the relationship between the predictors and outcomes, the covariation that occurs through time is lost. In a within-person design, conclusions can be made about the simultaneous effects of within-person covariation as well as between-person differences. Additionally, a daily diary design made it was possible to test for lagged effects in the present study; that is, the effect of a stressor on the change in memory failures from one day to the next, controlling for the effects of stressors on the previous day. Lagged analyses allow researchers to look beyond what is occurring on a concurrent day and test for temporal associations from one day to the next.

*Research Questions and Hypotheses*

The general purpose of this study was to examine the effects of naturally occurring stressors on everyday memory failures. As stated earlier, a daily diary method

was implemented which allowed for the assessment of within-person covariation of stressors and memory failures over time. Although the biological perspective consistently reports a negative relationship between stressors and cognitive functioning, many of these conclusions have been drawn as a result of laboratory tests. Additionally, cognitive functioning is generally negatively associated with age, so the present study examined whether the relationship between stressors and memory failures was different for older adults of varying ages. Therefore, three general research questions were investigated in the present study.

1. What is the association of more frequent stressors with everyday memory failures?

Hypothesis 1. On days when individuals experience more stressors, they should also experience more memory failures. Additionally, stressors on one day should be associated with the change in memory failures from one day to the next. The majority of past research in the biological perspective suggests that cognitive functioning after both acute and chronic stressors is diminished.

2. Does the relationship between stressors and memory failures differ with age?

Hypothesis 2. Older adults should have a stronger relationship between stressors and memory failures compared to younger adults. Older adults have had more life experiences compared to younger adults, and therefore have been exposed to more stressors. Research on age-based cognitive reactivity suggests that the hippocampus atrophies with increased exposure to stressors and therefore might lend support to the idea of kindling effects mentioned earlier. Hippocampal volume is negatively associated with cognitive functioning, suggesting that older adults who have experienced more of

the cumulative effects of stress will have fewer resources than younger adults to combat the cognitive effects of stressors.

3. Are certain types of stressors associated with certain memory failures?

Hypothesis 3. Research on reactivity to different types of stressors suggests that health-related and/or interpersonal stressors are particularly salient for older adults' emotional well-being and therefore negative experiences associated with these areas may result in stronger reactions. However, there is no previous research examining the relationship between specific stressor types and specific types of everyday memory failures. Therefore, exploratory analyses were used to ascertain whether specific memory failures were associated with specific stressors.

These hypotheses were tested using new diary data from the Normative Aging Study (Bossé, Ekerdt, & Silbert, 1984). One hundred twenty-one adults (69 men, 52 women, age range 44 – 89) participated and main variables include stressor exposure (whether or not someone experienced a given stressor on a given day), memory failure (whether or not that memory failure was reported on a given day), and chronological age.

# CHAPTER III

## Methodology

### *Sample*

Participants for the analyses were drawn from the two most recent waves of data from the Normative Aging Study (NAS), a longitudinal study that began as an investigation of normal aging processes in men (Bossé et al., 1984). Beginning in 1961, over 6000 men in the Boston area were recruited through large companies with a stable workforce (e.g., an insurance company, the post office, and metropolitan police and fire departments). Participant screening consisted of three phases. The first involved a medical history form describing illnesses and surgeries, the second consisted of a clinic visit where blood pressure, chest X-rays, electrocardiogram, urinalysis, and vital capacity were obtained, and the third was an exam performed by an internist who took a full medical history and gave a comprehensive medical exam. If abnormalities (e.g., high blood pressure) were detected at any of these phases, the participant was rejected from the study.

The original NAS sample consisted of 2,280 initially healthy men who enrolled in the study between 1961 and 1970. At the time of enrollment, most men (74%) were aged 35 to 65 (total range was 21 to 81 years). Nearly all participants were White; less than 2% were African-American. Most (86%) had a high school diploma; 26% were college graduates. The men were from a higher socioeconomic level than the general Boston population, and most were Veterans. Twenty-three percent were employed as professionals, 21% as managers or proprietors, and 28% were service workers. Because

the men were selected on the basis of health, regardless of age or SES, the NAS differs from other samples because it lacks a correlation between health and age or SES. Given the selection criteria, older men who entered the study were increasingly less representative of their age peers with regard to health. As older participants have died, the remaining sample resembles more closely the general male population with respect to rates and causes of mortality. Of the original 2,280 participants, 662 (29%) had died as of April 1999. Of the survivors, 1,470 (91%) are classified as continuing participants. Compared to other studies, the attrition rate is quite low, and the mortality rate is about one-third to one-half of that in similar aged cohorts.

Data for the present investigation were drawn from the two most recent waves of NAS data. In 2001, 1125 participants (882 males, 243 females) completed a Health and Social Behavior questionnaire that assessed domains such as personality, health behaviors, and life event stressors. Starting in August 2002, recruitment efforts began for the most recent wave of data (daily diary questionnaire). As of March 2003, data from this most recent wave included 121 individuals (69 males, 52 females) and 962 days (average of 7.95 days of data per person) and these data were used in the present analyses. Table 1 compares the samples of the two most recent waves of data collection (data from 2001 collection period and diary data for the present study) on demographic variables of interest (i.e., age, marital status, self-rated health, life event stressors, and neuroticism). It should be noted that the two samples did not differ significantly on any of the variables. Even though the sample size for the present investigation was much smaller than the sample collected in 2001 (121 vs. 1125), it is important to point out that

the smaller subsample does seem to be representative of the larger sample from which it was drawn on important demographic characteristics.

*Procedure*

Participants for the current diary subsample ($n$ = 121) were recruited through mailed flyers with attached postcards and were instructed to indicate their willingness or unwillingness to participate and then return the postcard to the Boston VA. Not all participants were recruited at once; men who were scheduled for a health visit within the next year were excluded from the recruitment mailing list because they would be offered the chance to participate in the diary study at the conclusion of their health visit. Efforts were also made to recruit couples first, because the application to the VA IRB only requested permission to recruit 600 individuals. This decision was primarily driven by the amount of grant money available to conduct the study and compensate participants. Once postcards were returned indicating interest in participating, eight separate diary booklets (for an example, please see Appendix C) labeled Days 1 though 8 were sent to each consenting participant. Additionally, instructions indicating when to complete the diary (approximately ½ hour before going to bed) and when to mail the surveys (all at once when the eight were completed), a pre-addressed postage-paid envelope, and a form to be completed for payment were sent. For eight consecutive evenings, participants completed short semi-structured questionnaires about their daily experiences (e.g., stressors, physical symptoms, positive and negative affect, memory failures, pain, and social support). Husbands and wives were instructed to complete each survey separately. It was estimated that the questionnaire would take approximately 15-20 minutes to

complete and on the final day participants were also asked questions regarding the previous week. At the conclusion of the eight-day period, participants mailed each of their surveys to the researchers. If participants completed five or more of the eight study days, they received an honorarium of $30. If they completed four or fewer days, they received $15. However, only one individual failed to complete more than five days of the diary. He had surgery mid-way through his study week and was only able to complete three diary days.

## *Measures*

### *Daily Stressors*

Daily stressors were assessed through a revised version of the Daily Inventory of Stressful Events (DISE; Almeida et al., 2002). The DISE was originally designed as a telephone interview with an investigator rated approach for measuring stressor severity. As mentioned previously, the DISE measures content classifications of the stressors, focus (i.e., who was involved), environmental threat, subjective severity, objective severity, and domains of primary appraisal. Specific classification codes had the lowest reliability partially because of the high number of possible codes ($n$ = 54). In order to include the DISE in the NAS questionnaire, a paper-pencil version was developed (see Appendix C, questions 7-13).

As can be seen from this revised version of the DISE, information obtained from the original measure regarding content classification and focus of involvement were consolidated into forced-choice responses so as to facilitate ease of coding and classification. Additionally, because the NAS measure does not allow for narrative

responses, objective measures of severity and environmental threat were not possible in the current investigation.

Participants answered questions regarding arguments (Appendix C, question 7), potential arguments (question 8), stressors that occur at work/volunteer settings (question 9) and home (question 10), network stressors, stressors that occur to a network of friends and family (question 11), health-related events (question 12), and other stressors (question 13) each day. Additionally, they were asked to report who else (if anyone) was involved, and the main focus of the stressor.

*Stressor Variables*

Stressor variables were computed from the frequency of stressors. "Sum stress" was calculated for each day for each person and represents the number of all stressors experienced (possible range was 0-7, with 0 indicating no stressors experienced and 7 indicating all stressors experienced). Additionally, five stressor variables representing different types of stressors were also created for each person for each day. "Interpersonal tensions" represents whether or not an argument or potential argument occurred in any of the possible stressor domains (i.e., responding affirmatively to question 7, question 8, question 9b, or question 10b; possible range was 0-1, with 0 indicating no interpersonal stressor was experienced and 1 indicating that an interpersonal stressor was experienced). "Demands" represents whether or not the participant reported having too much to do in the home, workplace, or volunteer setting (i.e., responding affirmatively to having too much to do for question 9c or question 10c; possible range was 0-1, with 0 indicating no demand stressor was experienced and 1

indicating that a demand stressor was experienced). "Network stressor" represents whether or not something happened to a close friend or family member that turned out to be stressful for the participant (i.e., responding affirmatively to question 11; possible range was 0-1, with 0 indicating no network stressor was experienced and 1 indicating a network stressor was experienced). "Health stressor" represents whether or not something happened regarding the participant's health (i.e., responding affirmatively to question 12; possible range was 0-1, with 0 indicating no health stressor was experienced and 1 indicating a health stressor was experienced). "Other stressor" represents whether or not anything else stressful happened to the participant (i.e., responding affirmatively to question 13; possible range was 0-1, with 0 indicating no other stressor was experienced and 1 indicating that an other stressor was experienced).

*Everyday Memory Failures*

Everyday memory failures were assessed through a revised version of an everyday memory questionnaire developed by Sunderland et al. (1983). The original questionnaire consisted of 35 questions designed to tap five distinct aspects of everyday memory failures. In order to reduce participant burden for the present investigation, one item from each of the five factors was chosen (see Appendix C, questions 18-22). These questions were chosen because they represented memory failures that could be common in a normally aging sample. The original scale was compiled with the following consideration in mind: (a) that as wide a range of memory failures as possible should be included; and (b) that they should be types of failures that the majority of subjects had the opportunity to make in their daily lives. The 35 items were grouped under the headings

of "speech," reading and writing," "faces and places," "actions," and "learning new things" to represent five distinct domains where memory failures were likely to occur. Sunderland et al. (1983) distributed the questionnaire to participants and instructed them to complete it on each evening over seven consecutive days, indicating for each example whether that form of memory failure had happened to them that day. In order to demonstrated the validity of the questionnaire, correlations between the subjective test (i.e., the 35-item questionnaire) and objective tests (i.e., laboratory-based cognitive tests) were calculated. More frequent subjectively reported memory failures were associated with poorer immediate ($r$ = .50) and delayed ($r$ = .46) story recall. Additionally, more subjective memory failures were also associated with poorer performance on an objective paired association task ($r$ = .46).

To demonstrate that a shortened version of this scale could maintain the five domains of the original scale and also capture commonly experienced memory failures, a pilot study ($n$ = 30, 16 men, 14 women) was conducted in October 2001. Participants were a convenience sample from the Tucson community and ranged in age from 35-82 ($M$ = 56, $SD$ = 10.2). The five everyday memory questions outlined above were included in a daily diary questionnaire where participants completed the survey every evening for eight consecutive days. Results indicated that the five items tap different aspects of memory failures (i.e., bivariate correlations ranged from .20 to .45), suggesting that the shortened version maintains Sunderland et al.'s (1983) original goal of five distinct memory failure types.

In order to provide descriptive information from the pilot study, Tables 2 and 3 report the means and between- and within-person standard deviations and between-person correlations for variables of interest, respectively. Between-person variability refers to the extent to which people differ from each other, while within-person variability refers to how much people vary from themselves (i.e., fluctuate on a day-to-day basis). In general, Table 2 indicates that for many variables people differ from themselves as much (or more) as they differ from each other. In Table 3, the between-person correlations show a significant association with the sum of the memory failures and many of the stressor variables.

An additional question was added to assess everyday memory failures regarding prescription medication (Appendix C, question 23). A consistent medication regimen is a critical component of the maintenance of health as people age, and although many older adults (age 55+ years) incorporate taking prescription medication into their daily routines, as many as 50% to 75% do not adhere to the medication regimen presented to them (O'Brien, Petrie, & Raeburn, 1992). Although there are numerous reasons for nonadherence to prescription medications (e.g., price of medication, belief that the medication is not helping), the present study focused on memory failures associated with nonadherence.

*Memory Failure Variables*

Memory failure variables were constructed in a similar manner as the stressor variables. The frequency of all memory failures for each day ("Memory sum" range was 0-6 and repeated for all eight days) and whether each memory failure occurred on each of

the days (values of either 0 (did not experience memory failure in question) or 1 (did experience memory failure in question)) were computed.

*Control Variables*

*Neuroticism* may be related to cognitive performance, such that lower levels of neuroticism are related to better episodic memory performance (e.g., Meier, Perrig-Chiello, & Perrig, 2002). Additionally, Perrig-Chiello, Perrig, and Staehelin (2000) found that neuroticism was a significant predictor of memory decline for men over the age of 75. Although it was possible that neuroticism would be linked to everyday memory performance in the present study, there is also evidence to suggest that no such relationship exists. Wetherell, Reynolds, Gatz, and Pederson (2002) did not find a significant relationship between neuroticism and cognitive decline in normal aging. In spite of controversial findings, neuroticism was used as a control variable in the present study. Participants completed a measure of neuroticism (the EPI-Q) in 2001 and this data will be used in the current investigation. The EPI-Q is a short questionnaire version of the EPI (Eysenck Personality Inventory) containing 18 items (9 assessing extraversion and 9 assessing neuroticism) and was found to be suitably reliable and valid (Janakiramaiah, 1983). The range of possible scores was 0 - 9, with a higher score indicating a higher level of neuroticism.

The present study also controlled for exposure to *life event stressors* in order to rule out the hypothesis that stressors beyond those occurring at the daily level are accounting for the variability in everyday memory failures. Participants completed a measure of life event stressors (the ELSI; Elders Life Stress Inventory) in 2001 and this

information was used in the current investigation. The ELSI was designed specifically for use in older populations and is a brief (31 item) self-administered scale that taps stressful events particularly relevant to older samples (Aldwin, 1991). It includes items such as institutionalization of a spouse, assuming the care of significant others, and divorce or marital problems of children. The number of items that a participant endorsed was used to represent the sum of the number of his/her stressful life events, and therefore the possible range was 0-31 with a higher number indicating exposure to more stressful life events.

Participants' self-rated health was used as a control variable in the present study because previous researchers have found a link between health status and cognitive functioning (e.g., Hultsch, MacDonald, Hunter, Levy-Bencheton, & Strauss, 2000). One item was used from the survey conducted in 2001 that was designed to assess a global measure of health. Participants were asked to rate in general, how they would classify their health from 1 (excellent) to 5 (poor).

### *Couple Data and Issues of Nonindependence*

Because some of the participants were part of a couple where both members were reporting ($n$ = 39 couples), the data were not completely independent. However, issues at the couple level were not the central focus of the present study. Therefore, analyses were conducted to determine if it was appropriate to treat the data as coming from independent sources. Specifically, bivariate correlations were conducted to see if there were any significant associations between wives' variables of interest and husbands' variables of interest. None of the husbands' and wives' variables were significantly related (with the

exception of age which would be expected). Another set of analyses examined the potential relationship of couple status (i.e., whether the participant's spouse was also a participant) and *gender* to each variable of interest, because gender was not a specific focus of the presentation but may nonetheless be related to important variables (i.e., memory performance (West, Welch, & Knabb, 2002)). A MANOVA was conducted to examine if any of the variables of interest differed by couple status or gender. Neither of the multivariate tests for the MANOVA nor any of the follow-up between-person analyses were significant. To further test for the potential effects of gender and couple status, multiple anovas with each variable of interest as the dependent variable and gender, couple status, and gender*couple status as the independent variables were conducted. The effects of gender and couple status did not appear to be important for the variables of interest in any of these analyses. With the minor exception of women reporting more tip of the tongue memory failures compared to men, the main effects of gender and couple status and the interaction of gender*couple status did not significantly relate to any of the variables of interest. In the interest of parsimony, gender and couple status were not included as control variables for the subsequent analyses.

### *Plan of Analysis*

In order to maximize data that were gathered through a daily diary design, Hierarchical Linear Modeling (HLM) was implemented for analysis. In the HLM framework, individual change/variability is represented through a two-level hierarchical model (Hawkins, Guo, Hill, Battin-Pearson, & Abbott, 2001). At Level 1, each person's variability is represented by an individual regression equation that depends on a set of

parameters (intercept and slope) (Hawkins et al., 2001). These individual parameters become the outcome variables in a Level 2 model, where they may depend on some person-level characteristics (Hawkins et al., 2001). These submodels express relationships among variables within a given level, and specify how variables at one level influence relations occurring at another (Raudenbush & Bryk, 2002). Specifically, multiple observations are seen as nested within the person, and this treatment of multiple observations allows the investigator to proceed without difficulty when the number and spacing of time points varies across persons (Raudenbush & Bryk, 2002).

HLM is frequently used to model intraindividual variability; that is, people's variability around their own average. Because estimates of between-person effects and within-person variability are possible with HLM (Lee & Bryk, 1989), conclusions regarding both the variability within people across occasions and the differences between people can be made. Variability does not imply irreversible or cumulative growth or change (Nesselroade, 1991), so a specific time predictor is not needed in the Level 1 equation. Instead, time-varying covariates (variables measured at every occasion) can be used to replace specific time indicators to explain variation in the outcome variable (Raudenbush & Bryk, 2002).

Because HLM is deeply rooted in regression, a brief example of multiple regression and its extension to multiple levels follows. Consider the hypothetical example of the relationship between an occasion-level predictor variable (e.g., stressor on a given day) and one occasion-level outcome variable (e.g., memory failures on a given day) within a single person. The regression equation for this example is:

$$\text{MEMORY FAILURES}_{it} = \beta_{0it} + \beta_{1it}(\text{STRESSOR})_{it} + r_{it.}$$

The intercept, $\beta_{0it,}$ is defined as the expected number of memory failures for person i when no stressors are experienced at time t. The slope, $\beta_{1it,}$ is the expected change in memory failures associated with each unit increase in stressor exposure. The error term, $r_{it,}$ represents a unique effect associated with person i (i.e., how much they vary from the mean). Typically, it is assumed that $r_{it}$ is normally distributed with a mean of zero and a variance $\sigma^2$ (Raudenbush & Bryk, 2002). If one wanted to compare two or more people, separate regression equations could be used. However, this method is an inefficient way to try to capture interindividual differences in intraindividual variability. HLM remedies this problem by simultaneously assessing interindividual differences in intraindividual variability (Raudenbush & Bryk, 2002). For example, a person-level variable (e.g., age) can be incorporated to directly examine interindividual differences in variability, and in order to simultaneously test these effects the intercept and slope in the equation above (the Level 1 equation) become outcome variables for two Level 2 equations:

$$\beta_{0i} = \gamma_{00} + \gamma_{01}(W_i) + u_{0i}$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11}(W_i) + u_{1i}$$

where

$\gamma_{00}$ is the mean of Y (memory failures) when no stressors are experienced, controlling for W (age);

$\gamma_{01}$ is the effect of W on Y when no stressors are experienced;

$\gamma_{10}$ is the average slope between stressors and memory failures controlling for W;

$\gamma_{11}$ is the effect of W on the slope between stressors and memory failures;

$u_{0i}$ is the random effect (i.e., how much they vary from the mean) for each person for the Y intercept;

$u_{1i}$ is the random effect for each person for the slope between stressors and memory failures.

There are four variance components associated with the above equation:

$\sigma^2$ is the variance in $r_{it}$ (Level 1 random effects, within-person variance);

$\tau_{00}$ is the variance in $u_{0i}$ (Level 2 random effects, between-person variance in the intercept);

$\tau_{11}$ is the variance in $u_{1i}$ (Level 2 random effects, between-person variance in the slopes);

$\tau_{01}$ is the covariance between $u_{0i}$ and $u_{1i}$ (covariance between intercepts and slopes).

Specifically, $u_{0i}$ and $u_{1i}$ are random variables with means of zero, variances $\tau_{00}$ and $\tau_{11}$, respectively, and covariance $\tau_{01}$ (Raudenbush & Bryk, 2002). With a single Level 1 predictor and a single Level 2 predictor, the above equations are the simplest example of a full hierarchical linear model. More complex forms of the full hierarchical model result when additional predictors are added at Level 1, because an additional equation is needed at Level 2 to model the relationship between that predictor and the outcome (i.e., the new slope). The present study utilized a combination of simple and more complex models to address relevant research questions.

# CHAPTER IV

## Results

### *Descriptive Analyses*

Before conducting analyses designed to address the research hypotheses outlined previously, descriptive analyses were conducted to obtain information regarding (a) sample characteristics, (b) average values for variables of interest, (c) distributions of those variables, (d) aggregated between-person associations, and (e) within-person associations.

Table 4 represents descriptive characteristics for the stressor variables. The first five rows report the percentage of days, between-person standard deviation, and within-person standard deviation for the total sample and then for people who reported having any of the stressors. For example, people reported experiencing interpersonal tensions on 23.3% of the study days, which means the average person experienced interpersonal tensions on 2 days of the 8-day study. The between- and within-person standard deviations are expressed in percentage units. On average, people fluctuated around their own mean (within-person standard deviation) of experiencing interpersonal tensions more than they differed from others (between-person standard deviation) (29.2 vs. 25.4). When converting these percentages into days, a given individual within one standard deviation of his or her mean could expect to have an interpersonal tension between 0 and 4.2 days. Additionally, the proportion of the sample within one standard deviation from the sample mean varied between 0 and 3.90 days with interpersonal tensions. More than two thirds of the sample (69.4%) reported having an interpersonal tension, so the

corresponding numbers in the last three columns describe the characteristics of interpersonal tensions for those people only. It is important to examine these last three columns because they depict variability between- and within-people that is not influenced by participants who have no variability on the variable as a result of not experiencing the stressor in question. For those who reported any interpersonal tensions, they experienced them on 33.5% of the study days, which means the average person who reported having at least one interpersonal tension experienced them on approximately 3 days of the 8-day study. Again, it is important to note the differences in variability between- and within-people. For those who experienced any interpersonal tensions, they appeared to be fluctuating around their own average more than they differ from others (42.0 vs. 24.2). This trend in variability was true across all of the stressors; that is, people tended to differ from themselves just as much (if not more) than they differed from each other. When looking at the comparison of between- and within-person standard deviations for both the total sample and those who reported any of the stressor variables, this same trend is apparent. It is also evidenced in the amount of variability in the target stressor that is due to between- and within-person variation. As an example of this point, 47% (between-person standard deviation divided by the total variation) of the variability in interpersonal tensions for the total sample was between people and 53% (within-person standard deviation divided by the total variation) was within people. The last row in the table depicts descriptive characteristics for the sum of stressors variable and indicates that people are reporting .82 stressors per day, which translates to approximately 6.5 stressors for the study period. In contrast, when looking at just those people who reported having

at least one stressor on any of the days, they reported an average of .92 stressors per day which means they were experiencing about 7.36 stressors during the 8 day study period. The most frequently reported stressors were interpersonal tensions, and the least prevalent were those in the "other" category. When comparing the frequency of stressors from the present study with the frequency of stressors from the National Study of Daily Experiences (NSDE; Almeida et al., 2002) that utilized the original DISE stressor measure, the distributions were similar. Specifically, interpersonal tensions (22.6% in NSDE, 23.3% in present study), network stressors (8.0% in NSDE, 14.7% in present study), and "other" (1.7% in NSDE, 8.1% in present study) stressors seemed to have comparable distributions. It is possible that health stressors (1.0% in NSDE, 14% in present study) were more prevalent in the current study because the participants were older (mean age for NSDE was 47 vs. 72 in the present study).

Table 5 represents descriptive characteristics for the memory failure variables. For example, people reported experiencing tip of the tongue failures on 40.4% of the days, or roughly 3.2 of the 8 study days. Additionally, people tended to differ more from others than they did from themselves in terms of the total sample of participants (34.9 vs. 29.7), but that trend shifts when examining the 77.7% of the sample who reported having any tip of the tongue failures; that is, those individuals differed more from themselves than they did from others (38.2 vs. 31.0). The trend in variability for this table is different from the trend seen in Table 4. Specifically, it appears that for the total sample, people were consistently differing more from each other than they were from themselves. However, when looking at only those participants who reported having any of the

memory failures, people were consistently differing more from themselves than they were from each other. The last row highlights descriptive characteristics for the sum of memory failures variable. On average, the total sample reported having .82 memory failures per day, which translates to approximately 6.5 memory failures across the 8-day study period. When looking only at those participants who reported having at least one memory failure, they reported having an average of .92 memory failures per day, or about 7.68 over the entire study period.

Table 6 shows the between- and within-person correlations for the stressor variables. Between-person correlations compare the association between two variables at the person level (e.g., people who have more interpersonal tensions tend to have more demands compared to people with fewer interpersonal tensions), while within-person correlations examine the association between two variables across time within the same person (i.e., on days when someone has a network stressor he or she is more likely to also have a health stressor compared to days with no network stressors). None of the stressor variables were significantly associated with age (See Figure 5). However, many of the stressor variables were associated with each other at the between-person level. This pattern of results suggests that stressor exposure is not independent; that is, when people experience a given stressor, they were also likely to experience another type of stressor.

Table 7 shows the between- and within-person correlations for the memory failure variables. In contrast to the correlation table with the stressor variables, age did significantly correlate with some of the memory failure variables. Specifically, age was positively associated with the sum of memory failures (See Figure 5), going back to

check whether you did something you meant to do, having a tip of the tongue failure, and having difficulty picking up a new skill. Additionally, many of the memory failure variables were associated with each other, both for between and within people correlations. However, forgetting to take one's medication(s) was only correlated with one other memory failure (having trouble picking up a new skill) at the between-person level, and none at the within-person level. Similar to the pattern for stressors, this pattern of results suggests that memory failures were not independent from each other; that is, when people (between-person) or a particular individual (within-person) experienced a given memory failure, they were also likely to experience another type of memory failure.

*Between-Person Analyses*

In order to examine the relationships between the control variables and the sum of memory failures and the sum of stressors, bivariate correlations were conducted (see Table 8). As expected, the mean of memory failures and mean of daily stressors were correlated. It is particularly interesting to note that the sum of daily stressors and the total number of life event stressors both correlated significantly with the sum of the memory failures, but they were not correlated with each other. This indicates that the different types of stressors were indeed distinct but had a unique relationship with memory failures. This relationship was tested further in the between-person regression analysis.

The next set of analyses examined the between-person relationships of the sum of memory failures, sum of stressors, and age. The first regression model represents a between-person analysis of the first hypothesis (i.e., that the sum of stressors will be

associated with the sum of the memory failures, independent of the effects of health status, neuroticism, and number of stressful life events). As can be seen from the first column in Table 9, the sum of the stressors and the total number of stressful events were positively associated with the sum of the memory failures. The second regression model represents a between-person analysis of the second hypothesis (i.e., that age will moderate the relationship between the sum of stressors and sum of memory failures). As can be seen from the second column in Table 9, age (centered around its grand mean) was not associated with the sum of memory failures, nor did it moderate the relationship between the sum of stressors and sum of memory failures. This model was also conducted with the control variables included, but the results were the same. Therefore, the more parsimonious model was presented. These between-person results suggest that people who report more stressors also tend to report more memory failures, and that this relationship did not differ by age. However, it is important to examine these relationships in the HLM framework so that within-person processes and between-person differences in within-person processes can be examined.

*Within-Person Analyses: HLM*

Several researchers (e.g., Nezlek, 2001; Raudenbush & Bryk, 2002) recommend conducting a preliminary analysis to ensure that there is enough variability at Level 1 and Level 2 to warrant continuation with analyses. This preliminary analysis is termed a fully unconditional model (also referred to as a null model), in which no term other than the intercept is included at any level (Curran, 2000; Nezlek, 2001). For example, the fully

unconditional model that was used to examine the between-person and within-person variability in the frequency of memory stressors was:

Level 1: $MEMORY_{it} = \beta_{0it} + r_{it}$

Level 2: $\beta_{0i} = \gamma_{00} + u_{0i}$

In addition to providing a point estimate and confidence interval for the grand mean, $\gamma_{00}$ (Raudenbush & Bryk, 2002), this model also provides information about the outcome variability at each of the two levels. The $\sigma^2$ parameter represents the within-group variability, and $\tau_{00}$ captures the between-group variability (Raudenbush & Bryk, 2002). From these two parameters, the intraclass correlation coefficient was calculated, which measures the proportion of the variance in the outcome variable that is between people (Level 2 units) (Raudenbush & Bryk, 2002). This correlation can be calculated through the following formula:

$$\rho = \tau_{00} / (\tau_{00} + \sigma^2)$$

Results from this analysis indicated that $\tau_{00}$ was 0.56 and $\sigma^2$ was 0.42, resulting in an intraclass correlation coefficient of 0.57. This coefficient is interpreted in terms of variability, such that 57% of the variability in the sum of memory failures was between people and 43% was within people. This finding is not surprising given the pattern of the between- and within-person standard deviations in Table 5. Specifically, people in the total sample consistently differed from others more than they differed from themselves for each of the six types of memory failures. However, it is important to remember that for those who reported having at least one memory failure, they differed from themselves more than they differed from others. Because there was sufficient variability in the

outcome variable (the chi square statistic in the final estimation of variance components table was significant ($\chi^2 = 1344.76, p < .001$) and the intraclass correlation indicated that variability in the outcome variable stems from both levels), the next step was full model specification in order to attempt to explain some of the within- and between-person variability.

*Full Model Specification*

*Hypothesis 1.* To estimate average effects for the entire sample, the intercept and slope of the Level 1 within-person model become the dependent variables for the Level 2 between-person equations. In order to address the first hypothesis, the following model was tested:

Level 1: $MEMORY_{it} = \beta_{0it} + \beta_{1it}\,(STRESSOR)_{it} + r_{it}$

Level 2: $\beta_{0i} = \gamma_{00} + \gamma_{01}(NEUROTICISM) + \gamma_{02}(LIFE\ EVENT\ STRESSORS) + \gamma_{03}(HEALTH) + u_{0i}$

$\beta_{1i} = \gamma_{10} + u_{1i}$

This model addressed the within-person association between stressor frequency and memory failure frequency on a daily basis, controlling for between-person differences in neuroticism, life event stressors, and self-reported health. A positive and significant statistic for $\gamma_{10}$ would indicate that on days when individuals experience more stressors, they also tend to experience more memory failures, irrespective of their scores on the neuroticism, life event stressor, or health scales.

Results from the analyses conducted to address Hypothesis 1 can be found in Table 10. For Model 1, the control variables were centered around their grand mean, so

the grand mean of the sum of the memory failures ($\gamma_{00} = .67$) indicates the number of memory failures when the control variables were at their mean and when no stressors were experienced (i.e., sum of stressors is 0). Neuroticism and self-rated health were not significantly related to daily memory failures, but stressful life events ($\gamma_{01} = .06, p < .001$) and the sum of daily stressors ($\gamma_{10} = .08, p < .05$) were positively associated with daily memory failures. In other words, people who experienced more stressful life events also tended to experience more daily memory failures, compared to people who experienced fewer stressful life events. Additionally, on days when people experienced more daily stressors, they were likely to report more memory failures compared to stressor-free days. It is important to note that even after controlling for the significant effects of stressful life events, the sum of daily stressors was still significantly related to daily memory failures. By using the following formula, the amount of variance explained at Level 1 was calculated:

$$\sigma^2_{uc} - \sigma^2_{c} / \sigma^2_{uc}$$

The numerator represents the difference between the variability in Level 1 variables from the fully unconditional model and the currently specified model. The denominator represents the Level 1 variability from the fully unconditional model. The result of this calculation was .05, indicating that 5% of the within-person (Level 1) variability in daily memory failures can be explained by the sum of daily stressors.

Model 2 is identical to Model 1 with the addition of previous day memory failures as a predictor of current day memory failures, therefore making the specification equivalent to (but more flexible than) a change score model when looking at Level 1

variables (Raudenbush & Bryk, 2002). In order to conduct a lagged analysis for the first hypothesis, the following model was tested:

Level 1: $MEMORY_{it} = \beta_{0it} + \beta_{1it}(STRESSOR)_{it} + \beta_{2it}(MEMORY)_{it-1} + r_{it}$

Level 2: $\beta_{0i} = \gamma_{00} + \gamma_{01}(NEUROTICISM) + \gamma_{02}(LIFE\ EVENT\ STRESSORS) + \gamma_{03}(HEALTH) + u_{0i}$

$\beta_{1i} = \gamma_{10} + u_{1i}$

$\beta_{2i} = \gamma_{20} + u_{2i}$

The interpretation of the coefficients is similar to those in Model 1; the control variables were centered around their grand mean, so the grand mean of the sum of the memory failures ($\gamma_{00} = .64$) indicates the number of memory failures when the control variables are at their mean, when no stressors were experienced (i.e., sum of stressors is 0), and when no memory failures were experienced the previous day (i.e., previous day memory failures is 0). Neuroticism, self-rated health, previous day memory failures, and sum of stressors were not significantly related to the change in daily memory failures, but stressful life events ($\gamma_{01} = .06, p < .001$) were positively associated with daily memory failures. In other words, people who experienced more stressful life events also tended to experience more daily memory failures, compared to people who experienced fewer stressful life events. The findings from Model 2 were different from those of Model 1 because the sum of stressors was not significantly related to the sum of daily memory failures. The amount of variance explained at Level 1 was calculated in the same manner outlined for Model 1. Results of that calculation indicated that 7% of the variability in

the sum of daily memory failures was explained by the sum of daily stressors and the previous day memory failures.

*Hypothesis 2.* In order to address the second hypothesis, age was added as a Level 2 variable to examine interindividual differences in intraindividual variability. Similar to Hypothesis 1, two separate models were conducted. Specifically, one examined the effects of concurrent day stressors on concurrent day memory failures, and the second examines the effects of stressors on the change in memory failures (lagged analysis). Equation 2 tests for age differences in the average number of memory failures experienced, while Equation 3 tests for the between-person interaction effect of age on the within-person association between stressor frequency and memory failure frequency.

Level 1: $$MEMORY_{it} = \beta_{0it} + \beta_{1it}(STRESSOR)_{it} + r_{it} \quad (1)$$

Level 2: $$\beta_{0i} = \gamma_{00} + \gamma_{01}(AGE) + u_{0i} \quad (2)$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11}(AGE) + u_{1i} \quad (3)$$

The effects of the control variables were tested in the first hypothesis, and although the models used to test the second hypothesis were also conducted with the inclusion of the control variables, the results were identical to those reported below. Therefore, the more parsimonious models are presented. Results from the analyses conducted to address Hypothesis 2 can be found in Table 11. For Model 1, age was centered around its grand mean, so the grand mean of the sum of the memory failures ($\gamma_{00}$ = .71) indicates the number of memory failures for a person of average age (i.e., 72) when no stressors were experienced (i.e., sum of stressors is 0). Age ($\gamma_{01}$ = .03, $p < .001$) and the sum of daily stressors ($\gamma_{10}$ = .08, $p < .05$) were positively associated with daily

memory failures. In other words, older adults reported more memory failures compared to younger adults. It is important to note that "older" and "younger" should be considered in the relative sense because most participants in the sample would be considered older adults. On days when people experienced more daily stressors, they were likely to report more memory failures compared to stressor-free days. Age did not moderate the stressor-memory failure relationship, so there appeared to be no between-person differences (in age) in the within-person relationship between sum of daily stressors and sum of memory failures. Because age was added as a predictor in this model, the following equation was used to calculate the amount of variance explained at the Level 2:

$$\tau_{00uc} - \tau_{00c} / \tau_{00uc}$$

The numerator represents the difference in Level 2 (between-person) variability from the fully unconditional model and the currently specified model. The denominator represents the variability in Level 2 from the fully unconditional model. Results of this calculation indicate that 4% of the variability in between-person differences of daily memory failures can be explained by age.

Model 2 is identical to Model 1 with the exception that previous day memory failures were added as a predictor, therefore making the analysis similar to the previous lagged model. The interpretation of the coefficients is similar; age was centered around its grand mean, so the grand mean of the sum of the memory failures ($\gamma_{00} = .67$) indicates the number of memory failures for a 72-year-old when no stressors were experienced (i.e., sum of stressors is 0), and when no memory failures were experienced the previous

day (i.e., previous day memory failures is 0). The sum of stressors was not significantly related the change in daily memory failures, but age ($\gamma_{01} = .03, p < .001$) and previous day memory failures ($\gamma_{02} = .10, p < .01$) were positively associated with daily memory failures. In other words, older adults tended to experience more daily memory failures compared to younger adults. Additionally, the positive association between memory failures on the previous day and memory failures for the subsequent day indicated that for every unit difference in memory failures on the previous day, there was a .10 unit difference in memory failures for the subsequent day. Similar to the results from Model 1, age did not moderate the within-person relationship between the sum of daily stressors and the sum of daily memory failures. In contrast, the findings from Model 2 were different from those of Model 1 because the sum of stressors was not significantly related to the sum of daily memory failures. The amount of variance explained at Level 2 was calculated in the same manner outlined for Model 1. Results of that calculation indicate that 11% of the between-person variability in the sum of daily memory failures can be explained by age.

*Hypothesis 3.* To address the third hypothesis, the following model was tested for each type of memory failure.

Level 1: $\text{MEMORY TYPE}_{it} = \beta_{0it} + \beta_{1it}\,(\text{INTERPERSONAL})_{it} + \beta_{2it}\,(\text{DEMAND})_{it} +$

$\beta_{3it}\,(\text{NETWORK STRESSOR})_{it} + \beta_{4it}\,(\text{HEALTH-RELATED STRESSOR})_{it} +$

$\beta_{5it}\,(\text{OTHER STRESSOR})_{it} + r_{it}$

Level 2: $\beta_{0i} = \gamma_{00} + u_{0i}$

$$\beta_{1i} = \gamma_{10} + u_{1i}$$

$$\beta_{2i} = \gamma_{20} + u_{2i}$$

$$\beta_{3i} = \gamma_{30} + u_{3i}$$

$$\beta_{4i} = \gamma_{40} + u_{4i}$$

$$\beta_{5i} = \gamma_{50} + u_{5i}$$

This model is different from the one outlined to test the first hypothesis because the outcome variable is now dichotomous (i.e., having a memory failure or not). Therefore, results are expressed in terms of odds ratios. For example, on days that individuals experience a network stressor, what are the odds that they will also forget to take their medication as scheduled?

Before conducting the models outlined above, the intraclass correlation coefficient was calculated for each of the six memory failure variables. Because the outcome variables were dichotomous, the following equation was used:

$$\tau_{00} / [\tau_{00} + (\pi^2/3)]$$

Results from these calculations indicate that 62% of the variability in whether someone goes back to check if they did something they meant to do was between people, and 38% was within people. The between-person variability in whether someone starts to read something again without realizing he/she had read it before was 72%, with 28% of the variability stemming from within-people. The between-person variability in whether someone experiences a tip of the tongue failure was 74%, with 26% of the variability coming from within-people. The between-person variability in whether someone has

trouble picking up a new skill was 71%, with 29% of the variability coming from within-people. The between-person variability in whether someone had trouble recognizing a familiar face was 80%, with 20% of the variability coming from within-people. Lastly, the between-person variability in whether someone forgot to take his/her medication was 66%, with 34% of the variability coming from within-people. As would be expected with variables that likely indicate general cognitive functioning, all variables had more variability between people (i.e., differences between people in cognitive abilities), but it is important to note that each variable also varied within-people.

Results from the six models conducted to address the third hypothesis can be found in Table 12. It is important to note that the slopes of the Level 2 equations predicting the within-person relationships between stressors and memory failures were constrained to be equal across all persons (i.e., $u_{1i}$ through $u_{5i}$ were removed). Because of the large number of Level 1 predictors, the models did not converge when the slopes were allowed to vary. Constraining the slopes to be equal across persons is a typical solution when models will not converge (Raudenbush & Bryk, 2002). The coefficients in Table 12 are expressed in terms of odds ratios, which require different interpretations from the models presented earlier. An odds ratio is an association between a predictor variable and an outcome variable and can be interpreted as the predicted likelihood of having one event occur given the occurrence of another event. Interpersonal tensions were positively related to the likelihood of going back to check whether you did something you meant to do, such that on days when interpersonal tensions were experienced, individuals were almost twice as likely to experience that specific memory

failure (OR = 1.93, $p < .001$). The trend was similar when looking at the relationship between interpersonal tensions and tip of the tongue memory failures and having difficulty picking up a new skill (OR = 1.39 and 1.97, respectively). Additionally, on days when health stressors were experienced, individuals were 1.9 times more likely to have difficulty picking up a new skill. Interestingly, when people experienced days when they felt they had too much to do (i.e., demands), they were 53% less likely to forget to take their medication(s) (OR = .47, $p < .05$). It is also important to note that the intercepts for each of the six models were below 1.0, indicating that participants were less likely to report having the targeted memory failure when no stressors were experienced.

Although linking specific types of stressors and memory failures was a novel component of the present study, further exploration into how these links might be affected by age could shed light on potential age differences in reactivity. Therefore, the same analyses outlined above were conducted again with the addition of age as a Level 2 variable. Results from the six models conducted to address this extension of the third hypothesis can be found in Table 13. Similar to the models presented earlier, it is important to note that the slopes of the Level 2 equations predicting the within-person relationships between stressors and memory failures were constrained to be equal across all persons (i.e., $u_{1i}$ through $u_{5i}$ were removed). Even when this technique was implemented, the model testing predictors of forgetting to take one's medication(s) could not be computed. This could be due to the fact that participants only reported forgetting to take their medication(s) on 3.5% of the study days (roughly 33 out of 962 days) and that by adding age to each Level 2 equation, the model became too complex for the data

that were available. Similar to the models reported earlier, the intercepts for each of the five models that could be computed were significant and lower than 1.0, indicating that participants were less likely to report having the targeted memory failure when no stressors were experienced. Additionally, interesting age differences in reactivity did emerge for some of the models.

In order to properly interpret and graph the odds ratios for the significant interactions, a median split was conducted on the sample by age, and then the above models were recomputed. Results from these analyses indicate that "older" adults (i.e., participants over the age of 72), compared to "younger adults" (i.e., participants age 72 or less), were less likely to go back to check whether they did something they meant to do when they encountered a network stressor (OR = .91, $p < .05$, see Figure 6), but they were more likely to report the same memory failure when they experienced a stressor that fit in the "other " category (OR = 1.20, $p < .05$, see Figure 7). There appeared to be no age differences in reactivity when looking at the models testing predictors of whether someone starting reading something that they had already read before or having a tip of the tongue failure, but it is also important to note that older adults were more likely to report having these memory failures even when no stressors were experienced (i.e., the effect of age on the intercept is significant in both models, OR = 1.07, $p < .05$ and OR = 1.07, $p < .01$, respectively). In terms of having trouble picking up a new skill, older adults appeared to be more reactive to network stressors (OR = 1.07, $p < .05$, see Figure 8), health stressors (OR = 1.11, $p < .05$, see Figure 9), and demands (OR = 1.13, $p < .05$, see Figure 10). Interestingly, they were less reactive to stressors that fit in the "other"

category (i.e., news events, weather, traffic, etc.) for this model (OR = .90, $p < .05$, see Figure 11). Lastly, there appears to be no statistically significant effects for age or type of stressor on whether someone fails to recognize familiar faces.

# CHAPTER V

## Discussion

This chapter begins with a brief overview of the findings from the present investigation. After considering the main findings, some conclusions about the relationship between age, stressors, and memory failures are presented and when appropriate, the study's limitations are discussed. Implications and directions for future research are also presented.

The main purpose of this study was to investigate the relationship between daily stressors and memory failures in a naturalistic setting, to see if the biological processes that have been found in laboratories could be extrapolated to an everyday setting. Although the findings from laboratory-based studies have been valuable in providing some understanding of the possible physiological links between stress and cognition, the present study sought to test this relationship within the context of peoples' everyday lives by examining a within-person process. Additionally, the impact of between-person differences in age on the within-person association between stressors and memory failures was examined. Three major findings resulted from this investigation: (a) naturalistic stressors and memory failures are significantly related; (b) some specific stressor types are related to specific memory failures; and (c) some age differences in reactivity to specific stressors are apparent.

### *The Stressor-Memory Failure Relationship*

The between-person regression results suggest that people who report more stressors also tend to report more memory failures, but this finding does not shed any

light on the within-person process that may be occurring. Therefore, it was important to examine this relationship in the HLM framework so that the fluctuation of stressors and memory failures within a person over consecutive days could be examined. In this study, the covariation through time of stressors and memory failures was assessed via a daily diary paradigm across eight days.

Analyses conducted on concurrent days (i.e., stressors and memory failures on the same day) showed that on days when stressors were experienced, more memory failures were reported compared to stressor-free days. This association remained even after controlling for the effects of neuroticism, life event stressors, and health. This point is important to emphasize because it demonstrates that the relationship between daily stressors and memory failures was not due to personality or physical health. Interestingly, life event stressors were also related to the number of memory failures, such that people who reported more life event stressors also reported more memory failures. When looking at change in memory failures from one day to the next (i.e., the lagged analysis), the effect of daily stressors was no longer significant, but the between-person effect of life event stressors remained. This robust finding could be particularly important for linking the biological and naturalistic literatures. Specifically, the number of life events someone experienced two years prior to the everyday memory failures reported in this investigation strengthens the assertion that stressors can have lasting effects on cognition (e.g., Heffelfinger & Newcomer, 2001; Starkman et al., 1992). Perhaps stressful life events alter individuals' biologies (i.e., hippocampi) in ways that makes them more vulnerable to everyday memory failures. Additionally, it is also

possible that daily stressors are biologically linked to memory failures through the release of cortisol (e.g., Kirschbaum et al., 1996). The general trend in the association between stressors (life events and daily events) and memory failures supports the findings of many laboratory-based studies (e.g., Kirschbaum et al., 1996; Sahakian et al., 1999; Vedhara et al., 2000), and builds upon previous work by extending it to a naturalistic setting. This study did not directly test the underlying physiological processes of stressors and memory failures, but the results found in a naturalistic setting lend ecological validity to findings that have been previously restricted to the laboratory. Although life event stressors and daily stressors are different types of events (Wheaton, 1999), they are both uniquely important when examining everyday memory failures. This finding is crucial to underscore because it shows not only the powerful effects that stressful life events can have on memory but also the effects of seemingly minor stressors that people experience more frequently on a daily basis. Therefore, even if someone does not experience any life event stressors, the day-to-day stressors that he or she experiences can still negatively impact his or her memory.

It is important to point out the possibility that life event stressors could be related to the change in everyday memory failures from one day to the next (i.e., lagged-day analyses) because the addition of the second Level 1 predictor (previous day memory failures) interfered with the relationship between concurrent stressors and memory failures, such that the two predictor variables were competing for the within-person variability.

The finding that daily stressors and life event stressors are related to memory failures may have important implications for the daily lives of older individuals. The link between stressors and physical health is not a new concept for scientists or those in the general population (Almeida et al., 2002); for example, when people have a heart attack they are typically told to cut back on stressful situations (e.g., work) that may exacerbate their physical condition. However, many people are likely unaware of the link between stressful situations and their ability to find a word that they are searching for. Daily stressors should be taken seriously, not just for their impact on physical or emotional health, but for their apparent impact on cognitive health as well. Findings from this investigation (i.e., significant impact of stressors on memory failures when controlling for health status) support the notion that even for people in relatively good physical health, it is important for them to know that stressors can still be affecting their cognitive well-being and it would be beneficial to attempt to avoid stressful situations.

Although the relationship between the sum of daily stressors on one day and the change in memory failures from one day to the next was not significant, it is still possible that a temporal association exists but that the current investigation was unable to detect it. Specifically, it is possible that a lag of 24 hours is too long to adequately capture the potential time-ordered relationship between stressors and memory failures. Perhaps future studies could implement shorter time intervals of data collection so the lag would be less than 24 hours. For example, the Experience Sampling Method (ESM) developed by Csikszentmihalyi and Larson (1987) requires participants to carry a device that randomly signals them throughout the day when they are to complete a measure for the

study. This method is particularly useful when recording inner experiences, such as mood, that may fluctuate often during the day and thus be subject to recall biases if assessed several hours or days later (Eckenrode & Bolger, 1995; Zautra et al., 1994). Additionally, it is possible that this method would be extremely useful for measuring memory failures because the interval that participants would need to remember that they forgot something would be shortened. As mentioned earlier, reducing the interval between the occurrence of the memory failures and participants' reports of these failures is also one way to increase the agreement between subjective and objective everyday memory assessments (Hickox & Sunderland, 1992). This method may also eliminate the potential bias introduced by having the participants complete diaries at the same time of day or day of week (Eckenrode & Bolger, 1995; Zautra et al., 1994).

*The Role of Age*

By including age in the analyses, three distinct issues were addressed. The first involved age differences in the frequency of memory failures. The second addressed age differences in stressor exposure, and the third examined the between-person differences in the within-person association between stressors and memory failures (i.e., reactivity).

*Age differences in memory failure frequency.* Significant age differences did exist in the number of memory failures reported (i.e., the bivariate correlation between age and sum of memory failures was significant). Because hippocampal volume is known to decrease with age (Anderson & Craik, 2000), this finding supports the laboratory-based results of research that hippocampal volume and age are negatively associated with cognitive functioning. This finding is consistent with cross-sectional work that has

documented age differences in cognition as well as longitudinal evidence of cognitive decline with age (e.g., Colsher & Wallace, 1991; Earles & Coon, 1994; Evans et al., 1993; Kausler & Hakami, 1983; Wilson et al., 1999).

The finding of age differences in memory failures can be especially important in the daily lives of older adults. When examining the metamemory and metacognition literature, it becomes clear that peoples' beliefs about their memory can be linked to their behaviors. Factual knowledge about memory tasks and processes, memory monitoring, and memory self-efficacy are aspects of metamemory (Hultsch et al., 1987). Similarly, memory self-efficacy is defined as beliefs about one's capability to use memory effectively in different situations (Bandura, 1989). Many researchers believe it is important to study memory self-efficacy because it may determine whether older adults will employ strategies to help them remember crucial information. For example, in a recent study examining metacognitive components of medication instruction recall, Neupert and McDonald-Miszczak (in review) found that older adults tended to over-predict their ability to perform the recall task more than younger adults when certain analyses were used. When the calibration of older adults' memory beliefs to their actual memory abilities is inaccurate, important health-promoting behaviors may be compromised (e.g., forgetting to take one's medication, forgetting a doctor's appointment, forgetting important warnings regarding medication interactions). Therefore, if older adults became more aware of the links between age and memory failures and stressors and memory failures, they might be more likely to realistically calibrate their expectations and use memory-enhancing strategies (e.g., pill boxes).

*Age differences in stressor exposure.* There appeared to be no age differences in the number of daily stressors people experienced (i.e., exposure, as assessed through bivariate correlations). Follow-up bivariate correlation analyses were conducted to see if there were age differences in exposure to life event stressors, but this relationship was also not significant. Additionally, the potential curvilinear effect of age on exposure was also tested for daily stressors and life event stressors through two separate multiple regression analyses. Results indicated that no such effect was present for either model.

Although recent research calls into question the assumed linear relationship between age and stressors, Aldwin and Levenson (2001) suggest that the relationship between age and stressors depends upon the type of stressor (e.g., life events, chronic stressors, daily hassles) that is examined. Middle aged and older adults tend to experience more life events such as: (a) network stressors (misfortunes that happen to close others), (b) illness events, (c) changes in social roles, and (d) shifts in the patterns of everyday life events (Zautra et al., 1994). However, older adults tend to have fewer desirable and undesirable daily events (Zautra et al., 1991). This decrease in daily stressor exposure may be due to a reduction in social roles and time commitments across the life course. Based on these findings, one would expect a positive relationship between life event stressors and age and a negative correlation between daily stressors and age. Perhaps one reason no age differences in stressor exposure were apparent in the present study results from the relatively small age range of the participants (i.e., only older adults were sampled). Specifically, there was not a true "younger adult" sample with which to compare the current sample in terms of exposure. To further explicate this

point, Figure 12 represents the distribution of age for the sample. Although the distribution looks relatively normal, over two-thirds of the sample falls between the ages of 65 and 80, once again suggesting that the age range may be too small to detect differences in exposure. Stressor exposure did not vary by age in the current sample, but it may be more meaningful to look at age differences in how individuals react to the daily stressors in their lives (i.e., reactivity).

*Age differences in reactivity.* Based on previous research that found a link between the cumulative effects of stress hormones and smaller hippocampi (e.g., Heffelfinger & Newcomer, 2001; Starkman et al., 1992; Uddo et al., 1993; Vasterling et al., 2002), it was hypothesized that there would be age differences in cognitive reactivity to daily stressors. Specifically, older adults who had presumably been exposed to more stressors throughout their lifetime compared to younger adults (Pearlin & Mullan, 1992) would have fewer resources (i.e., smaller hippocampi) to combat the negative effects of stressors, thereby resulting in heightened cognitive reactivity to stressors. However, age did not moderate the within-person relationship between stressors and memory failures. Follow-up analyses were conducted to see if a curvilinear (i.e., quadratic) effect for age was present, but no apparent effect existed. Similar to the rationale given for the lack of age differences in exposure, perhaps the present study lacked a sufficient age range to capture the potential effect of cumulative stressor exposure. However, it is also possible that age does not moderate the within-person relationship between the *sum* of daily stressors and memory failures. Instead, perhaps age differences in reactivity to *specific* stressors and memory failures are important to examine. It is possible that the important

differences are at a more specific level where stressors of certain domains (i.e., health-related stressors) differentially impact specific memory failures (i.e., having trouble picking up a new skill) depending on age. As will be discussed in greater detail later, this avenue of research does appear to be beneficial for shedding light age differences in reactivity.

*The Relationship Between Types of Stressors and Types of Memory Failures*

Although the relationship between specific types of stressors and specific memory failures had not been previously investigated, the varying effects of different stressors on mood and physical health had been established (e.g., Finlay-Jones, 1989; Leserman et al., 1998; Neilson et al., 1989). Therefore, the differential impact that specific stressors might have on distinct memory failures was considered an important, but exploratory, part of the present study.

*Interpersonal Tensions*

When participants experienced interpersonal tensions, they were more likely to also report a tip of the tongue failure, having trouble picking up a new skill, and going back to check whether they did something they meant to do. There could be many reasons why interpersonal tensions are related specifically to these three memory failures, but recent research suggests that these specific failures could be related to the familiarity and frequency of, and attention paid to the task (Dalton, 1993). For example, tip of the tongue failures typically occur for infrequently used words (Burke, MacKay, Worthley, & Wade, 1991) and may result from failure to devote full attention to the task at hand (Pollina et al., 1992; Pollina et al., 1993). Picking up a new skill is inherently a novel

task, and going back to check could refer to something out of one's normal routine (although from the current data one cannot be sure what the participant was going back to check). In contrast, recognizing familiar faces and remembering to take medication are tasks that are not novel. It is possible that interpersonal tensions are especially distracting for older adults because research suggests that they tend to be solution-oriented when faced with an interpersonal conflict (Bergstrom & Nussbaum, 1996) and therefore effort and attention are placed into finding a solution. Because effort and attention are directed toward the interpersonal conflict, one can imagine that less attention is available to remember or learn novel information. Therefore, perhaps interpersonal tensions have a particularly strong impact on memory failures that involve unfamiliar, infrequent, or attention-demanding tasks because they command the individual's attentional resources.

The findings from the present study regarding the associations between interpersonal tensions and three memory failure types are in line with previous assertions that interpersonal conflicts or tensions can be particularly detrimental to individuals' psychological (Rook, 1984; Sherman, 2003) and physical functioning (Kiecolt-Glaser, 1999). This study extends those findings by highlighting the important impact that these stressors can have within a person on cognitive well-being. Indeed, one reason for this finding may have physiological underpinnings. Kiecolt-Glaser et al. (1994) found that close personal relationships that are chronically abrasive and stressful may provoke persistent physiological alterations. They further speculated that heightened sympathetic nervous system activity is one key mechanism fueling endocrine and immune alterations. Similar to the effects that interpersonal stressors have on physical health (e.g., immune

functioning), perhaps these stressors also affect memory through a physiological process. Although one might expect older adults to terminate relationships that have negative interactions based on socioemotional selectivity theory (Carstensen, 1995), this is not always possible because support and strain are often derived from the same relationships (Walen & Lachman, 2000). Thus, it is important to understand the sources and ramifications of negative interactions because they may provide a chronic source of stress (Lachman, 2003). Although the findings from the present study are not surprising in light of previous research, it should be noted that this was the first time daily interpersonal tensions had been linked with everyday memory failures.

Because interpersonal relationships are considered salient by the vast majority of people (Antonucci, 2001), the finding that tensions arising from these relationships may impact memory is potentially very important for the daily lives of older adults. Taken with the findings from previous studies that chronically abrasive or stressful relationships can alter one's physiology (Kiecolt-Glaser et al., 1994), it becomes even more important to realize the effects of consistently toxic relationships. Individuals who find themselves in relationships where conflict abounds are likely to experience more problems with their memory compared to individuals in conflict-free relationships.

*Health Stressors*

When participants experienced health stressors, they were more likely to also report having trouble picking up a new skill. Similar to the rationale used to explain the relationship between interpersonal tensions and various memory failures, perhaps health stressors exert a particular influence on memory failures that explicitly require attention

to something novel (i.e., a *new* skill). Specifically, when looking at the types of events that were categorized as health stressors in the present study (i.e., accidents, potential accidents, medication-related issue, health insurance issue, illness, receiving treatment, problems during health care visit), each one could be seen as a deviation from one's "normal" daily routine and a threat to his or her physical well-being. Perhaps threats to physical well-being are particularly disrupting and therefore available attention is focused on resolving the issue rather than learning something novel. Indeed, previous research indicates that older adults, in general, have more trouble paying attention and concentrating when learning new things (Rabinowitz & Ackerman, 1982; Rosch, 1997). The finding from the present study supports previous research that familiarity with the task is an important component of whether someone will report a memory failure (Dalton, 1993) and that physical health and cognition are linked (e.g., Zelinski, Crimmins, Reynolds, & Seeman, 1998).

It is also important to note that the relationship between health stressors and having trouble picking up a new skill was not referring to between-person differences in health status; rather, it was looking at the daily fluctuation over time of health stressors and their impact on memory failures. This finding is an important extension of previous work on between-person differences, and it should be mentioned that this was the first time daily health stressors had been linked with everyday memory failures. Results also suggest that it is beneficial to examine stressful events related to health in addition to general or global health status of an individual.

Because older adults typically experience more health-related events compared to younger adults (Zautra et al., 1994), the effects that these events have above and beyond the physical well-being of an individual could be particularly salient for their daily lives. Specifically, the effects that these events may have on memory functioning could be especially discouraging for older adults who may have already noticed a decline in both their physical and cognitive health. By implementing health-promoting behaviors (e.g., exercise, diet) and potentially avoiding some health-related stressors, individuals may see improvement not only in their physical well-being but in their cognitive well-being as well.

*Demands*

In a somewhat surprising finding, on days when people experienced demands, they were less likely to forget to take their medication(s). Perhaps this finding can be explained by Lazarus' (1999) conceptions of eustress and challenge. He defines eustress as the constructive type of stress that is compatible with or protective of good health and challenge as the sensibility that, although difficulties stand in the way of gain, they can be overcome with verve, persistence, and self-confidence. It is possible that people tend to perceive demands as opportunities to rise to a challenge and promote their health as opposed to allowing them to exert negative consequences. Additionally, it is also possible that the presence of demands is just one predictor of medication adherence. For example, previous researchers have found that adherence depends on the chain of communication of frequently complex instructions from the physician to the pharmacist to the patient (Morrow, Leirer, & Sheikh, 1988). Additionally, people may actively

choose to not adhere to their medication regimen because of the cost of the medication or belief that the medication is not helping (Gould, McDonald-Miszczak, & Gregory, 1999).

Regardless of age, people often encounter demands in their daily lives. It is encouraging to know that the often unavoidable stressors of having too much to do could actually serve as motivators and have positive impacts on some areas of memory. Additionally, demands may serve as specific motivators for individuals to adhere to their medication regimens, thereby positively impacting their physical health as well.

### *Age Differences in Reactivity to Different Types of Stressors*

It was initially hypothesized that older adults would be more cognitively reactive (i.e., report more memory failures) to daily stressors. Although this relationship was not significant when examining the sum of daily stressors and memory failures, a further exploration of possible age differences in reactivity to different types of stressors was tested. Indeed, results from these analyses indicate that it is important to look more closely at the specificity of stressors and memory failures because some age differences were present.

#### *Network Stressors and "Other" Stressors*

When examining network stressors and those that fit into the "other" category, age differences in reactivity were mixed; that is, older adults were more likely to report having trouble picking up a new skill when faced with a network stressor, and were more likely to report going back to check whether they did something they meant to do when faced with an "other" stressor. In contrast, older adults were less likely to report having trouble picking up a new skill when faced with an "other" stressor and less likely to

report going back to check whether they did something they meant to do when faced with a network stressor. Therefore, even within the same stressors and same memory failures, the pattern of age differences in reactivity was mixed. According to the factors presented by Sunderland et al. (1983), going back to check fits under the "actions" category and having trouble picking up a new skill fits under the "learning new things" category, therefore representing distinct areas of memory failures even though both require paying attention to the task. Perhaps the hypothesized effect of cumulative stressor exposure over the lifespan is only apparent in distinct types of memory failures and stressors for older adults (i.e., network stressors and learning new things and "other" stressors and going back to check). This finding is important because it highlights the possibility that older and younger adults do not react to the same stressors in the same way. However, even though the stressors fit under the categories of "network" and "other", it is possible that younger and older adults experience distinctly different events in each of these categories. For example, perhaps network events for older adults are more likely to consist of deaths or serious health issues, while for younger adults emotional and relationship problems are more prevalent. If future research could examine even more specific aspects of these stressors, trends in age differences in reactivity to different types of stressor could become clearer. Because younger and older adults do appear to react differently depending on the type of stressor and memory failure, older adults should be encouraged that the stressors in their lives will not always result in a higher likelihood of experiencing memory failures. Many stressors are unavoidable, and older adults should be aware that when they do experience a stressor they might fare better than younger

adults in certain cognitive situations. For example, the two most common "other" stressors in the present study were the explosion of the Columbia shuttle and a severe snow storm. While older adults appeared to be more reactive to these stressors when reporting action-based memory failures (e.g., going back to check), they were less reactive when reporting whether they had trouble picking up a new skill. Future research could more explicitly test the mechanisms underlying these mixed results and provide clearer insight into implications for the lives of older adults.

*Health Stressors and Demands*

The findings for age differences in reactivity to health stressors and demands were more straightforward; older adults were consistently more likely to report having trouble picking up a new skill when faced with these types of stressors. These findings support the notion that the cumulative effects of stressors over the lifespan may increase the likelihood of experiencing a memory failure when encountering a stressor (e.g., Anderson & Craik, 2000), especially when the memory failure involves a novel experience or context (Dalton, 1993) (e.g., learning a *new* skill). Additionally, this seems to strengthen the importance of examining the kindling effect (i.e., repeated exposure to the same state may increase reactivity in older adulthood) (Adamec, 1990). Perhaps the findings for these types of stressors were clearer because health stressors and demands have more consistent effects. Older adults typically experience more health-related events compared to younger adults (Zautra et al., 1994), so therefore one might expect that the accumulation of health events could negatively impact memory functioning (e.g., the kindling effect, Adamec, 1990). Additionally, demands at home and the workplace tend

to pile up over the course of a lifetime, so even though many of the older participants were retired, the cumulative effects of these stressors could have resulted in heightened cognitive reactivity to learning new skills which often require focus and attention.

Because health stressors and demands seemed to be particularly salient for predicting the likelihood of a particular memory failure for older adults, measures that older adults could employ to avoid these types of stressors may be beneficial. As mentioned earlier, health-promoting behaviors such as exercise and eating a healthy diet may do more than just improve physical well-being; they may also reduce the frequency of health-related stressful events and therefore have a positive influence on cognitive well-being. Additionally, older adults should consider taking measures to reduce the likelihood of encountering demands. Although findings mentioned previously indicated that demands could be beneficial motivators, that analysis did not consider the possibility that age differences in reactivity to demands provide new information on these types of stressors. Retirement may reduce the number of demands in the workplace, but there may still be demands stemming from the home environment. Perhaps calibrating expectations to realistic abilities could reduce the number of instances where people feel they have too much to do. If they are able to set more realistic goals for themselves, they may be less likely to feel overwhelmed.

### *Limitations*

Although this study provided an important and unique perspective of the interconnections between naturalistic stressors, everyday memory failures, and age, it is important to recognize its limitations. The memory failures examined in the present

investigation did span a wide range of domains, but they do not represent an exhaustive list of possible areas where people may experience failures, and therefore generalizations to all possible memory failure domains are not possible. The memory failures studied in the current investigation generally fit under the categories of encoding and attention failures (memory failures that result from inattention). For example, finding that one must reread material because one has been thinking about something else fits into this category. Inability to remember whether one has turned off lights or locked a door may result from failure to encode a fairly trivial activity. Additionally, finding that one cannot quite remember something even though it's on the tip of his or her tongue has been interpreted to tap an individual's failure to devote full attention to the task at hand (Pollina et al., 1992; Pollina et al., 1993). Although findings from the present study clearly support the notion that daily stressors are associated with everyday memory failures, future studies could further explore this relationship by examining memory failures that tap into different domains of cognitive functioning.

Other limitations of the present investigation result from the nature of data collection. Because the original daily stressor measure was converted from a telephone diary into a paper/pencil questionnaire, the data were more subjective in nature. Specifically, the original telephone interview had the benefit of probing for details regarding the stressor and therefore making objective ratings as to whether the reported stressor was indeed a distinct event or an affective response to a stressor. Additionally, although eight consecutive days is typically considered sufficient to capture an understanding of individuals' daily lives (e.g., Almeida et al., 2002; Zautra et al., 1991;

Zautra et al., 1994), perhaps the current investigation would have benefited from even more consecutive days of data. It is possible that increasing the number of diary days might increase the reliability and validity of reports as well as increase the variability in memory failure variables.

An additional limitation of the current study is linked with the characteristics of the participants in the sample. Most of the men in the present investigation were war veterans, and therefore had been exposed to distinctly different stressors throughout their lifetime compared with a non-veteran sample. Although the women in the present study were not veterans and analyses did not indicate any major gender differences on any of the variables of interest, future studies should examine non-veterans to see if the findings from the present study are still applicable.

It is important to note that the design of present study did not allow for causal claims regarding the relationship between stressors and memory failures. Because this study was not conducted in a controlled laboratory setting with independent variables that were manipulated by a researcher (e.g., different levels and types of stressor exposure), conclusions were only made regarding the correlational association between daily stressors and memory failures. The lagged analyses conducted in the present study attempted to examine the potential temporal association between stressors and memory failures, but longitudinal experiments in controlled settings that assess memory failures, induce various levels of stressors, and then measure memory failures again have been more beneficial for ruling out a potential reverse ordering (e.g., that memory failures could cause a daily stressor). Additionally, because this study was conducted in a

naturalistic setting, it is possible that variables that may typically be controlled or held constant in a laboratory or experimental setting could cause the covariation between daily stressors and memory failures. However, even with these limitations regarding causation and rival explanations, it is important to emphasize that the naturalistic setting of the current investigation allowed for the examination of stressors and memory failures as they occurred in the everyday lives of older adults and represent more ecologically valid findings than those that have been found in laboratory settings.

### *Future Research*

Because the simultaneous examination of naturalistic stressors and memory failures was a novel component of this study, there are many possibilities for future research. In addition to previously mentioned directions for future studies (i.e., including more content classifications of memory failures, implementing the Experience Sampling Method to shorten the length of time between reports, and sampling non-veterans), the addition of various sampling techniques and sample selection could further elucidate the findings of the present investigation.

In terms of sampling techniques, future studies could explicitly examine the potential link between underlying physiological processes and naturally occurring stressors and memory failures. For example, researchers could instruct participants to provide a salivary cortisol sample each day during the eight-day daily diary period and then examine the daily covariation of both naturalistic stressors and the physiological representation of stress and how they relate to each other and daily memory failures. In order to more completely examine this relationship, the re-incorporation of a telephone

interview method would allow for more objective reports of stressors. Similarly, future research could also incorporate laboratory-based cognitive tests (e.g., processing speed, working memory) to examine the relationships between stressors, stress hormones, memory failures, and objective cognitive tests. In the future, this type of analysis may be possible with data from the Normative Aging Study. Data are currently being collected from men coming to the Boston VA for a health visit within the next calendar year. At the conclusion of their visit where their physical and cognitive health is assessed, they are given the opportunity to participate in the daily diary study. Although this opportunity to link laboratory and self-report measures is exciting, it will likely involve a relatively small number of men and therefore replication with a larger and more diverse sample will be needed.

In order to more accurately test for the cumulative effects of stressors on memory over time, future studies could implement a traditional longitudinal design that would follow participants over the course of a number of decades. For example, once each year participants could come into the lab and provide a sample of cortisol and complete a cognitive battery. At the end of their appointment, they would be sent home with a daily diary that would assess their daily stressors and memory failures. This method would allow for a more complete test of the notion that stress impacts cognition, both inside and outside of the laboratory. Further, the longitudinal nature of the design would make the assessment of age differences *and* age changes in reactivity to stressors possible.

Because interesting findings emerged when examining specific stressors and memory failures, future studies may benefit from investigating even more detailed

aspects of certain stressors. For example, interpersonal tensions were the most prevalent form of stressor in the present study, so perhaps research that assessed the effects of various argument domains (e.g., financial issues, household maintenance) could shed further light on this important relationship.

The samples of future studies would likely benefit from a larger age range than was present in the current investigation, because conclusions regarding age differences in reactivity could be strengthened by analyses that compared a true younger adult sample to an older adult sample. Although interesting findings did emerge by comparing "younger" and "older" adults in the present study, the hypotheses regarding cumulative stressor exposure over the lifespan could be more adequately addressed with a larger age range.

### *Concluding Remarks*

Perhaps the most important finding from the present study involves the association found between daily stressors and everyday memory failures in a naturalistic setting. This study did not directly test the underlying physiological processes of stressors and memory failures, but the results found in a naturalistic setting lend ecological validity to findings that have been previously restricted to the laboratory. Additionally, although some evidence for age differences in reactivity was found, firm conclusions regarding these relationships should not be made until future studies can replicate these findings. Examining stressors and memory failures in a naturalistic setting is a new area that will likely provide many avenues of investigation for future research, and the implication that stressful events (both daily stressors and life event stressors) are

related to memory functioning in older adults is particularly important given the cognitive decline that typically accompanies the aging process.

# Appendix A

## Tables

Table 1. Descriptive characteristics of the full NAS sample ($n$ = 1125) collected in 2001 and the subsample ($n$ = 121) used in the present study.

| | Full sample | | Subsample | | |
|---|---|---|---|---|---|
| Variable | *M* | *SD* | *M* | *SD* | *range* |
| Age | 72.18 | 7.44 | 72.69 | 7.46 | 44-89 |
| Life event stressors | 3.63 | 4.02 | 3.44 | 3.95 | 0-30 |
| Neuroticism | 2.27 | 2.16 | 2.28 | 2.08 | 0-8 |
| Self-rated health | 2.66 | 0.96 | 2.62 | 0.95 | 1-5 |
| Marital Status | 87.3 | | 98.3 | | |

Note. Marital status is presented in terms of percentage of the sample that is married.

Table 2. Descriptive characteristics of variables from the pilot study ($n$ = 30).

| | Total sample | | | | Those who reported any | | |
|---|---|---|---|---|---|---|---|
| | % of days | B/W SD | W/I SD | %people | % of days | B/W SD | W/I SD |
| **Stressors** | | | | | | | |
| Argument | 23.3 | 31.2 | 21.9 | 60.0 | 38.8 | 32.0 | 43.9 |
| Potential Argument | 36.8 | 27.9 | 36.0 | 80.0 | 46.1 | 25.9 | 46.9 |
| Work Stressor | 27.9 | 29.1 | 28.7 | 66.7 | 41.8 | 26.0 | 47.9 |
| Home Stressor | 25.6 | 26.9 | 31.3 | 73.3 | 34.9 | 25.6 | 42.7 |
| Network Stressor | 22.5 | 30.7 | 21.6 | 56.7 | 39.7 | 31.3 | 43.1 |
| Health Stressor | 18.3 | 27.4 | 19.3 | 43.3 | 42.3 | 26.8 | 44.4 |
| Other | 22.5 | 31.6 | 20.1 | 56.7 | 39.7 | 32.8 | 43.0 |
| **Memory Failures** | | | | | | | |
| Go back to check | 41.1 | 38.8 | 25.5 | 70.0 | 58.8 | 33.0 | 42.6 |
| Read it Before | 12.9 | 24.0 | 14.5 | 36.7 | 35.2 | 28.4 | 43.6 |
| Tip of the tongue | 31.3 | 32.1 | 28.6 | 73.3 | 42.6 | 30.3 | 45.2 |
| Trouble picking up new skill | 10.2 | 20.1 | 13.4 | 30.0 | 34.1 | 23.3 | 44.7 |
| Fail to recognize people | 6.3 | 20.9 | 3.5 | 10.0 | 62.5 | 33.1 | 52.6 |

Note. B/W SD represents between-person standard deviations and W/I SD represents within-person standard deviations.

Table 3. Between-person correlations from the pilot study.

| | Age | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Memory | .36* | -- | | | | | | | |
| 2. Argument | .14 | .46* | -- | | | | | | |
| 3. Potential arg. | -.01 | .44* | .73* | -- | | | | | |
| 4. Work stressor | -.26 | .32 | .45* | .42* | -- | | | | |
| 5. Home stressor | -.11 | .33 | .38* | .34 | .53* | -- | | | |
| 6. Network stressor | -.30 | .15 | .58* | .53* | .53* | .36* | -- | | |
| 7. Health stressor | -.05 | .58* | .55* | .61* | .65* | .53* | .50* | -- | |
| 8. Other stressor | -.02 | .54* | .53* | .40* | .60* | .55* | .47* | .80* | -- |

Note. Memory represents the sum of all memory failures.
$n = 30$.
* $p < .05$.

Table 4. Descriptive characteristics of stressor variables from the present study.

| | Total sample | | | | Those who reported any | | |
|---|---|---|---|---|---|---|---|
| | % of days | B/W SD | W/I SD | %people | % of days | B/W SD | W/I SD |
| Interpersonal Tensions | 23.3 | 25.4 | 29.2 | 69.4 | 33.5 | 24.2 | 42.0 |
| Demands | 15.5 | 20.0 | 23.0 | 52.1 | 29.8 | 18.6 | 44.1 |
| Health Stressor | 14.0 | 21.5 | 20.0 | 47.1 | 29.6 | 22.7 | 41.5 |
| Network Stressor | 14.7 | 21.3 | 21.4 | 54.5 | 27.0 | 22.3 | 39.3 |
| Other | 8.1 | 13.0 | 16.0 | 47.1 | 20.7 | 13.1 | 40.6 |
| Sum of Stressors[a] | 0.82 | 0.78 | 0.66 | -- | 0.92 | 0.77 | 0.74 |

Note. B/W SD represents between-person standard deviations and W/I SD represents within-person standard deviations.

$n$ = 121 participants, 962 days.

[a]: Because the sum of stressors variable is a summed score, the values indicated in the table are the average number of stressors and the average dispersion across the days.

Table 5. Descriptive characteristics of memory failure variables from the present study.

| | Total sample | | | | Those who reported any | | |
|---|---|---|---|---|---|---|---|
| | % of days | B/W SD | W/I SD | %people | % of days | B/W SD | W/I SD |
| Go back to check | 20.0 | 25.3 | 24.7 | 59.5 | 33.6 | 25.0 | 41.5 |
| Read it Before | 4.9 | 15.5 | 6.1 | 15.7 | 30.9 | 27.4 | 38.7 |
| Tip of the tongue | 40.4 | 34.9 | 29.7 | 77.7 | 52.0 | 31.0 | 38.2 |
| Trouble picking up new skill | 5.9 | 16.3 | 7.9 | 19.8 | 29.8 | 25.4 | 40.0 |
| Fail to recognize people | 8.0 | 22.1 | 6.6 | 18.2 | 43.8 | 33.8 | 36.2 |
| Forget to Take medication | 3.5 | 10.1 | 6.1 | 14.0 | 24.7 | 14.5 | 43.0 |
| Sum of Memory failures[a] | 0.82 | 0.81 | 0.55 | -- | 0.96 | 0.80 | 0.64 |

Note. B/W SD represents between-person standard deviations and W/I SD represents within-person standard deviations.

$n$ = 121 participants, 962 days.

[a]: Because the sum of memory failures variable is a summed score, the values indicated in the table are the average number of memory failures and the average dispersion across the days.

Table 6. Between-person (lower quadrant) and within-person (upper quadrant) correlations among stressor variables from the present study.

| | Age | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 1. Sum stressor | -.02 | -- | .60*** | .53*** | .48*** | .53*** | .41*** |
| 2. Interpersonal tensions | .06 | .73*** | -- | .14 | .08 | .17 | .06 |
| 3. Demands | -.15 | .70*** | .39*** | -- | .07 | .12 | .12 |
| 4. Network stressor | .02 | .54*** | .18 | .20* | -- | .07 | .19* |
| 5. Health stressor | -.00 | .66*** | .38*** | .37*** | .14 | -- | .08 |
| 6. Other stressor | .03 | .62*** | .24** | .39*** | .50*** | .28** | -- |

$n$ = 121 participants, 962 days.

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

Table 7. Between-person (lower quadrant) and within-person (upper quadrant) correlations among memory failure variables from the present study.

| | Age | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| 1. Sum memory | .31*** | -- | .64*** | .54*** | .71*** | .48*** | .54*** | .24** |
| 2. Go back to check | .22* | .76*** | -- | .25** | .23** | .20* | .15 | -.00 |
| 3. Read it before | .16 | .65*** | .48*** | -- | .18* | .17 | .36*** | .08 |
| 4. Tip of the tongue | .37*** | .80*** | .49*** | .31*** | -- | .19* | .22** | .00 |
| 5. New skill | .18* | .56*** | .35*** | .25** | .35*** | -- | .13 | .09 |
| 6. Recognize people | .11 | .66*** | .35*** | .52*** | .37*** | .25** | -- | .06 |
| 7. Take medication | .01 | .24** | .01 | .13 | .01 | .26** | .11 | -- |

$n$ = 121 participants, 962 days.

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

Table 8. Between-person correlations among control variables, sum of memory failures, and sum of stressors.

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1. Sum memory | -- | | | | |
| 2. Sum stressors | .35*** | -- | | | |
| 3. Neuroticism | -.03 | .15 | -- | | |
| 4. Health | .08 | -.01 | .26** | -- | |
| 5. Life event stressor | .33*** | .06 | .18 | .18 | -- |

$n = 121$.

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

Table 9. Regression models predicting sum of memory failures representing between-person analyses of Hypotheses 1 and 2, respectively.

| Variable | Model 1 | | | Model 2 | | |
|---|---|---|---|---|---|---|
| | $R^2$ | B | (SE) | $R^2$ | B | (SE) |
| Sum of stressors | .23 | .33*** | (.08) | .25 | .38*** | (.09) |
| Stressful life events | | .06*** | (.02) | | | |
| Neuroticism | | -.04 | (.03) | | | |
| Self-rated health | | .04 | (.07) | | | |
| Age | | | | | .02 | (.01) |
| Age*Sum of stressors | | | | | .02 | (.01) |

$n$ = 121 participants, 962 days.

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

Table 10. Hierarchical linear modeling estimates and standard errors predicting memory failures for Hypothesis 1.

| | Model 1 | | Model 2 | |
|---|---|---|---|---|
| Fixed effects | Coeff. | (se) | Coeff. | (se) |
| Intercept, $\beta_0$ | | | | |
| Overall memory failures, $\gamma_{00}$ | .67*** | (.07) | .64*** | (.07) |
| Stressful life events, $\gamma_{01}$ | .06*** | (.02) | .06*** | (.02) |
| Neuroticism, $\gamma_{02}$ | -.03 | (.04) | -.04 | (.04) |
| Self-rated health, $\gamma_{03}$ | .05 | (.08) | .06 | (.07) |
| Sum stressor slope, $\beta_1$ | | | | |
| Intercept, $\gamma_{10}$ | .08* | (.04) | .04 | (.03) |
| Previous day memory failure slope, $\beta_2$ | | | | |
| Intercept, $\gamma_{20}$ | | | .06 | (.03) |

$n$ = 121 participants, 962 days.

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

Table 11. Hierarchical linear modeling estimates and standard errors predicting memory failures for Hypothesis 2.

| | Model 1 | | Model 2 | |
|---|---|---|---|---|
| Fixed effects | Coeff. | (se) | Coeff. | (se) |
| Intercept, $\beta_0$ | | | | |
| Overall memory failures, $\gamma_{00}$ | .71*** | (.08) | .67*** | (.08) |
| Age, $\gamma_{01}$ | .03** | (.01) | .03*** | (.01) |
| Sum stressor slope, $\beta 1$ | | | | |
| Intercept, $\gamma_{10}$ | .11** | (.04) | .01 | (.04) |
| Age, $\gamma_{11}$ | .00 | (.00) | -.00 | (.01) |
| Previous day memory failure slope, $\beta 2$ | | | | |
| Intercept, $\gamma_{20}$ | | | .10** | (.03) |

$n$ = 121 participants, 962 days.

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

Table 12. Hierarchical non-linear modeling analyses predicting the odds of experiencing six different memory failures.

| | Go back to check | Read it before | Tip of the tongue | New skill | Recognize faces | Take medication |
|---|---|---|---|---|---|---|
| Intercept | .17*** | .04*** | .57*** | .04*** | .07*** | .05*** |
| Network stressor | 1.25 | 1.73 | 1.16 | .69 | 1.14 | .64 |
| Health stressor | 1.28 | .70 | 1.11 | 1.90* | 1.42 | .66 |
| Inter-personal tensions | 1.93*** | 1.06 | 1.39* | 1.97* | .98 | 1.16 |
| Demands | 1.49 | 1.06 | 1.34 | 1.06 | 1.22 | .47* |
| Other | 1.21 | .79 | .87 | .97 | .77 | .75 |

$n$ = 121 participants, 962 days.

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

Table 13. Hierarchical non-linear modeling analyses of age differences in reactivity and the odds of experiencing five different memory failures.

| | Go back to check | Read it before | Tip of the tongue | New skill | Recognize faces |
|---|---|---|---|---|---|
| Intercept | .16*** | .04*** | .53*** | .05*** | .07*** |
| Age | 1.04 | 1.07* | 1.07** | 1.02 | 1.05 |
| Network stressor | 1.27 | 1.73 | 1.17 | .50 | 1.14 |
| Age | .91* | 1.01 | 1.01 | 1.07* | 1.02 |
| Health stressor | 1.40 | .73 | 1.46 | 1.17 | 1.58 |
| Age | 1.00 | .99 | 1.01 | 1.11* | .97 |
| Inter-personal tensions | 1.91** | 1.07 | 1.42 | 1.79 | 1.00 |
| Age | 1.02 | .96 | 1.01 | 1.01 | .96 |
| Demands | 1.57 | 1.09 | 1.42 | .69 | 1.21 |
| Age | 1.01 | .96 | .99 | 1.13** | .97 |
| Other | .90 | .64 | .83 | 1.18 | .70 |
| Age | 1.20* | .88 | 1.09 | .90* | 1.05 |

Note. Forgetting to take one's medication is not included because the model failed to converge. See page 87 for an explanation.

$n$ = 121 participants, 962 days.

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

# Appendix B

## Figures

Figure 1. Cognitive-behavioral model of the stressor-distress process. Emphasized component is in bold.

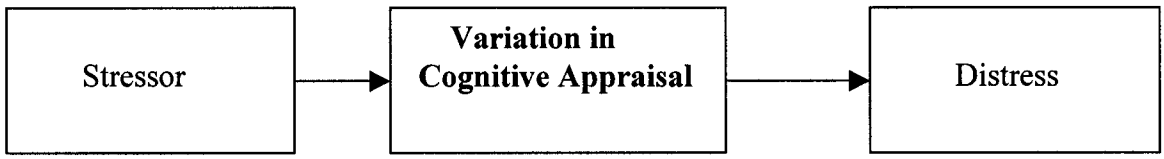


Figure 2. Sociological model of the stressor-distress process. Emphasized component is in bold.

Figure 3. Biological model of the stress process. Emphasized component is in bold.

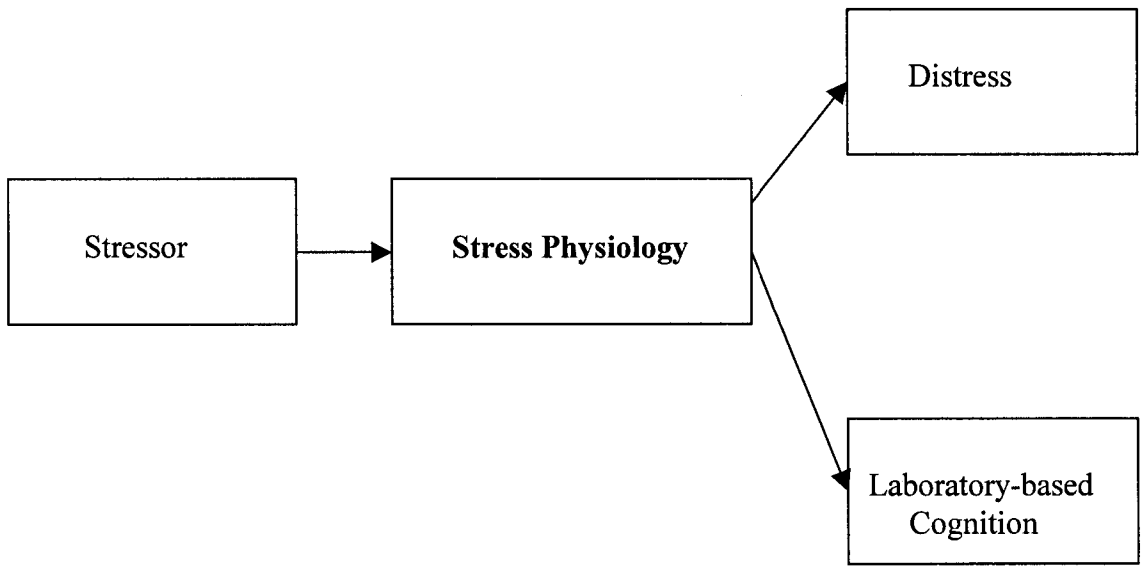


Figure 4. Model tested in the current investigation.

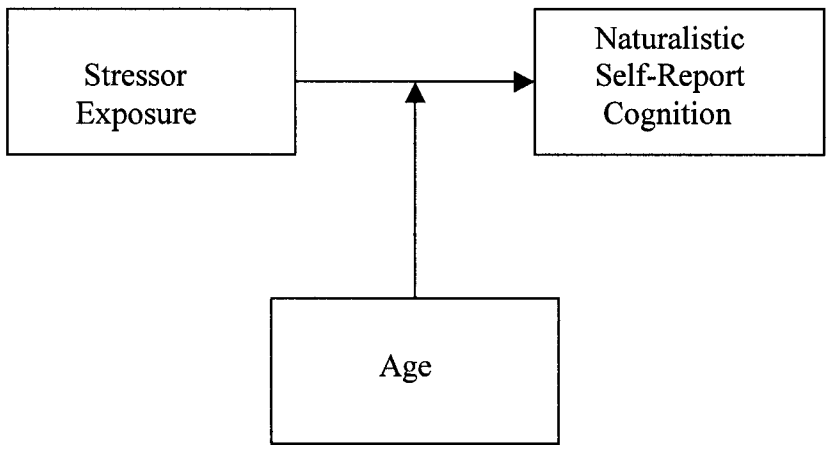


Figure 5. Means of stressors and memory failures by age group.

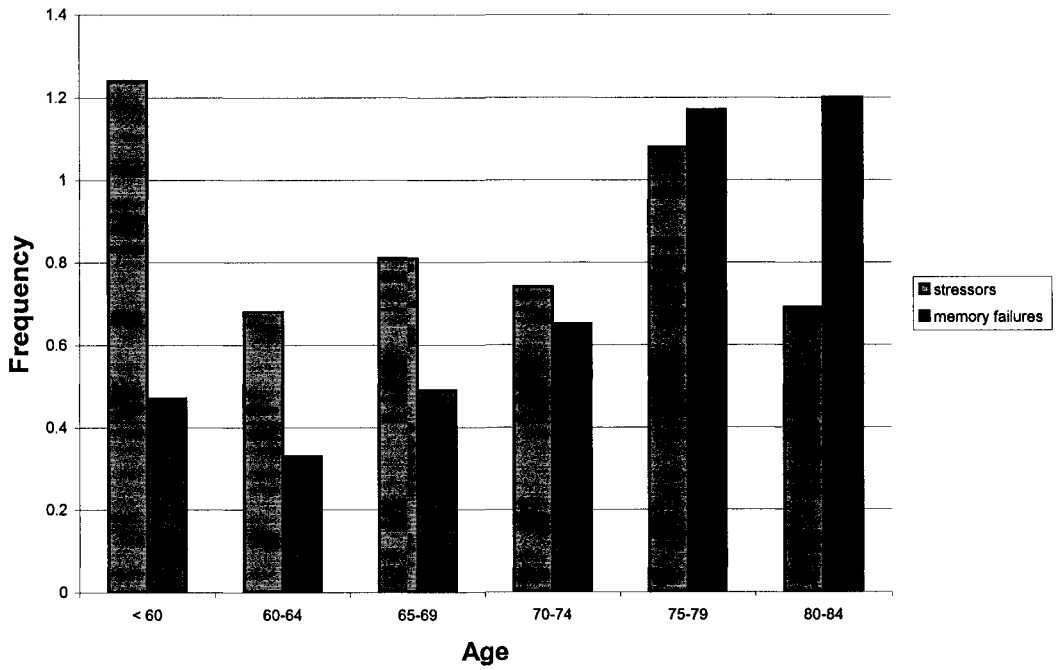


Figure 6. Age differences in the likelihood of going back to check when encountering a network stressor.

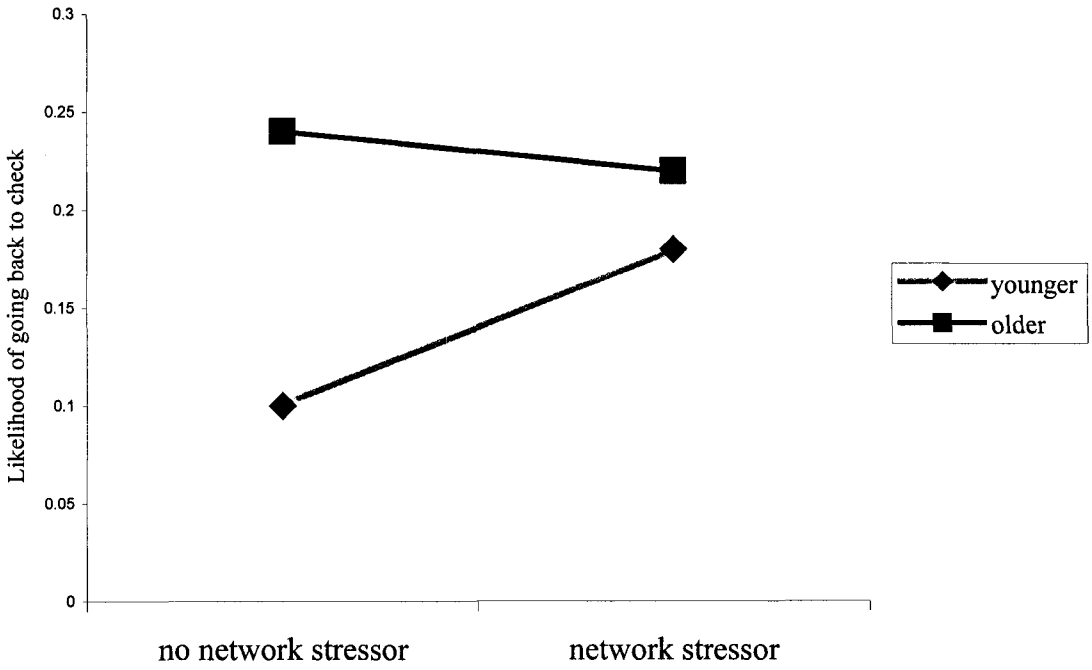


Figure 7. Age differences in the likelihood of going back to check when encountering an "other" stressor.

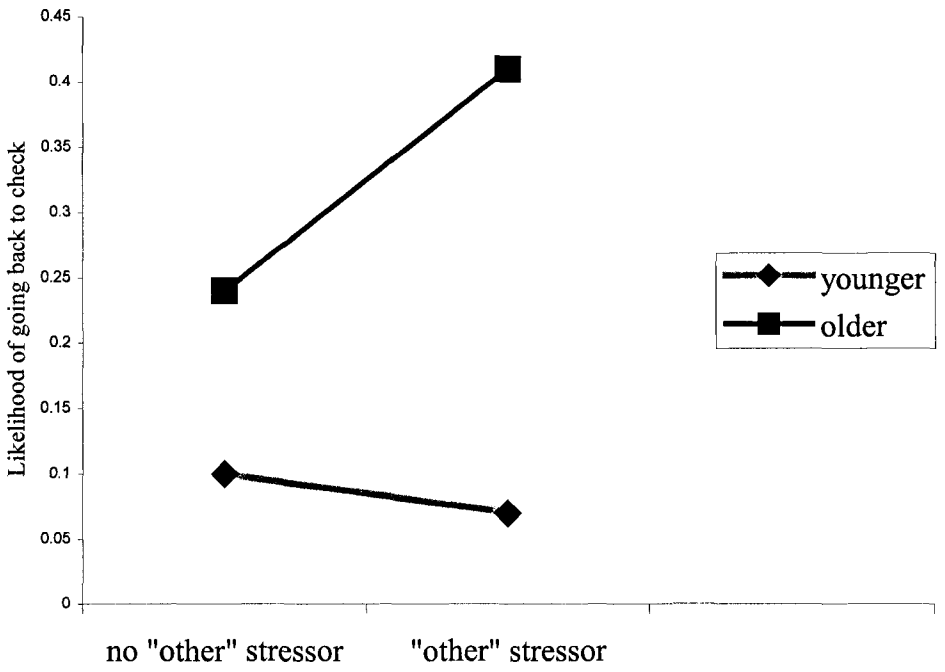


Figure 8. Age differences in the likelihood of having trouble picking up a new skill when encountering a network stressor.

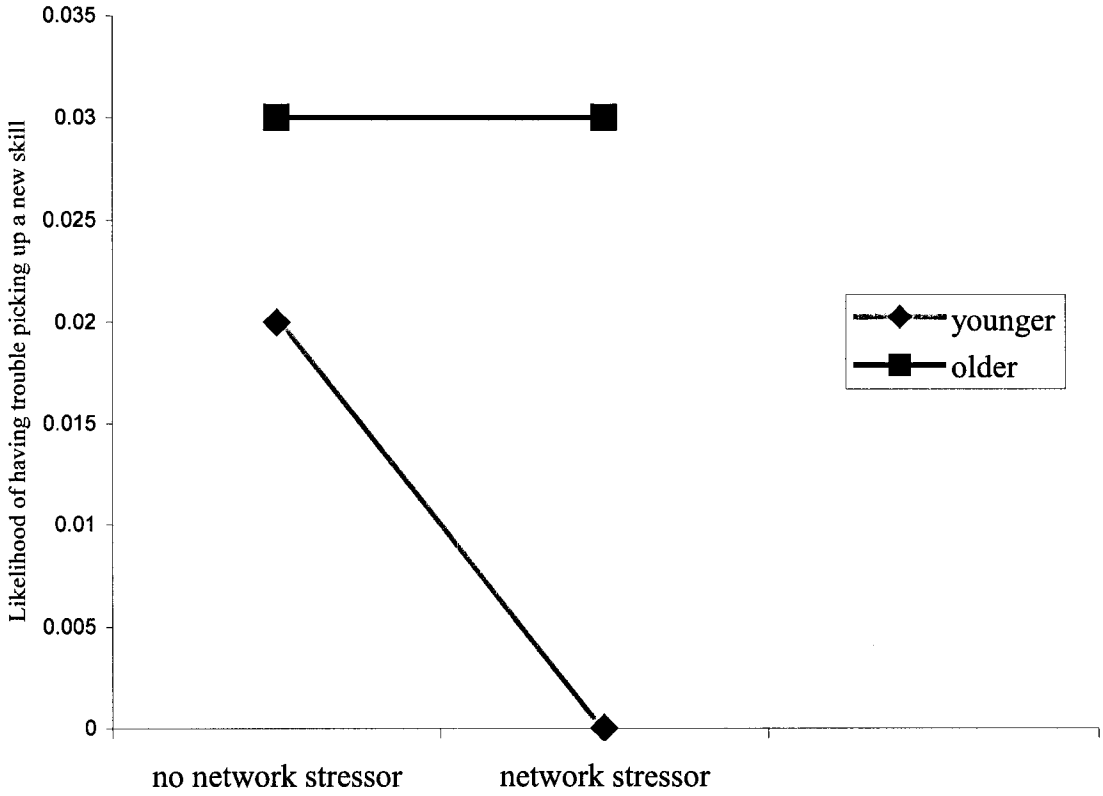


Figure 9. Age differences in the likelihood of having trouble picking up a new skill when encountering a health stressor.

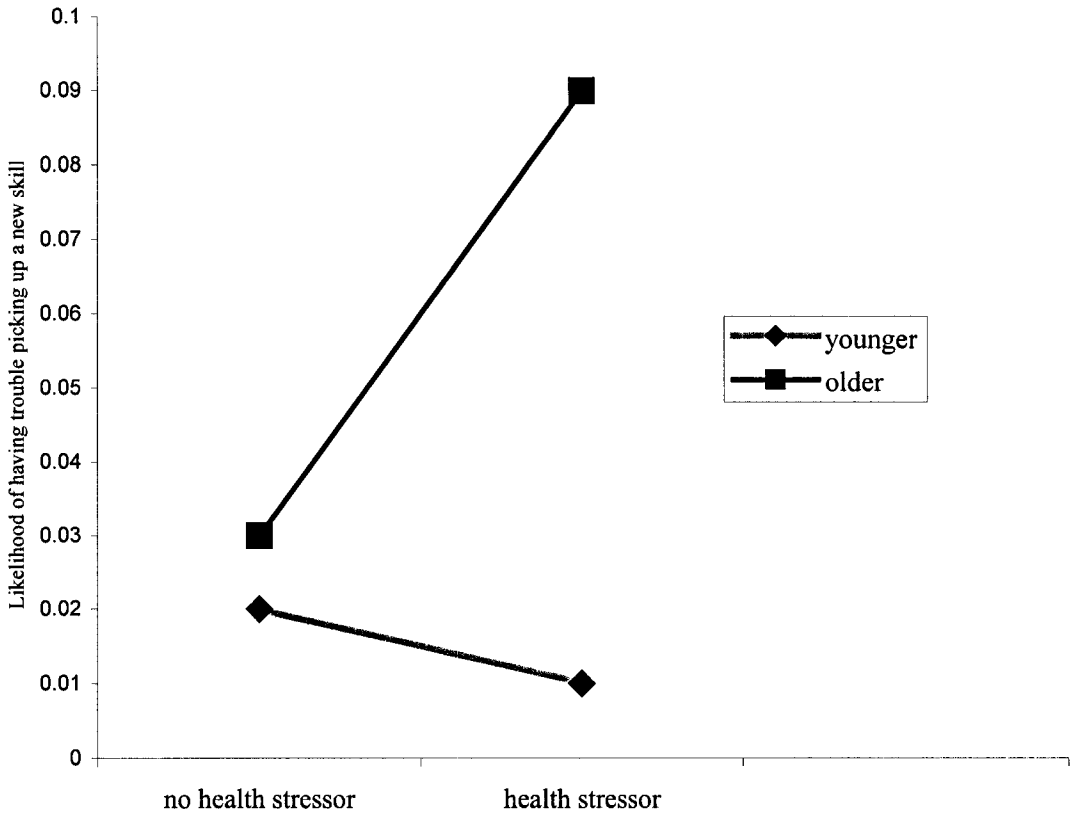


Figure 10. Age differences in the likelihood of having trouble picking up a new skill when encountering a demand.

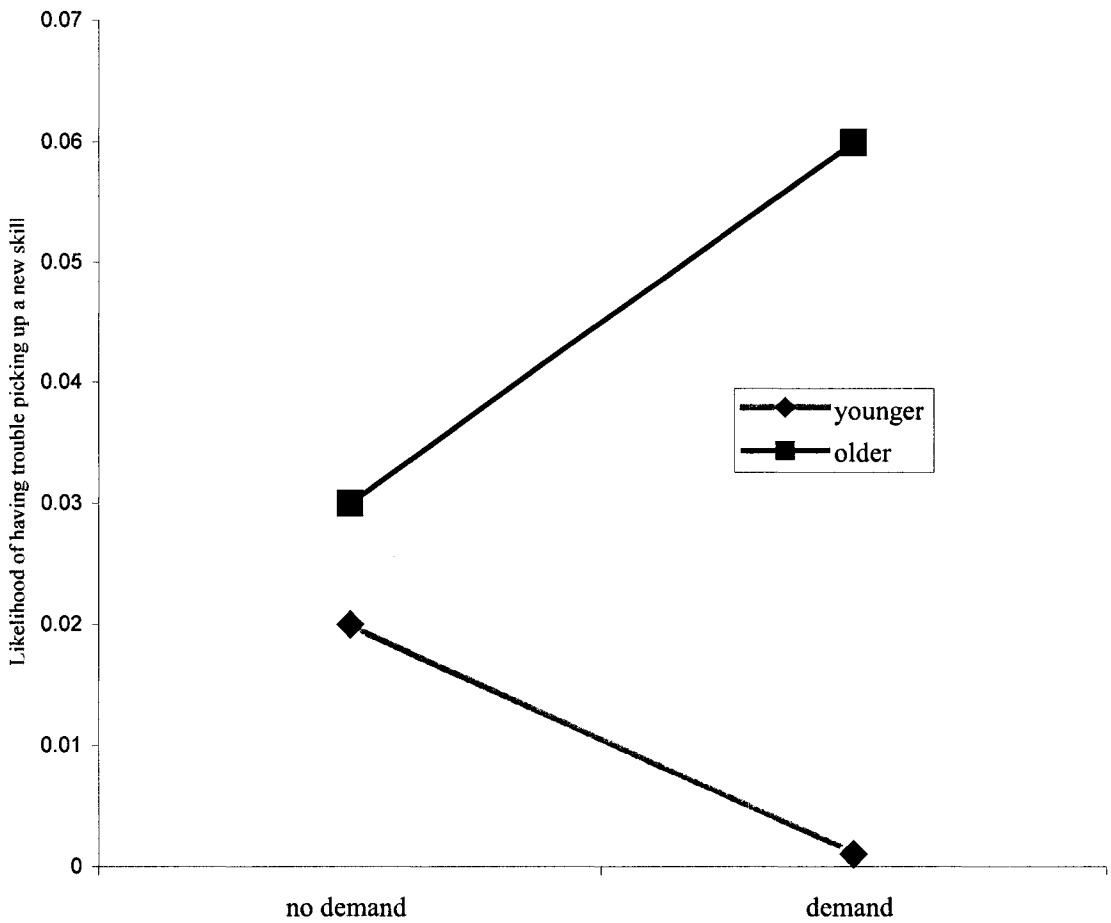


Figure 11. Age differences in the likelihood of having trouble picking up a new skill when encountering an "other" stressor.

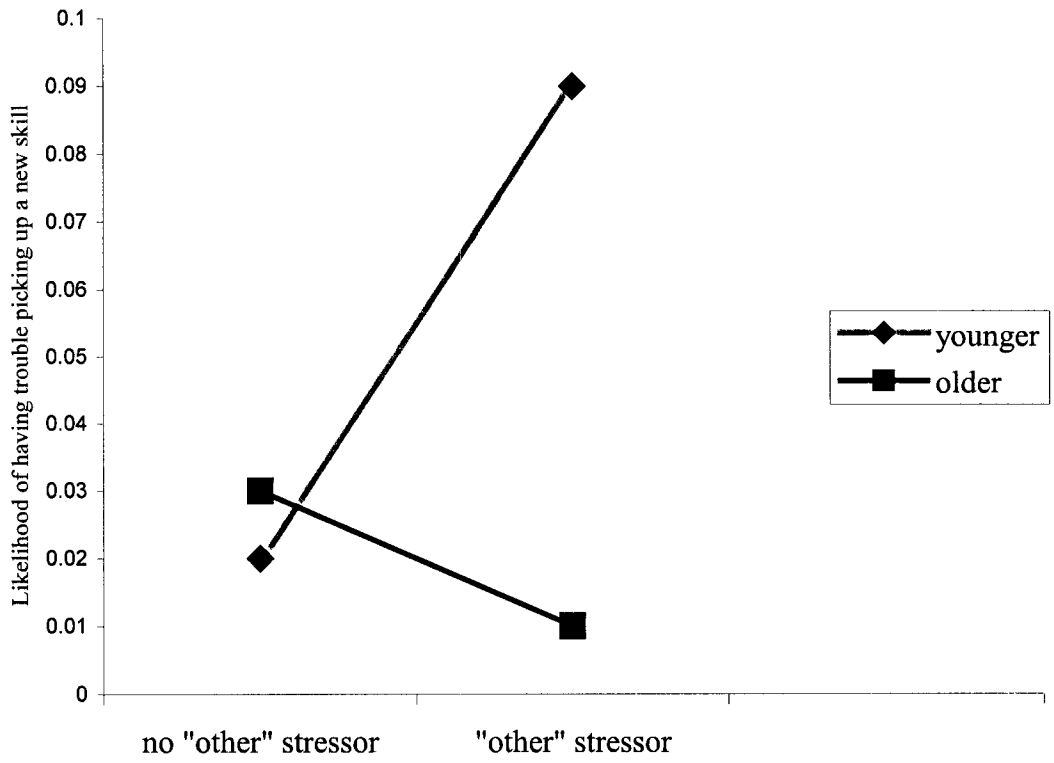
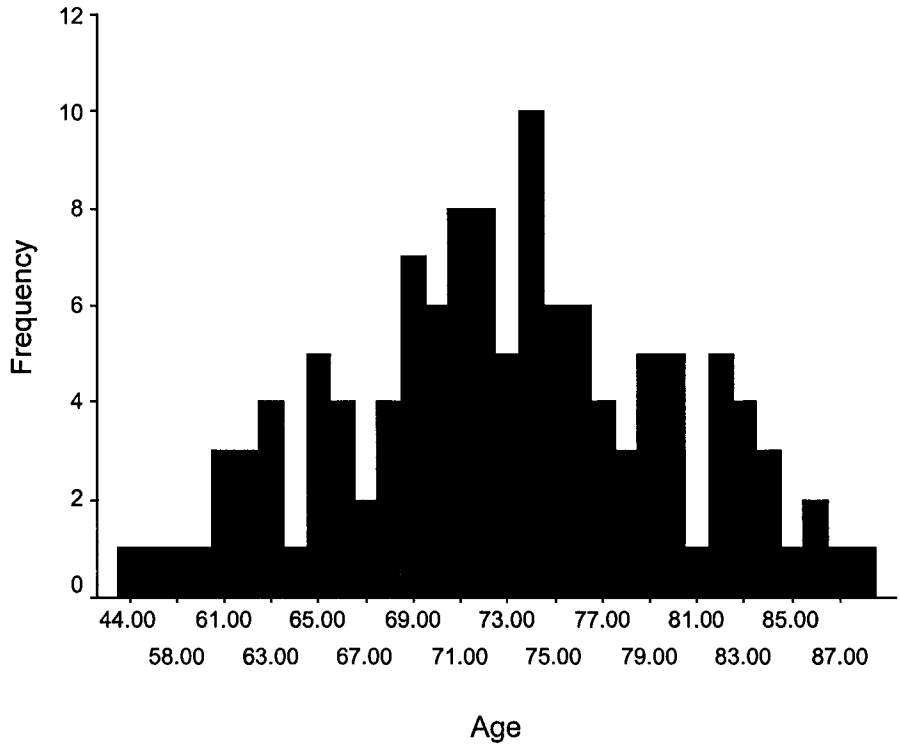


Figure 12. Frequency distribution of age.



# Appendix C

## Daily Diary Questionnaire

Note: This questionnaire was transformed into a double-sided booklet, but for purposes of presenting as an Appendix, the single-sided version is presented.

1. What number between 0 and 100 best describes your average level of bodily pain today? A "0" would mean "no pain" and a "100" would mean "pain as bad as it can be".

_____

2. In the past 24 hours, did you experience any of the following physical symptoms? (check all that apply).

___ Headache
___ Constipation/Diarrhea
___ Muscle Soreness
___ Shortness of Breath
___ Tightness in Chest
___ Trembling/Shaking
___ Backache
___ Cold/Flu Symptoms
___ Heart Pounding
___ Nausea/Upset Stomach
___ Hot or Cold Flashes
___ Congestion
___ Poor Appetite
___ Sore Throat
___ Dizziness

3. Have you had any of the following problems with your work or other regular daily activities as a result of your physical health today?

| | No | Yes, Slightly | Yes, Very Much |
|---|---|---|---|
| Did you cut down the amount of time you spent on work or other activities? | | | |
| Did you accomplish less than you would like? | | | |
| Were you limited in the kind of work or other activities you did? | | | |
| Did you have difficulty performing the work or other activities? | | | |
| Did you experience any side effects from medications you are taking? | | | |

4. In the past 24 hours, how many cigarettes did you smoke? (one pack = 20 cigarettes)

_____ cigarettes _____ I don't smoke

5. In the past 24 hours, how many alcoholic beverages did you have? (one drink = bottle of beer, a glass of wine, or shot of liquor)

_____ drinks _____ I don't drink alcoholic beverages

6. Using the following scale, indicate to what extent you have felt these emotions in the past 24 hours by circling the number in the appropriate box.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| very slightly or not at all | a little | moderately | quite a bit | extremely |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Interested | 1 | 2 | 3 | 4 | 5 | Irritable | 1 | 2 | 3 | 4 | 5 |
| Distressed | 1 | 2 | 3 | 4 | 5 | Alert | 1 | 2 | 3 | 4 | 5 |
| Excited | 1 | 2 | 3 | 4 | 5 | Ashamed | 1 | 2 | 3 | 4 | 5 |
| Upset | 1 | 2 | 3 | 4 | 5 | Inspired | 1 | 2 | 3 | 4 | 5 |
| Strong | 1 | 2 | 3 | 4 | 5 | Nervous | 1 | 2 | 3 | 4 | 5 |
| Guilty | 1 | 2 | 3 | 4 | 5 | Determined | 1 | 2 | 3 | 4 | 5 |
| Scared | 1 | 2 | 3 | 4 | 5 | Attentive | 1 | 2 | 3 | 4 | 5 |
| Hostile | 1 | 2 | 3 | 4 | 5 | Jittery | 1 | 2 | 3 | 4 | 5 |
| Enthusiastic | 1 | 2 | 3 | 4 | 5 | Active | 1 | 2 | 3 | 4 | 5 |
| Proud | 1 | 2 | 3 | 4 | 5 | Afraid | 1 | 2 | 3 | 4 | 5 |

**For questions 7-13, please tell us about stressful experiences that may have happened to you in the past 24 hours. If you check "NO" for a question, skip to the next one. If you check "YES", then please provide the additional information inside the box before moving on to the next question.**

7. In the last 24 hours, did you have an argument or disagreement with anyone?
___ No ___ Yes

NO YES

a. Who was it with?
___ Spouse
___ Your Child(ren)
___ Your Grandchild(ren)
___ Other Family Member
___ Friend
___ Neighbor
___ Co-worker
___ Someone Else _____

b. What was the main topic of the argument?
_____ Money/Financial Issues
_____ Family obligation/responsibilities
_____ Household-related tasks
_____ Work /Volunteer-related tasks
_____ Scheduling
_____ Other _____

c. How stressful was this for you?
___ Not At All __A Little __ Somewhat __Very

d. How much control do you feel you had over this situation?
___ None __A Little __ Some __ A lot

e. Is the issue resolved? __ No __ Yes

**Continue on next page – Question # 8**

8. In the last 24 hours, did anything happen (other than what you have already mentioned) that you could have argued or disagreed about, but you decided to let it pass?
___ No ___ Yes

NO YES

a. Who was it with?
___ Spouse
___ Your Child(ren)
___ Your Grandchild(ren)
___ Other Family Member
___ Friend
___ Neighbor
___ Co-worker
___ Someone Else _____

b. What was the main topic of the potential argument or disagreement?
_____ Money/Financial Issues
_____ Family obligation/responsibilities
_____ Household-related tasks
_____ Work /Volunteer-related tasks
_____ Scheduling
_____ Other _____

c. How stressful was this for you?
___ Not At All __A Little __ Somewhat __Very

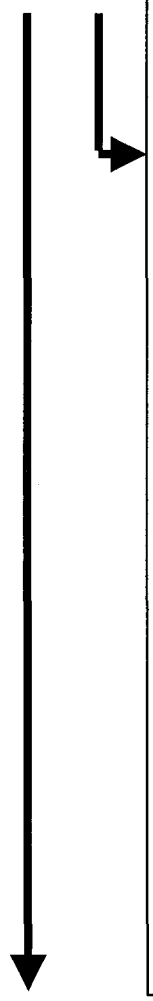
d. How much control do you feel you had over this situation?
___ None __A Little __ Some __ A lot

e. Is the issue resolved? __ No __ Yes

**Continue on next page – Question # 9**

9. In the last 24 hours, did anything happen <u>in your workplace or volunteer setting</u> (other than what you have already mentioned) that most people would consider stressful?
___ No ___ Yes

NO YES



a. <u>Who</u> else was involved?
___ No one else
___ Spouse
___ Your Child(ren)
___ Your Grandchild(ren)
___ Other Family Member
___ Friend
___ Co-worker
___ Someone Else _____

b. Was there and argument or disagreement?
___ No ___ Yes

c. What was the <u>main source</u> of the stress?
_____ Income or job security
_____ Mistakes
_____ Having too much to do
_____ Scheduling
_____ Other _____

d. How <u>stressful</u> was this for you?
___ Not At All __A Little __ Somewhat __Very

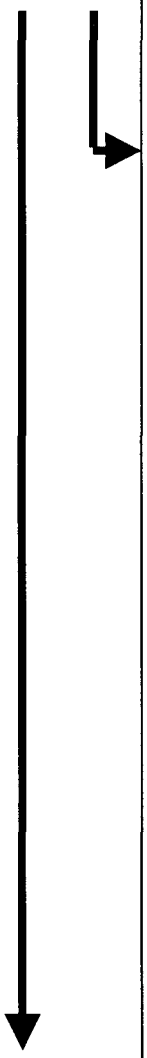
e. How much <u>control</u> do you feel you had over this situation?
___ None __A Little __ Some __ A lot

f. Is the issue resolved? __ No __ Yes

**Continue on next page – Question # 10**

10. In the last 24 hours, did anything happen <u>at home</u> (other than what you have already mentioned) that most people would consider stressful? ___ No ___ Yes

NO YES



a. <u>Who</u> else was involved?
___ No one else
___ Spouse
___ Your Child(ren)
___ Your Grandchild(ren)
___ Other Family Member
___ Friend
___ Neighbor
___ Co-worker
___ Someone Else _____

b. Was there and argument or disagreement?
___ No ___ Yes

c. What was the <u>main source</u> of the stress?
_____ Household maintenance
_____ Neighborhood concerns
_____ Having too much to do
_____ Scheduling conflicts
_____ Financial issues
_____ Pet problems
_____ Other _____

d. How <u>stressful</u> was this for you?
___ Not At All __A Little __ Somewhat __Very

e. How much <u>control</u> do you feel you had over this situation?
___ None __A Little __ Some __ A lot

f. Is the issue resolved? __ No __ Yes

**Continue on next page – Question # 11**

11. In the last 24 hours, did anything happen to a close friend or relative (other than what you have already mentioned) that turned out to be stressful for you?
___ No ___ Yes

NO YES

a. What relation is this person to you?
___ Spouse
___ Your Child(ren)
___ Your Grandchild(ren)
___ Other Family Member
___ Friend
___ Neighbor
___ Co-worker
___ Someone Else _____

b. What happened to this person?
_____ Financial problem
_____ Legal problem
_____ Health or safety issue
_____ Work-related issue
_____ Death
_____ Emotional problem
_____ Relationship problem
_____ Other _____

c. How stressful was this for you?
___ Not At All __A Little __ Somewhat __Very

d. How much control do you feel you had over this situation?
___ None __A Little __ Some __ A lot

e. Is the issue resolved? __ No __ Yes

**Continue on next page – Question # 12**

12. In the last 24 hours, did anything stressful happen (other than what you have already mentioned) regarding your personal health? ___ No ___ Yes

NO YES

a. Who else was involved?
___ No one else
___ Spouse
___ Your Child(ren)
___ Your Grandchild(ren)
___ Other Family Member
___ Friend
___ Neighbor
___ Co-worker
___ Someone Else _____

b. What was the main problem?
_____ Accident
_____ Potential accident
_____ Medication-related issue
_____ Health insurance issue
_____ Illness
_____ Receiving treatment
_____ Problems during health care visit
_____ Other _____

c. How stressful was this for you?
___ Not At All __A Little __ Somewhat __Very

d. How much control do you feel you had over this situation?
___ None __A Little __ Some __ A lot

e. Is the issue resolved? __ No __ Yes

**Continue on next page – Question # 13**

13. In the last 24 hours, did anything else happen (other than what you have already mentioned) that most people would consider stressful? ___ No ___ Yes

NO YES

a. Who else was involved?
___ No one else
___ Spouse
___ Your Child(ren)
___ Your Grandchild(ren)
___ Other Family Member
___ Friend
___ Neighbor
___ Co-worker
___ Someone Else _____

b. Was there an argument or disagreement?
___ No ___ Yes

c. What was the main source of the stress?
_____ Weather
_____ Traffic/transportation
_____ Political
_____ News event
_____ Mistakes/confusion
_____ Ethical/moral conflict
_____ Other _____

d. How stressful was this for you?
___ Not At All __A Little __ Somewhat __Very

e. How much control do you feel you had over this situation?
___ None __A Little __ Some __ A lot

f. Is the issue resolved? __ No __ Yes

**Continue on next page – Question # 14**

14. Overall, to what extent did the stressful events you experienced in the past 24 hours affect each of the following areas of your life? (Please put a "√" in the appropriate box to tell us your answer).

| | Not at all | A little | Somewhat | A lot |
|---|---|---|---|---|
| Your daily routine? | | | | |
| Your financial situation? | | | | |
| The way you feel about yourself? | | | | |
| The way others feel about you? | | | | |
| Your physical health or safety? | | | | |
| The health/well-being of someone you care about? | | | | |
| Your plans for the future? | | | | |

15. In the past 24 hours, did you receive emotional support (e.g., listening to you, comforting you) from anyone? ___ No ___ Yes

16. From whom did you receive support? (check all that apply)

___ Spouse
___ Your Child(ren)
___ Your Granchild(ren)
___ Other family member
___ Friend
___ Neighbor
___ Co-worker
___ Someone else

17. How satisfied were you with the support you received?

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| not at all | a little | moderately | quite a bit | extremely |

For questions 18 – 23, please check the appropriate response.

In the past 24 hours:

18. Did you go back to check whether you had done something that you meant to do?
___ No ___ Yes

19. Did you start to read something (a book or an article in a newspaper or a magazine) without realizing you had already read it before? ___ No ___ Yes

20. Did you find that a word was "on the tip of your tongue," you knew what it was but could not quite find it? ___ No ___ Yes

21. Did you have difficulty picking up a new skill, for example, finding it hard to learn a new game or to work some new gadget after you had practiced once or twice?
___ No ___ Yes

22. Did you fail to recognize, by sight, close relatives or friends, or fail to recognize famous people seen on television or in photographs? ___ No ___ Yes

23. Did you forget to take your medications as scheduled?
___ No ___ Yes

24. How happy are you with your life right now? (Circle the number that best applies).

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Extremely Happy | | | | | | | | Extremely Unhappy |

# Appendix D

## Human Subjects Approval

Human Subjects Protection Program
http://www.irb.arizona.edu

THE UNIVERSITY OF
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TUCSON ARIZONA

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Tucson, AZ 85724-5137
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28 April 2003

Shevaun Neupert, M.S.
Advisor: David Almeida, Ph.D.
School of Family/Consumer Sciences
Division of Family Studies/Human Development
FCS Building, Room 210
PO BOX 210033

**RE: DAILY STRESSORS AND MEMORY FAILURES IN A NATURALISTIC SETTING: FINDINGS FROM THE NORMATIVE AGING STUDY**

Dear Ms. Neupert:

We received documents concerning your above cited project. This project involves secondary data analysis of existing data collected under the project "VA Normative Aging Study" (PI: Avron Spiro III, Ph.D., Boston University; IRB approval letter, original data collection instruments, recruitment materials provided for review; data provided without identifiers). Therefore, regulations published by the U.S. Department of Health and Human Services [45 CFR Part 46.101(b) (4)] exempt this type of research from review by our Institutional Review Board.

Exempt status is granted with the understanding that no further changes or additions will be made to the procedures followed (which we have on file) without the review and approval of the Human Subjects Committee and your College or Departmental Review Committee.

Thank you for informing us of your work. If you have any questions concerning the above, please contact this office.

Sincerely,

Rebecca Dahl

Rebecca Dahl, R.N., Ph.D.
Director
Human Subjects Protection Program

RD/js
cc: Departmental/College Review Committee

# Appendix E

## Author's Note

The views expressed in this paper are those of the author and do not necessarily represent the views of the Department of Veterans Affairs. The VA Normative Aging Study (NAS) and the VA Dental Longitudinal Study (DLS) are supported by the Cooperative Studies Program/ERIC, US Department of Veterans Affairs. These studies are research components of the Massachusetts Veterans Epidemiology Research and Information Center (MAVERIC).

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