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AN EXAMINATION OF THE RELATION BETWEEN MEMORY SELF-EFFICACY AND WORKING MEMORY WITHIN THE COGNITIVE RESERVE FRAMEWORK

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By

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Abstract

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Abstract Title: Examination of the relation between memory self-efficacy and working memory within the cognitive reserve framework

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Dementia has been found to negatively affect multiple aspects of cognitive functioning. Despite an increasing prevalence of cognitive decline, many aging adults do not experience reduced cognitive functioning. The reason as to why some experience cognitive decline and others do not is still unclear. One leading theory thought to explain this phenomenon is the cognitive reserve theory (CR), which proposes that certain lifestyle factors (e.g., educational attainment, occupational attainment, and leisure activity participation) prolong one’s cognitive functioning and reduce the risk of cognitive decline. Memory self-efficacy (MSE), defined as one’s beliefs in their memory ability, was found to be positively related to cognitive ability, but has not been studied in concert with CR factors. Additionally, working memory, which intersects memory and executive functioning, has seldom been examined in past CR studies. The present study sought to fill these gaps by constructing a hierarchical regression to analyze if MSE explains working memory variance over and above the existing CR factors. A sample of United States adults age 55+ were recruited via MTurk. MSE ($\beta = .42$, $p < .001$) explained variance in working memory over and above existing CR factors (i.e., educational attainment, occupational attainment, and leisure activity participation) in a hierarchical regression analysis, after controlling for age, depression, and anxiety, R^2 change = .17, $F(1, 186) = 40.70$, $p < .001$. These findings illustrate that MSE explains a large, unique portion of variance that is not explained by CR factors commonly thought to explain cognitive functioning.

Keywords: memory self-efficacy, cognitive reserve, working memory, aging, cognitive functioning

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Examination of the Relation Between Memory Self-Efficacy and Working Memory Within the Cognitive Reserve Framework

Individuals experience a higher likelihood of cognitive decline or dementia as they age, which can cause a decline in functional ability and independence (Aartsen et al., 2002; Fritsch et al., 2005). Dementia have been found to affect multiple aspects of cognitive functioning. Cognitive functioning is an umbrella term that describes multiple aspects of cognitive ability, including both memory and executive functioning (Fisher et al., 2019). Memory refers to the ability to retain information and recall it at a later time (Zlotnik & Vansintjan, 2019). Executive functioning refers to the cognitive ability that allows an individual to plan, organize, and judge situations for appropriate behavior (McCabe et al., 2010). The prevalence of cognitive decline has increased dramatically in recent years (Nichols et al., 2019). The percentage of individuals 65 + is becoming a larger segment in the world's population (He et al., 2015). This increase has been thought to result from longer life spans due to medical advancements, an increase in the world's population, and improved medical technology to detect cognitive decline (Aartsen et al., 2002; Crimmins, 2015; Fritsch et al., 2005; Nichols et al., 2019; Semenova & Stadtlander, 2016). Additionally, greater public awareness of dementia developed in the 1990s, which was largely led by pharmaceutical companies when drug treatments for dementia were developed, as well as by a greater societal interest in nutritional supplements (Alzheimer's Society, 2019, Messerer & Johansson, 2001). In a longitudinal global study that ran from 1990 to 2016, Nichols et al. (2019) reported 43.8 million individuals experienced cognitive decline in 2016, which is more than double the reported amount from the onset of the study (20.2 million in 1990).

Despite this overall growth, many aging adults do not experience cognitive decline. In fact, some research has examined "SuperAgers", a group of older adults age 80 or older that feature extraordinary cognition relative to their age (Randolph, 2018). These SuperAgers have some brain features, such as cortical thickness, that are similar to those of 50 – 65-year-old individuals (Randolph, 2018). The reason as to why some older individuals experience cognitive decline and others do not is still unclear to researchers (Steinberg et al., 2013). Even within dementia, some individuals with dementia are able to function independently and retain their cognitive abilities longer than others with dementia, even if they have had dementia for the same amount of time (Steinberg et al., 2013). Similar to the reason why some experience dementia and others do not, the reason as to why some individuals with dementia maintain functional capacity longer than others with the same disease burden has baffled researchers. However, there are some leading theories that have attempted to explain this difference. One of these theories that has gained considerable attention in the literature is the cognitive reserve theory (CR).

Cognitive Reserve (CR)

The CR theory argues that specific lifestyle factors facilitate cognitive functioning and reduce the risk of cognitive decline (George, 2013; Stern, 2006). The CR theory might explain the difference between SuperAgers and those who experience dementia (George, 2013; Randolph, 2018; Stern, 2006). The CR theory has also been found to explain how individuals with dementia can retain their level of cognitive functioning, even when the pathology of dementia or Alzheimer's disease (e.g., beta-amyloid plaques, neurofibrillary tangles) is present (George, 2013; Stern, 2006). These specific factors, according to CR theory, would then help to explain why the rate of decline in cognitive functioning is not linear or equivalent for all individuals, and why some patients with Alzheimer's disease maintain functional capacity and independence for a longer period of time compared to others that have similar pathology present (Ho & Chan, 2005; Stern, 2012; Stern et al., 1999).

Along this same line of thought, the CR theory also supports the need for neuropsychological assessment despite technological advances in brain imaging, as the post-mortem neuropathological severity of Alzheimer's disease does not necessarily equate to the pre-mortem pathological or behavioral severity of cognitive decline symptoms (Caselli et al., 2015; Lezak, 2012). Given that the CR factors are thought to contribute to the retention of cognitive functioning, CR is also thought to compensate, reroute, or cope in the face of negative brain changes by utilizing the brain's neuroplastic ability (Sobral et al., 2015; Stern, 2006, 2012; Vance et al., 2012).

Existing CR Factors

Although past researchers have proposed several CR factors, three have strong support in the literature: educational attainment, occupational attainment, and participation in leisure activities.

Educational Attainment. Perhaps the most-supported CR factor, educational attainment has been found to be positively associated with cognitive functioning (Aartsen et al., 2002). Rodriguez et al. (2019) reported that those with higher educational attainment performed better on recognition tasks, verbal fluency tasks, working memory tasks, and processing speed tasks. Further, Sobral and Paúl (2013)'s study — which identified a positive relationship between educational attainment and cognitive test scores in an Alzheimer's disease population — suggested that educational attainment serves as a protective factor even when cognitive decline has progressed, supporting its role as a CR factor. Additionally, another study found that this positive effect of education was found to be stronger for those with dementia than without (Staekenborg et al., 2020). This positive relation between educational attainment and cognitive functioning and a potential protective effect was also echoed by Esiri and Chance (2012), Evans et al. (1997), and Fritsch et al. (2002). In terms of the extent of this positive relation, Evans et al. estimated that the risk of developing Alzheimer's disease decreased by 17% for each year of completed education.

Occupational Attainment. Similar to educational attainment, occupational attainment has also been found to have a positive relation with cognitive functioning, and thus, a negative relation with dementia risk, supporting its role as a CR factor (Stern, 1994). Occupational attainment is defined as an occupation's degree of cognitive difficulty. Operational definitions require participants to think of their longest-held job, and these jobs are coded for cognitive difficulty (Ghaffari et al., 2012; Kim et al., 2020; Qiu et al., 2003). Smyth et al. (2004) found that Alzheimer's disease patients were more likely to have previously held occupations that required low mental stimulation compared to those that did not have Alzheimer's disease, while Kim et al. (2020) and Qiu et al. (2004) found that "blue collar" workers (e.g., manual labor workers) faced a higher risk of cognitive impairment, although Kim et al. only found this for females and not males. Andel et al. (2005) found a protective effect against dementia risk for occupations that were cognitively demanding. Similarly, Seidler et al. (2004) conducted a dementia odds ratio analysis and reported that those who experienced high variability at work, high work independence, and high social demands at work each had a decreased odds ratio for dementia.

Leisure Activity Participation. The third prominent CR factor, leisure activity participation, is defined as engagement in an activity that is independent of fulfilling school, occupational, or living needs (Park et al., 2019; Verghese et al., 2006). Examples of common leisure activities include reading, completing puzzles, visiting friends, dancing, walking, and reading (Sobral & Paúl, 2013). Many studies have divided leisure activities into three different domains: cognitive (e.g., completing puzzles, reading), social (e.g., spending time with friends), and physical (e.g., walking, dancing)— with the positive relation between cognitive leisure activities and cognitive functioning generating the greatest support in the literature (Fratiglioni & Wang, 2007; Niti et al., 2008; Sattler et al., 2012; Scarmeas et al., 2003).

Leisure activity engagement may bestow similar protective benefits that both education and occupational attainment are suggested to foster (Fratiglioni et al., 2004; Scarmeas et al., 2001; Sobral & Paúl, 2013; Verghese et al., 2003). Of note, some research has argued that leisure activities might explain CR variance that was previously thought to be explained by education (Jonaitis et al., 2013), supporting its position as a CR factor. Further support has been found in studies that reported positive findings attributed to leisure activities after controlling for education (Fratiglioni et al., 2004; Lindstrom et al., 2005; Verghese et al., 2003; Wilson et al., 2002). In addition, compared to occupational attainment and educational attainment, may be a more modifiable lifestyle factor during later life. When aging adults want to promote cognitive functioning, increasing their educational or occupational attainment might not be an option, whereas participation in leisure activities is an option. Even leisure activity participation that began in middle- to late-life has been found to be beneficial for cognitive functioning (Esiri & Chance, 2012; Krell-Roesch et al., 2017; Park et al., 2019; Vemuri et al., 2014). Further, this benefit attributed to late-life participation in activities has been found to be present even after controlling for education, number of years worked, and age (Leung et al., 2011; Trieber., 2010).

Other CR Considerations

Anxiety and Depression. In addition to educational attainment, occupational attainment, and leisure activity participation, the relations between psychosocial factors, particularly anxiety and depression, and cognitive decline have been investigated in a CR framework (Esiri & Chance, 2012). Like leisure activities, anxiety and depression can often be modifiable factors that can change over time (Bomyea et al., 2015). Both anxiety and depression have been negatively associated with memory ability (Lukasik et al., 2019; Murphy & O'Leary, 2009) and positively associated with dementia risk (Burton et al., 2012; Diniz et al., 2013; Santabárbara et al., 2020). Research has looked at the relations between various memory domains and each of these psychosocial variables independently, finding a negative relation between anxiety and working memory (Lukasik et al., 2019), as well as a negative relation between depression and immediate memory (Evans et al., 1997), delayed memory (Christensen et al., 1997), verbal memory (Biringer et al., 2005), visual memory (Biringer et al., 2005; Murphy & O'Leary, 2009), and working memory (Christensen et al., 1997).

Regarding CR, recognizing and promptly treating depression or anxiety can lead to a reduced risk of developing dementia, which has been argued to be indicative of CR (Barnes & Yaffe, 2011; Esiri & Chance, 2012). Similarly, Evans et al. (2019) found that older individuals without depression or anxiety scored higher on a cognitive assessment and a measure of CR, compared to older individuals with depression or anxiety. Interestingly, both Geerlings et al. (1999) and O'Shea et al. (2014) found that the presence of depression in individuals with high educational attainment — which are thought to be individuals with higher CR as educational attainment is widely regarded as a CR factor (Aartsen et al., 2002) — displayed greater cognitive decline and greater mortality rates than people without depression. Thus, depression, and anxiety, could negatively affect cognition, so much so that even CR factors are not beneficial in reducing the risk of cognitive decline. Therefore, it is important to examine the avenue with which depression and anxiety affects cognitive ability.

How Anxiety and Depression Affect Cognitive Ability. When considering how anxiety and depression might affect cognitive ability, two key explanations have been proposed.

Social Isolation. Anxiety and depression have been found to be positively related to social isolation (García-Peňa, 2013; Lukasik et al., 2019), and social isolation has been found to be negatively associated with cognitive functioning in numerous studies (DiNapoli et al., 2014; Lukasik et al., 2019; Shankar et al., 2013). Support for this explanation can be found in the CR theory, as social activity participation has been thought to build reserve due to its association with better cognitive ability (Bennett et al., 2006).

Effort and Attention. Past research has supported an explanation proposing that anxiety and depression reduces one's concentration and capacity due to internal distractions, a decrease in motivation, and a reduced amount of effort put into completing tasks (Hartlage et al., 1993; Robinson et al., 2013). These symptoms are in line with the DSM-5 criteria for both anxiety and depression, such as impaired concentration (American Psychiatric Association, 2013). Therefore, tasks that require more effort will display worse performance due to anxiety and depression (Hartlage et al., 1993; Maloney et al., 2014).

Memory Self-Efficacy (MSE)

The idea that depression causes amotivation in accomplishing tasks is similar to Bandura's self-efficacy theory, which refers to an individual's self-perception of their ability to organize and execute tasks under given conditions (Bandura, 1989, 1997; Mashinchi & Ravesloot, 2021). According to the self-efficacy theory, the self-efficacy beliefs result from both external (e.g., environmental/societal influences and beliefs such as stereotypes) and internal (e.g., biological, behavioral, and cognitive) factors (Bandura, 1997). Since past research has supported the correlation between self-efficacy on performance, Bandura hypothesized that those with low self-efficacy perform poorer on tasks, compared to those with higher self-efficacy (Bandura, 1989; Beaudoin & Desrichard, 2011). Numerous reasons for this difference have been hypothesized by Bandura, including less investment and commitment in tasks or goals; lower goal setting; a lack of effort, persistence, and motivation; and higher anxiety (Beaudoin & Desrichard, 2011; Lalitha & Aswartha Reddy, 2021).

The concept of memory self-efficacy (MSE), defined as the beliefs an individual holds about their memory ability, stems from Bandura's self-efficacy theory (Beaudoin & Desrichard, 2011; Hertzog et al., 1987). Similar to self-efficacy, depression has been negatively related with MSE scores (Cipolli et al., 1996; Sawin, 2021). Thus, a lack of confidence, and the presence of depression and anxiety, can play a key role in low levels of MSE. In addition to the internal and external factors described above, a third factor, previous memory performances, has also been proposed to affect MSE, as previous memory performances serve as a guide and predictor of future performance (Beaudoin & Desrichard, 2011). MSE is an important construct within metamemory that has been used to explain the cognitive decline that appears with aging (Beaudoin & Desrichard, 2011; Hertzog et al., 1987). MSE can be subdivided into two categories: global MSE and local MSE. Global MSE refers to beliefs about memory ability in a general sense, while local MSE refers to task-specific MSE (Beaudoin & Desrichard, 2011; Lachman, 1993).

Assessment of MSE

Judgments of Learning (JOLs). In line with the additional third factor proposed by Beaudoin and Desrichard (2011), one way to assess for MSE is through task-specific performance predictions, also referred to as judgments of learning (JOLs; Hertzog & Hulsch, 2000; Hertzog et al., 1990). More specifically, JOLs are item-level predictions of one's perceived confidence and ability to recall an item's task at a later time (e.g., "How confident are you that you will remember to buy milk on the way home from work?"; Hertzog & Hulsch, 2000).

With this definition, Hertzog et al. (1990) proposed that there are three key components that make up the foundation of a JOL: (a) global and local MSE, (b) an appraisal of the memory task, and (c) an unspecified set of cognitive processes that converts one's MSE into an estimate by mentally considering where one would fall on a bell curve distribution based on the task assessment. This definition is supported by a study by Meeks et al. (2007) which suggested that one's MSE may adjust how the individual approaches and performs a task. Given these foundational components, there can be three reasons for inaccurate performance predictions: (a) inaccurate global or local MSE, (b) inaccurate appraisal of the memory task, and (c) inaccurate estimation of one's MSE that was created by mentally considering where one would fall on a bell curve distribution.

Accuracy of JOLs. Speaking to the ways in which one's MSE can fluctuate, past research has reasoned that older adults should make more accurate predictions compared to younger adults because insight into cognitive ability, limits, and functioning increase over the lifespan (Kuhn, 2000; Irak & Çapan, 2018). Despite this, there is great discrepancy in the literature regarding the accuracy of JOLs for both older and younger adults. As noted in the literature, MSE might affect performance predictions more for older adults than for younger adults (Pearman & Trujillo, 2013; Serra et al., 2008). Serra et al. (2008) found that older adults are underconfident in their memory predictions, while Pearman and Trujillo (2013) found that older adults were not alone in their underconfident memory predictions, as younger adults were also underconfident. In sum, individuals, particularly older adults, are inconsistent in their memory predictions (Cauvin et al., 2019).

Evidence of MSE on Cognitive Functioning

Similar to the appeal of leisure activities as a malleable factor that can influence one's CR, one's MSE can be malleable and can influence cognitive ability in different domains (Hess & Hinson, 2006).

Memory Ability. MSE has been found to be positively related to memory task performance for older adults, such that higher MSE is associated with better memory performance (Lalitha & Aswartha Reddy, 2021; Pearman & Trujillo, 2013; Sawin, 2021). A study by de Oliveira et al. (2015) found that memory predictions were positively related to immediate memory, and this relation was not influenced by sociodemographic variables. The positive relation between MSE and memory performance has been echoed when both laboratory and simulated-naturalistic memory tasks were used (Turvey et al., 2000; West et al., 1996).

Executive Functioning. Compared to research examining memory ability and MSE, little to no studies have directly examined MSE in relation to executive functioning. Mäntylä et al. (2010) conducted a study with both young adults and middle-aged adults and found that executive functioning ability was positively related to perceived memory ability. Zahodne et al. (2015) examined self-efficacy beliefs in relation to educational attainment and several cognitive domains, including executive functioning (e.g., attention, inhibition abilities), in a nationally representative adult sample. Higher self-efficacy beliefs were positively associated with executive functioning. Additionally, interaction analyses revealed that individuals with low educational attainment, but high self-efficacy beliefs, performed similarly to those with high educational attainment and high self-efficacy on executive functioning tasks, illustrating that self-efficacy beliefs can buffer against the negative effects low educational attainment can have on executive functioning, given that low educational attainment was independently found to be related to worse cognitive functioning.

Working Memory. Working memory is defined as the ability to actively hold and manipulate information for a brief amount of time (Miyake & Shah, 1999). Working memory has been described as both a construct of memory and executive functioning (Cowan, 2008; McCabe et al., 2010) and has been distinguished from the construct of short-term memory due to its executive functioning feature of information manipulation, such as reordering numbers or completing mathematical problems (Aben et al., 2012). Working memory has been measured in multiple ways, such as with mental arithmetic or digit span tasks (Wechsler, 2008).

Despite past research exploring the relations between MSE and memory ability, and MSE and executive functioning, little research has examined the relations between MSE and working memory, specifically. Hoffman and Schraw (2007) investigated the influence of self-efficacy beliefs and working memory capacity on mathematical problem-solving performance, response time, and efficiency, and found that self-efficacy was beneficial as demands on working memory increased. These findings proposed that one's ability to efficiently and strategically solve problems increased with self-efficacy. However, this appears to be the only study investigating the relations between MSE and working memory. When MSE and working memory have been investigated in the same study, they are typically both predictor variables of performance, and the relations between the two of them are not examined (Zamani & Pouratashi, 2018).

Pilot Data

Pilot data was collected for this study by Mashinchi and Ravesloot (2021), which examined the relations between MSE, working memory, and community participation. Results from 203 participants revealed that MSE was positively related to working memory ability and engagement in the community. However, this pilot data did not examine the relation between working memory and MSE role in concert with existing CR factors, and thus, cannot speak to MSE's role within the CR framework.

Present Study

In addition to the fact that relations between MSE and working memory are understudied, additional gaps in the literature are apparent. Although there is existing literature examining CR and memory performance and MSE and memory performance, no study has examined these concepts (CR and MSE) in relation with one another. A study by Simon and Schmitter-Edgecombe (2016) examined both CR and MSE in independent models when examining the relation between memory performance and the use of compensatory strategies, but did not examine how MSE can be related to CR. In addition, Simon and Schmitter-Edgecombe did not use leisure activity participation or occupational attainment as factors of CR. Thus, by the author's knowledge, no study has examined MSE within the CR framework.

The present study sought to fill this gap in the literature by constructing a hierarchical regression to analyze if MSE explains variance over and above the existing CR factors. Two hypotheses are as follows:

1. MSE will explain statistically significant variance in working memory ability in a regression analysis in concert with existing CR factors (i.e., educational attainment, occupational attainment, and leisure activity participation), after controlling for age, depression, and generalized anxiety.
2. MSE will explain statistically significant variance in working memory ability over and above existing CR factors (e.g., educational attainment, occupational

attainment, and leisure activity participation) in a hierarchical regression analysis, after controlling for age, depression, and generalized anxiety.

Method

Participants

The first twenty-eight recruited participants were used as pilot data, and small changes to the Qualtrics survey form were made based on their results (e.g., wording, typos). These twenty-eight participants were not included in the final analysis. After pilot testing, three hundred and seventy-eight potential participants logged in to the study. Thirty-two potential participants did not go past the consent form. One hundred and eight participants were excluded from the final analysis because more than 5% of their data were missing. Thirty-four participants were removed because they were under 55 years old. Seven participants were removed from the analysis due to poor data quality, as indicated by these participants failing an attention check and from random responding. Although some participants indicated that they were experiencing effects from a mood/psychiatric condition, a medical condition, or were previously unconscious and sought treatment, these participants were included to increase the external validity of the study and to speak to the wide range of individuals that make up the older adult population. Thus, the final sample was made up of 197 United States residents age 55 or older.

Participants were recruited through Amazon MTurk, an online survey platform, and were required to have a HIT rate of 95% or greater, indicating strong work quality. A $0.57 monetary incentive was given to participants in exchange for their time. A post-hoc power analysis determined this sample yielded an actual power of .99 with the ability to reject the null hypothesis if an effect size of .15 was found. This effect size was chosen based on the results from the pilot data, and to ensure a small effect size would be able to be detected (Mashinchi et al., 2021).

Design

Seven predictor variables were used in the hierarchical regression analysis to address Hypothesis 1 and 2. These variables were: age, occupational attainment, educational attainment, leisure activity participation, depression levels, anxiety levels, and MSE. Step 1 of the regression includes age, depression, and anxiety as the predictor variables. Step 2 of the regression includes age, depression, anxiety, educational attainment, occupational attainment, and leisure activity participation as the predictor variables. Step 3 includes age, depression, anxiety, educational attainment, occupational attainment, leisure activity participation, and MSE as the predictor variables. The dependent variable was working memory ability, which was operationally defined by the total digit span task score (a combined score of forward, backwards, and sequencing).

To examine which variables predicted MSE, a multiple linear regression was conducted. Predictor variables included anxiety, depression, age, educational attainment, occupational attainment, and leisure activity participation. The dependent variable was MSE.

Assessments and Measures

Methodology for this study was inspired by Mashinchi and Ravesloot (2021) and Mashinchi et al. (2021), which served as pilot studies for this dissertation.

Demographics

Demographic information regarding age, gender, race, ethnicity, socioeconomic status, disability status, and health status was collected from each participant. Participants were provided a text box to self-report their age, gender, race, and ethnicity. To assess socioeconomic status, participants were asked, “Thinking about your life overall, which of the following best describes your yearly total household income before taxes?" and were provided an ordinal scale for their answer (see Table 2 for options).

To assess disability status, participants completed Washington Group Short Set of Questions on Disability (Center for Disease Control and Prevention [CDC], 2015) which queries any difficulty with seeing, hearing, walking, remembering/concentrating, communicating, and/or completing self-care tasks. The present study analyzed the data for the remembering/concentrating and completing self-care tasks items because they measure cognition and overall functioning, respectively (CDC, 2015).

In addition, participants were asked to indicate if they had noticed their ability to remember things had changed over the years (yes/no). Further, participants completed a measure that inquired health history and asked participants if they had been diagnosed with a serious medical condition (e.g., diabetes, lupus, cancer), a neurological condition (seizures, epilepsy, stroke), a psychiatric/mood condition, a substance use disorder, and if they were currently experiencing effects from these conditions using a yes/no answer option. Additionally, participants were asked if they had ever been knocked unconscious and if they were treated by a medical professional for this unconscious event.

Depression

All participants were asked to complete the Patient Health Questionnaire-Eight-Item (PHQ-8; Kroenke et al., 2009), which assessed their experience of depression. The PHQ-8 asks participants to indicate the frequency with which they experienced several depressive symptoms (e.g., feeling down or hopeless, experiencing little interest or pleasure in doing things) within the two weeks prior to completing the survey. Participants indicated their experience using a 4-point frequency scale, where 0 = not at all and 3 = nearly every day. Thus, a total PHQ-8 score ranges from 0-24, with scores greater than or equal to 10 indicating the respondent is experiencing a probable major depressive episode. As illustrated in a validity study by Kroenke and Spitzer (2002), a score greater than or equal to 10 had a sensitivity of 99% and a specificity of 92% for a major depressive episode.

Anxiety

All participants were asked to complete the Generalized Anxiety Disorder-Seven-Item (GAD-7; Spitzer et al., 2006), which assessed their experience of anxiety. The GAD-7 asks participants to indicate the frequency with which they have experienced several anxiety symptoms (e.g., feeling nervous, not being able to stop or control their worrying) within the two weeks prior to completing the survey, using a 4-point frequency scale, ranging from 0 = not at all to 3 = nearly every day. Thus, a total GAD-7 score ranges from 0-21, with a score greater than or equal to 10 indicating a possible experience of generalized anxiety. A score greater than or equal to 10 on the GAD-7 has demonstrated strong specificity (82%) and sensitivity (89%) for a diagnosis of generalized anxiety disorder (Spitzer et al., 2006).

Leisure Activity Participation

All participants were asked to indicate their participation in leisure activities. Examples of cognitive (e.g., reading, doing puzzles, doing art projects), social (e.g., having dinner or spending time with friends), and physical leisure activities (e.g., walking, hiking, playing golf) were provided for participants, but participants were asked to report any activity that they considered to be a leisure activity, even if it was not listed in the example. In a text box, participants were asked to write the total number of leisure activities they engage in on a regular basis (e.g., a given month). These data were then converted to a scaled variable with 0 =

participating in none of the areas, 1 = participating in one of the areas, 2 = participating in two of the areas, and 3 = participating in all three of the areas.

Educational Attainment

Participants were asked to indicate their highest level of education using the following 10-point ordinal scale: middle school or less = 1, less than high school = 2, high school/GED = 3; some college or technical training = 4, associate or technical degree = 5, bachelor's degree = 6, bachelor's degree plus other courses, but not enough to qualify for a master's degree = 7; master's degree = 8; master's degree plus other courses, but not enough to qualify for a doctorate degree = 9; doctorate degree = 10.

Occupational Attainment

All participants were asked to think about their primary life occupation and indicate their occupational attainment using the following 4-point ordinal scale, inspired from the Oklahoma Premorbid Intelligence Estimate (Scott et al., 1996): unemployed = 1, foreman, laborer, farmer, or service occupation = 2, clerical/sales occupation = 3; professional, technical, administrative, or managerial occupation = 4. Asking participants to think about their primary life occupation allowed them to participate even if they were retired.

Memory Self-Efficacy (MSE)

In line with Beaudoin and Desrichard's (2011) suggestion that MSE can be assessed through performance prediction JOLs, the present study asked participants to indicate their MSE on twelve items that pertained to the working memory task participants were asked to complete: 4 MSE items for digit span forward, 4 items for digit span backward, and 4 items for digit span sequencing (see Table 1). These items were completed before participants were presented with the working memory task. This MSE assessment was inspired by the Memory Self-Efficacy

Questionnaire (Berry et al., 1989) and has similar psychometric properties to the MSE assessment used in Mashinchi and Ravesloot (2021). The present study found that this MSE measure was highly reliable ($\alpha = .95$), with alpha levels for each of the conditions as follows: forward ($\alpha = .85$), backward ($\alpha = .86$), and sequencing (.90). See Table 1 for the MSE measure.

Similar to the Memory Self-Efficacy Questionnaire, MSE was assessed by asking participants if they can perform the task with a binary 'yes' or 'no' answer option. If yes was indicated, participants were asked to rate their confidence ranging from 10% to 100% confidence in ten-unit increments. MSE scores for the present study were calculated by summing the number of 'yes' responses that were made with at least 20% confidence, a procedure identical to Berry et al. (1989). Thus, MSE scores ranged from 0 to 12. Mean MSE scores and mean confidence ratings for each item are provided in Table 1.

Working Memory Ability

To measure working memory ability, the present study used a digit span task. This digit span task was similar to the Wechsler Adult Intelligence Scale - Fourth Edition Working Memory Index (WAIS-IV; Wechsler, 2008). In the present study, the digit strings presented to participants differed from the digit strings used in the WAIS-IV, but the procedure was similar. The digits for this study's task were presented on screen, making this a visual working memory task, whereas the WAIS-IV's Digit Span Task is a verbal memory task.

Mashinchi et al. (2021), which served as pilot data for this study, sought to examine if the performance from the online digit span measure differed from the WAIS-IV's Digit Span normative data, which was collected in-person. Results were based on 159 participants and indicated that digit span scores did not differ for the 65-69 or 70-75 age range. There were not enough participants to make comparisons for the 75 - 79 or 80 - 85 age ranges. The 55- 59 age range scored poorer on the online digit span task compared to the WAIS-IV normative data, although this is hypothesized to be due to a methodological issue, as participants were asked to type a space in between each number of their digit string, which might have been confusing or might have taxed the working memory ability for some participants. The present study will build from this measure to not include these unnecessary and confusing instructions.

In the present study, participants were asked to remember a set of numbers under three varied conditions: forward, backward, and sequencing. In the first condition, digit span forward, participants were instructed to recall the numbers in the same order in which they were presented. In the second condition, digit span backward, participants were instructed to recall the numbers in the reverse order in which they were presented (e.g., if presented 2-3, asked to recall it as 3-2). In the third condition, digit span sequencing, participants were asked to recall the digits presented in order from least to greatest in value (e.g., if presented 4-1-8, asked to recall it as 1-4-8).

The string of numbers was presented one-by-one in the middle of the screen for one second. The numbers and timing were programmed to auto-advance on the screen by a timer feature. Once all digits of a string were presented, the screen changed to include a text box in which participants were instructed to type in each number. The text box was programmed to recognize the correct answer. If correct, participants auto-advanced to a second trial with the same amount of digit strings. If correct again, participants auto-advanced to a digit string with an additional digit included. If participants were incorrect in the first trial, they still auto-advanced to a second trial with the same amount of digit strings. However, if the first trial was incorrect, and the second trial was incorrect, then participants auto-advanced to the next condition (e.g., backward). Scores were summed automatically by the software. Total digit span scores could range from 0-48, with each condition's score ranging from 0-16.

Procedure

The Institutional Review Board at the University of Montana approved this study prior to data collection. Data were collected online using a Qualtrics-based survey that was then posted on MTurk, an online platform for data collection. First, participants reviewed the informed consent and provided written consent to participating in the study. Once consent was given, all participants completed the MSE questionnaire. Next, all participants completed the working memory task. Then, participants completed the demographics questionnaire that included the health history survey and the disability status survey, followed by the PHQ-8 and the GAD-7. Participants then completed a short survey about community participation as part of an outside study. Finally, they received a debriefing form, outlining the purpose of the study. They then received a numerical code, which could be entered into MTurk to award the monetary incentive for their participation.

Results

Participants

Participants' ages ranged from 55 to 84 years (M = 66.26, SD = 5.99) and were predominantly female (73%) and Caucasian (89%). Fifty-two percent of participants had an education greater than a bachelor's degree. Eighty percent of participants reported that they noticed that their ability to remember things had changed over the years. Eighty-nine percent of participants reported that they did not have difficulty completing self-care tasks, while 55% of participants reported that they did not have difficulty remembering or concentrating. Fifteen percent of participants indicated a potential diagnosis of anxiety from the GAD-7 screener, while fifteen percent of participants indicated a potential diagnosis of depression from the PHQ-8 screener. See Table 2 for the full demographic statistics of the sample.

Assumption Checks

The assumptions of linearity, normally distributed errors, and uncorrelated errors were assessed for all variables. In accordance with Fox (2016), skewness values that were greater than an absolute value of 1 were transformed. This led to the following 4 variables being transformed using a log transformation: depression, anxiety, occupational attainment, and leisure activity participation. The transformed variables are what were used in the final analysis. After being transformed, all skewness values were less than 1, with the exception of the value for leisure activity participation (-1.887). Thus, these data for these analyses deviate somewhat from a normal distribution, warranting a degree of caution for interpreting the significance of inferential test statistics.

Additionally, a collinearity analysis was conducted to examine any problematic correlations between predictor variables. In accordance with Denis (2016), which stated that a VIF score of 10 suggests that a study's parameter β was not being precisely estimated due to a large standard error, the present study used a VIF cutoff score of 10. VIF scores for all variables passed this cutoff before (all VIFs < 3.27) and after the transformation of skewed variables (all VIFs < 2.73) for both regression analyses.

Hypothesis Tests

A bivariate Pearson r correlation matrix was created to examine the relations between variables. MSE was strongly related to working memory ability ($r = .40$, $p < .001$). Working memory ability was negatively correlated to depression ($r = -.20$, $p = .005$) and anxiety ($r = -.21$, $p = .003$). Further, occupational attainment was positively related to both educational attainment

(r = .30, p < .001), and negatively related to depression (r = .17, p = .02). Depression was strongly related to anxiety (r = .79, p < .001). All other correlations were not statistically significant (ps > .05). See Table 3 for the full correlation matrix.

To address Hypotheses 1 and 2, a hierarchical linear regression was conducted to investigate how well MSE predicted working memory ability after controlling for age, depression, and anxiety.

Step 1 of the model included age, anxiety, and depression as predictors. Step 2 included age, anxiety, depression, educational attainment, occupational attainment, and leisure activity participation as predictors, with a significant F change indicating that the inclusion of the predictors educational attainment, occupational attainment, and leisure activity participation explained variance over and above the predictors age, anxiety, and depression in Step 1. Step 3 included age, anxiety, depression, educational attainment, occupational attainment, leisure activity participation, and MSE, with a significant F change indicating that the inclusion of the predictor MSE in Step 3 explained variance over and above the predictors age, anxiety, depression, educational attainment, occupational attainment, and leisure activity participation in Step 2. See Table 4 and for a visual representation of the hierarchical regression. Means and standard deviations are presented in Table 2.

Step 1 of the model was statistically significant and revealed that age, anxiety, and depression accounted for 5.1% of the variance in working memory performance, $F(3, 190)$ = 3.41, p = .02, adjusted R^2 = .04. The beta weights and significance values, presented in Table 4, indicate which variables contributed most to predicting working memory performance when age, anxiety, and depression were entered together as predictors. With this combination of predictors, none of the predictor variables contributed to predicting working memory performance at a statistically significant level.

Step 2 of the model was not statistically significant, R^2 change = .01, $F(3, 187) = 0.70$, $p = .56$, adjusted $R^2 = .03$, as 1% of additional variance was accounted for by educational attainment, occupational attainment, and leisure activity participation. Further, the entire group of variables at Step 2 did not predict working memory performance at a statistically significant rate, $F(6, 187) = 2.05$, $p = .06$.

The addition of MSE in Step 3 improved the model, R^2 change = .17, $F(1, 186) = 40.70$, $p < .001$. Similarly, the entire group of variables at Step 3 accounted for a significant amount of variance in working memory performance, $F(7, 186) = 7.94$, $p < .001$, adjusted $R^2 = .20$, as 17% additional variance was accounted for by MSE. With this combination of predictors, MSE ($\beta = .42$, $p < .001$) was the only variable that contributed to predicting working memory performance at a statistically significant level (see Table 4).

Inspection of a correlational matrix of the variables (see Table 3) did not warrant a mediation analysis.

Exploratory Tests

To examine which variables predicted MSE, an exploratory multiple linear regression was conducted. The entire group of variables did not account for a significant amount of variance in MSE, $F(6, 187) = 0.87$, $p = .52$, $R^2 = .03$, adjusted $R^2 = -.004$. With this combination of predictors, none of the predictors contributed to predicting MSE at a statistically significant level (see Table 5).

Inspection of a correlational matrix of the variables (see Table 3) did not warrant a mediation analysis.

Discussion

Findings

The average performance on the digit span working memory task was 32.17 (*SD* = 7.94). This performance was above average, compared to the normed WAIS-IV data (Wechsler, 2008). Thus, it appears that our study's participants performed at a rate that was above average, compared to other same-age peers. Further, examining the distribution of MSE from the MSE questionnaire revealed that on average, participants felt more confident at completing digit span tasks with a shorter digit string, compared to a task with a longer digit string. This finding was expected. Further, of those that reported that they could complete the task for the longest digit strings in each digit span conditions, they rated their ability with high confidence (90-100%). Thus, it appears that if an individual felt they could complete the more difficult digit span tasks, then they also felt very confident that they could do so.

Consistent with the first hypothesis, MSE was positively related to and explained statistically significant variance in working memory ability when examined in concert with existing CR factors (e.g., educational attainment, occupational attainment, and leisure activity participation) and after controlling for age, depression, and anxiety. In fact, MSE was the only variable that explained this variance. Not only did it explain this variance, but it explained a large portion of this variance, as indicated by the beta value ($\beta = .42$). This finding is both novel and important, as this is the first time MSE has been examined in relation to working memory ability. Further, the present study was the first to revise an existing MSE measure to better capture MSE related to working memory ability. The present study, and its adaption to the MSE measure, illustrates the importance of the relation between one's subjective belief in their working memory ability and their objective working memory performance, and supports past literature that found a positive relation between subjective beliefs and objective performance in a healthy older adult sample (Mäntylä et al., 2010; Pearman & Trujillo, 2013; Lalitha & Aswartha Reddy, 2021; Sawin, 2021; Zahodne et al., 2015). The findings of the present study also further support for Bandura's self-efficacy theory (Bandura, 1989; Bandura, 1997). Given that Bandura's self-efficacy theory had not been examined in relation to working memory ability, the present study's novelty can contribute to this gap in the literature.

Consistent with the second hypothesis, MSE explained statistically significant variance in working memory performance over and above existing CR factors (e.g., educational attainment, occupational attainment, and leisure activity participation) in a hierarchical regression analysis, after controlling for age, depression, and anxiety. In fact, MSE was the only variable in the complete model that achieved statistical significance. It was surprising that none of the existing CR factors explained variance in working memory ability, as suggested by the overwhelming support of these factors in the CR literature. It is possible that this was due to the homogeneity of the sample, which made it difficult to detect differences among educational attainment, occupational attainment, and leisure activity participation. It is also possible that this was due to errors in collecting the leisure activity participation data, which is discussed in detail in the Limitations and Suggestions for Future Research section below. Additionally, the findings might support other research reporting nonsignificant relations between CR factors (i.e., educational attainment, occupational attainment, leisure activity participation), and cognitive functioning (Aartsen et al., 2002; Boyle et al., 2021; Iwasa et al., 2012; Miech et al., 2002; Suemoto et al., 2022). The present study's findings illustrate that MSE explains a large, unique portion of variance that is not explained by factors commonly thought to explain memory ability. The present study's results can serve as a key first step in supporting MSE's role within the CR framework and could potentially illustrate that the CR literature has neglected to identify a key factor, MSE, that can help to explain working memory ability.

Given that this is the first study that has examined memory self-efficacy (MSE) in concert with CR factors, it is hard to pin down a definitive definition of how MSE fits into a cognitive reserve framework. The literature appears to be mixed in the use of the term "cognitive reserve." Some research (Stern, 2013) takes a very narrow approach to the term "cognitive reserve" that can be thought of as a literal "reserve", in which lifelong factors (e.g., educational attainment) build up benefits that are later used when the brain is vulnerable to the risk of neurological changes due to injury or age-related changes. Other researchers take a broader perspective on the term "cognitive reserve", and describe any factor that has been shown to improve cognitive functioning in older adults as a cognitive reserve factor. More recent literature leans towards late-life interventions, such as learning new skills, which have been found to be beneficial for cognitive ability in older adults (Esiri & Chance, 2012; Krell-Roesch et al., 2011; Park et al., 2019; Venmuri et al., 2017). Thus, there is no consensus about the limits to what is included as "cognitive reserve" in the literature, leaving room for interpretation.

Within the narrower interpretation of the definition of cognitive reserve might be an argument that interventions, such as treatment of depression (Esiri & Chance, 2012), should not be considered cognitive reserve factors, but instead could be considered as beneficial to cognition within a cognitive reserve framework. Within this framework viewpoint, cognitive reserve factors is a term reserved for factors such as educational attainment that might build a reserve, while the term "within a cognitive reserve framework" removes more indirect factors, such as depression treatment, by a degree, but also acknowledges how it is in the same spirit in being beneficial to cognition. Given this consideration, the present study's manuscript will change this wording to reflect how MSE might be considered within a cognitive reserve framework, which appears to be more appropriate given the lack of knowledge about the relation between cognitive reserve and MSE. The position I took in the dissertation is how MSE and depression are related, which served as a basis for introducing MSE in the context of cognitive reserve.

Further, although MSE can be considered transient, MSE beliefs are not necessarily created in a moment-by-moment event, and instead can be thought to be beliefs developed over time. The role of stereotypes on beliefs can directly apply to MSE. For example, if a young child is told that older adults have poor memory due to their age, and this belief continues to be reinforced throughout life due to societal stereotypes, this belief is one that has been developed over time. At the time this child becomes an older adult, these beliefs might be well-instilled, and could affect their performance predictions in participating in a study identical to the present study. Similar to depression and its argument for being considered within the cognitive reserve framework, MSE can be modifiable, and can have an impact on cognitive performance due to doubt, less investment in tasks, and amotivation (Beaudoin & Desrichard, 2011).

In sum, the different approaches taken by the two different perspectives illustrate the openness to interpretation that is found in the current cognitive reserve literature. More narrowly, it is specifically a reserve that is gathered throughout time and aids in the ability to cope in the face of neurological changes. More broadly, it is any factor or skill that can promote cognitive functioning and reduce the risk of cognitive decline. Overall, these findings suggest that one's subjective beliefs are a key variable to consider when examining working memory ability. This result can greatly add to researchers' understanding of important contributors to working memory ability in an older adult population. MSE is a factor that should be considered when working memory is examined in an aging population given that a) working memory is a domain used frequently in everyday life (e.g., remembering a phone number, staying on task, and remembering multi-step directions to a location or to a recipe; Cowan, 2014), b) working memory ability is thought to diminish with age (Klencklen et al., 2017), and c) the strength of the present study's findings.

Additionally, these findings might also indirectly provide support for the age stereotype threat literature, which argues that negative societal stereotypes about age can interfere with an individual's ability to perform to their normal standard, a phenomenon known as stereotype threat (Steele & Aronson, 1995). In line with Bandura's self-efficacy theory and the age stereotype threat literature, low MSE might stem from one internalizing external, negative societal stereotypes about age from Western cultures (Hess, 2005; Inzlicht & Schmader, 2012; McDonald-Miszczak et al., 1999). Inzlicht and Schmader (2012) noted that those with low MSE are more negatively impacted by stereotype threat compared to those with high MSE, illustrating that MSE moderates age-related stereotype threat. This moderation is thought to be due to the characteristics that Bandura hypothesized are attributes of those with low self-efficacy: less investment in the tasks; lower expectations in task performance; less effort, persistence, and motivation; lower goals set (Beaudoin & Desrichard, 2011; Desrichard & Kopetz, 2005; Inzlicht & Schmader, 2012). It is possible that the present study can serve as a link in understanding the effects age-related stereotype threat can have on the older adult population.

Moreover, because MSE is a changeable factor, our findings provide support for another changeable factor that can be related to one's memory ability, and which can be improved at any age. These findings suggest that interventions that work to increasing MSE might also increase working memory ability, and vice versa. Possible intervention strategies might include exploring one's awareness of stereotype threat by analyzing how much an individual has bought into negative age-related stereotypes prominent in society. Further, other interventions include psychoeducation about a) normal age-related changes in memory compared to abnormal age-related changes in memory ability, such as dementia, and b) the neuropathological processes of working memory, such as the limits of working memory and how to increase one's working memory capacity. From these psychoeducation interventions, another intervention regarding the practice of the use of compensatory strategies (e.g., a calendar, a notebook, alarms) can help one to remember to carry out tasks. Additionally, brochures, workshops, or lectures designed to disseminate findings about the correlation between memory ability and healthy aging factors — such as diet, social support, and sleep patterns — can help aging individuals better understand the factors that might affect their memory functioning. Similarly, psychoeducation interventions that focus on the relation between memory and external health factors — such as stress, anxiety, depression, and other health issues — can also educate and motivate individuals to modify their lifestyle to increase their memory ability, such as by reducing stressors or seeking psychotherapy.

Based on these findings and these recommended interventions, it is recommended that neuropsychologists consider including a measure of MSE if a patient's working memory ability is deficit. If one's working memory performance is low, and their MSE is also low, addressing the low MSE with interventions in effort to increase it, such as psychoeducation about stereotype threat and normal age-related changes, might reveal increases in working memory ability in the future. Other interventions that both researchers and neuropsychologists might wish to consider is using the TOMM, which is a performance based-validity effort test that is disguised as a memory test, as an easy memory test to build up MSE before completing more difficult tasks.

Another similar option is to use an errorless learning intervention, in which the difficulty level of a test is designed so that a participant learns the skills necessary for a task in a positively-reinforcing way, so that they do not resort to completing the task with trial-and-error or random responding (Medalia, 2002). In this way, an errorless learning intervention can help a participant learn how to complete a memory task in a way that can build their MSE. Given that there are few modifiable factors identified in the literature, this finding is of great importance.

Finally, the exploratory analysis revealed that the predictor variables did not explain MSE variance at a statistically significant level. This was surprising, given that Bandura's self-efficacy theory suggests similarities between depression and anxiety's symptoms of amotivation to complete a task, greater anxiety when completing a task, and impaired concentration (Bandura, 1997; Beaudoin & Desrichard, 2011; Lalitha & Aswartha Reddy, 2021). The present study's findings also contrasted with Cipolli et al. (1996) and Sawin (2021) who found that depression has been negatively related with MSE scores. These results might suggest that there are other factors to consider when examining MSE, such as stereotype threat, which was not a variable examined in the present study.

Limitations and Suggestions for Future Research

The present study was subject to four primary limitations: 1) a lack of diversity in the sample, 2) recruiting participants via MTurk, 3) survey formatting, and 4) study formatting.

Speaking to the first limitation, despite choosing to recruit through MTurk to increase the diversity of participants compared to data collection in Montana, most participants identified as female (66.8%), Caucasian (65.6%), and achieved higher than a high school education (91.5%). Additionally, 15% of the sample indicated a potential positive diagnosis of generalized anxiety disorder and 15% indicated a potential positive diagnosis of major depressive disorder. This is slightly lower than the amount of age 55+ adults that have reportedly been diagnosed with a mental health disorder (20%; World Health Organization, 2017). This difference might illustrate that our sample was not indicative of the broader older adult population.

This lack of variation could decrease the external validity of this study's findings. Future research should retest these hypotheses with a larger and more diverse sample to increase the ability to generalize results. Additionally, future research should conduct cross-cultural research to examine if the cultural/societal beliefs (e.g., Western cultures such as the United States compared to Eastern cultures such as China) regarding older age influence MSE. Some cultures, such as Eastern cultures, believe that with age comes increased wisdom and regard in society, which greatly contrasts with the belief some Western cultures hold that older adults are a burden due to their increasing care needs.

Second, the sample for the present study was collected through an online survey platform. Although this did help to protect participants' health and well-being during the COVID-19 pandemic, the choice to recruit participants in this way affects the external validity of the findings, as some older adults might not be represented through this collection method. The present study should be replicated using in-person data collection to address the concern that the data could have low external validity due to its online characteristic. In addition, due to the online survey software, a smaller range in age could not be designated, and individuals who might not be considered as "older adults" (e.g., those age 55 - 65) were included. Future research should replicate this study with a smaller range of ages and examine possible changes that can occur in different age ranges (e.g., compare 55 - 65-year-old individuals with those age 85 - 95).

It is also important to note that 108 participants were excluded because they did not complete the entire survey, which might reflect a limitation of the length of the survey.

Additionally, 34 participants were excluded because their reported age was younger than 55. Although a MTurk filter was used to ensure that only participants ages 55 and older were able to access the study, it is possible that some participants have found ways to program a bypass to the filter to complete the survey for the monetary incentive. Thus, it is recommended that future research using MTurk plan to recruit almost double the participants that an a priori power analysis suggests are needed for the study and take time to screen data for completion and quality, as suggested by Chmielewski and Kucker (2019).

Third, despite no indications of issues in the pilot data collected at the beginning of this study, there appeared to be confusion from participants about what to enter in the empty for race and ethnicity. Although the researcher chose a text box in order to not confine participants' indication of their identity in a multiple-choice question, the confusion limited the present study's ability to get accurate estimates of participants' racial and ethnic identities. For example, some participants typed in "USA" and for ethnicity, some participants typed in answers that would better identify as race (e.g., "White"). One alternative to address this limitation in future studies would be to provide options for participants to choose from, as well as a text box to provide an opportunity to write in the option that feels most accurate to their identity.

Similarly, this also appeared to be an issue for the item asking about leisure activity participation. Again, despite no indication of issues in the pilot data collected at the beginning of the study, some participants interpreted the question to ask for the amount of time spent doing the activities or a ratio (e.g., 40% completing social activities, 40% completing cognitive activities, 10% completing physical activities), compared to the number of activities. This issue might be a reason why the CR factors surprisingly did not yield significant results in Steps 2 or 3 in the model. Thus, this limitation leaves the question about leisure activity participation's role in a model with MSE to remain open and not fully answered. Future research should replicate the study with adjustments to the question wording and answer options for these questions to get a more accurate depiction of participants' experience.

Moreover, there appeared to be a survey-software error in the skip logic for the demographic data. The survey software was programmed to skip a follow-up question (e.g., "if you answered yes above…") if participants indicated "no." However, an error in the software skipped the follow-up question for some, but also caused some of the individuals that indicated "no" to still see the follow-up question. Additionally, for one follow-up item that asked about whether an individual who endured an unconscious episode was treated by a professional, some of the individuals who indicated "yes" were not taken to the follow-up question. Thus, the reported number of individuals that saw the follow-up questions asking about the experience of current effects due to a history of a serious illness, mood/psychiatric condition, and unconscious episode do not match the number of individuals that indicated "yes" on the initial question. Future researchers using Qualtrics should consult with a support team to ensure this error does not happen in future data collection.

Finally, although Digit Span utilizes two trials per digit string amount, the MSE questionnaire only allowed participants to answer based on one trial opportunity. Future research should include items that ask about participants' ability and confidence on a second trial opportunity. Additionally, to better allow the present study's MSE measure a measure of working memory MSE, future research should revise the wording of the MSE measure items to say the following: "If I was briefly shown a string of 3 numbers (e.g., 2-4-8), I could remember and repeat all the numbers in the same order they appeared immediately after seeing them." By implementing this change in wording, the item clarifies the immediate time frame in which participants will be asked to recall the digit string, which better encompasses the nature of a working memory task. Additionally, using a less verbally-loaded task might be able to speak to the relation between working memory and MSE in a population such as those with dyslexia. Further, future research is encouraged to examine the differences between using a 20% confidence cut-off score for the MSE scoring criteria compared to using a higher value of confidence (e.g., 50%, 80%, 90%). The present study also only used one working memory task as a measure of working memory ability. There are several other working memory tasks, such as the letter-number sequencing and arithmetic subtests on the WAIS-IV. One suggestion for future would be to examine the relation between MSE and an index score of working memory, which would be comprised of the scores from the combined performance on the digit span, arithmetic, and letter-number sequencing WAIS-IV subtests. In this way, working memory would not be measured by just one task, but by multiple tasks that have been found to measure into working memory (Wechsler, 2008).

Conclusion

The present study is the first to examine the relation between MSE and working memory in concert with existing variables that have been deemed to contribute to one's CR and reduce one's risk for dementia and/or prolong cognitive functioning in the face of existing cognitive decline. Findings indicate the important role that MSE might play in working memory ability. Further, this study can be used as initial evidence to support interventions, such as psychoeducation about age-related stereotype threat and normal age-related memory changes, that can work to increase MSE, and subsequently — as our study revealed — working memory ability. Additionally, the present study can act as a first step to examining and supporting the role of MSE within the CR framework, given the unique amount of variance that MSE explained to working memory variance that was not explained by the existing CR factors that the literature recognizes.

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Table 1

Memory Self-Efficacy Assessment Items

Condition	**Item**	**Yes Response Rate (Mean Confidence Percentage)**
Forward	If I was briefly shown a string of **3** numbers (e.g., 2-4-8), I could remember and repeat all the numbers in the same order they appeared.	195 (84.80%)
	If I was briefly shown a string of **5** numbers (e.g., 2-4-8), I could remember and repeat all the numbers in the same order they appeared.	161 (72.36%)
	If I was briefly shown a string of **7** numbers (e.g., 2-4-8), I could remember and repeat all the numbers in the same order they appeared.	106 (59.72%)
	If I was briefly shown a string of **9** numbers (e.g., 2-4-8), I could remember and repeat all the numbers in the same order they appeared.	48 (62.40%)
Backward	If I was briefly shown a string of **2** numbers, I could remember and repeat all the numbers in the **reverse** order that they appeared (e.g., if I see 1-4, I could remember it as 4-1).	197 (90.25%)
	If I was briefly shown a string of **4** numbers, I could remember and repeat all the numbers in the **reverse** order that they appeared (e.g., if I see 1-4, I could remember it as 4-1).	151 (75.96%)
	If I was briefly shown a string of **6** numbers, I could remember and repeat all the numbers in the **reverse** order that they appeared (e.g., if I see 1-4, I could remember it as 4-1).	77 (62.21%)
	If I was briefly shown a string of **8** numbers, I could remember and repeat all the numbers in the **reverse** order that they appeared (e.g., if I see 1-4, I could remember it as 4-1).	42 (62.14%)

<u>Sequencing</u>	If I was briefly shown a string of **3** numbers, I could remember and recall all the numbers in the order of **least in value to greatest in value**.	188 (82.77%)
	If I was briefly shown a string of **5** numbers, I could remember and recall all the numbers in the order of **least in value to greatest in value**.	116 (69.40%)
	If I was briefly shown a string of **7** numbers, I could remember and recall all the numbers in the order of **least in value to greatest in value**.	50 (62.40%)
	If I was briefly shown a string of **9** numbers, I could remember and recall all the numbers in the order of **least in value to greatest in value**.	37 (62.97%)

Table 2

Descriptive Statistics (N) of Participants and Measures

	N	M	SD	Min.	Max.
Age	195 (99.0%)	66.26	5.99	55.00	84.00
Gender	195 (99.0%)				
Male	51 (25.9%)				
Female	144 (73.1%)				
Ethnicity	194 (98.0%)				
Caucasian	173 (89.2%)				
African American	13 (6.7%)				
Other	8 (4.1%)				
Education	195 (99.0%)				
Middle school or less	0 (0.0%)				
Less than high school	2 (1.0%)				
High school/GED	16 (8.1%)				
Some college or technical training	42 (21.3%)				
Associate or technical degree	34 (17.3%)				
Bachelor’s degree	57 (28.9%)				
Bachelor’s degree +, < Master’s degree	11 (5.6%)				
Master’s degree	25 (12.7%)				
Master’s degree +, < Doctorate degree	3 (1.5%)				
Doctorate degree	5 (2.5%)				

Occupation	195 (99.0%)
Unemployed	21 (10.7%)
Foreman/laborer/farmer/service	8 (4.1%)
Clerical/sales	45 (22.8%)
Professional/technical/ administrative/managerial	121 (61.4%)
Leisure Activity Participation	194 (98.5%)
No	4 (2.0%)
One	6 (3.0%)
Two	30 (15.2%)
Three	154 (78.2%)
Socioeconomic Status (Household)	195 (99.0%)
Less than $25,000	23 (11.7%)
$25,000 - $34, 999	36 (18.3%)
$35,000 - $49,999	38 (19.3%)
$50,000 - $74, 999	46 (23.4%)
$75,000 - $99,999	25 (12.7%)
$100,000 - $149,999	22 (11.2%)
$150,000 or more	5 (2.5%)
History of Serious Illness	194 (98.5%)
Yes	57 (28.9%)
No	137 (69.5%)

Current Effects of Serious Illness (If Endorsed History of Serious Illness)	159 (80.7%)
Yes	34 (21.4%)
No	125 (78.6%)
Neurological Illness	194 (98.5%)
Yes	24 (12.2%)
No	170 (86.3%)
Mood/Psychiatric Conditions	192 (97.5%)
Yes	33 (16.8%)
No	159 (80.7%)
Current Effects from Mood/Psychiatric Condition (If Endorsed Mood/Psychiatric Condition)	153 (77.7%)
Yes	26 (17.0%)
No	127 (83.0%)
Memory Change	193 (98.0%)
Yes	157 (79.7%)
No	36 (18.3%)
History of Substance Use Disorder	193 (97.5%)
Yes	28 (14.2%)
No	164 (83.2%)
History of Unconscious Episode	193 (98.0%)

Yes	23 (11.7%)
No	170 (86.3%)
History of Unconscious Episode - Treated by Professional (If Endorsed History of Unconscious Episode)	16 (69.6%)
Yes	9 (56.3%)
No	7 (43.7%)
GAD-7	197 (100%)
< 10	167 (84.8.%)
≥ 10	30 (15.2%)
PHQ-8	197 (100%)
< 10	166 (84.3%)
≥ 10	31 (15.7%)
Difficulty with Self-Care	195 (99.0%)
No difficulty	176 (89.3%)
Some difficulty	15 (7.6%)
A lot of difficulty	3 (1.5%)
Cannot do at all	1 (0.5%)
Difficulty Remembering/Concentrating	195 (99.0%)
No difficulty	108 (54.8%)
Some difficulty	82 (41.6%)
A lot of difficulty	5 (2.5%)

Cannot do at all	0 (0.0%)				
Working Memory Ability	197 (100%)	32.17	7.94	7.00	46.00
Total MSE	197 (100%)	6.87	3.05	0.00	12.00

Note. The ns for the following follow-up questions do not match the number of individuals that indicated "yes" on the initial item due to a survey-system error: Current Effects of Serious Illness (If Endorsed History of a Serious Illness), Current Effects from Mood/Psychiatric Condition (If Endorsed Mood/Psychiatric Condition), and History of Unconscious Episode - Treated by Professional (If Endorsed History of Unconscious Episode).

Table 3

Bivariate Correlations between Study Variables

	MSE	Working Memory	Leisure Activity	Occupation	Education	Age	Depression
Working Memory	.40***	-	-				
Leisure Activities	.07	.11	-				
Occupation	.05	-.01	-.02				
Education	.01	.03	.10	.30***			
Age	.02	-.09	.01	-.01	-.004		
Depression	-.13	-.20**	-.12	-.17*	-.10	-.09	
Anxiety	-.08	-.21**	-.13	-.13	-.04	-.03	.79***

Note. Education refers to educational attainment, Occupation refers to occupational attainment, Leisure Activity refers to leisure activity participation, MSE refers to memory-self efficacy, and Working Memory refers to working memory ability. Significance is two-tailed.
The following variables were transformed (log) before analyses: depression, anxiety, leisure activity participation, and occupation.
* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4

Regression Model Examining Working Memory Ability

Model	Variable	R^2	Std. Error of the Model	R^2 Change	β
1*		.05	7.71	-	
	Age				-.11
	Depression				-.10
	Anxiety				-.12
2		.06	7.72	.01	
	Age				-.11
	Depression				-.10
	Anxiety				-.12
	Education				.04
	Occupation				-.05
	Leisure Activity				.08
3***		.23	7.02	.17	
	Age				-.11
	Depression				-.01
	Anxiety				-.15

Education	.05
Occupation	-.06
Leisure Activity	.06
MSE	.42***

Note. MSE refers to memory self-efficacy, Education refers to educational attainment, Occupation refers to occupational attainment, and Leisure Activity refers to leisure activity participation.
The following variables were transformed (log) before analyses: depression, anxiety, leisure activity participation, and occupation.
Model 1: age, depression, and anxiety
Model 2: age, depression, anxiety, educational attainment, occupational attainment, and leisure activity participation
Model 3: age, depression, anxiety, educational attainment, occupational attainment, leisure activity participation, and MSE
Model 1: Adj. $R^2 = .04$, $F(3, 190) = 3.41$, $p = .02$. Model 2: Adj. $R^2 = .02$, $F(6, 187) = 2.05$, Sig. F Change = .56, $p = .06$. Model 3: Adj. $R^2 = .23$, $F(7, 186) = 7.93$, Sig. F Change < .001, $p < .001$.
* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 5

Regression Model Examining MSE

Variable	R^2	Std. Error of the Model	β
	.03	3.05	
Age			.01
Depression			-.20
Anxiety			.08
Education			-.03
Occupation			-.03
Leisure Activity			-.06

Note. Education refers to educational attainment, Occupation refers to occupational attainment, and Leisure Activity refers to leisure activity participation.
The following variables were transformed (log) before analyses: depression, anxiety, and occupation.
Model: age, depression, anxiety, leisure activity participation, educational attainment, and occupational attainment.
Model 1: Adj. R^2 = -.004, $F(6, 187) = 0.87$, $p = .52$.
* $p < .05$, ** $p < .01$, *** $p < .001$.