MODELING AGE DIFFERENCES IN RISKY DECISION MAKING

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Dissertation

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ABSTRACT

The current study analyzed age and other potential predictors for risky decision making. Forty younger adults (19-25 years) and 40 older adults (63-86 years) made risk based decisions related to health, nutrition and finance. Variables hypothesized to influence risky decision making were measured and investigated as possible predictors across each of the domains and in total. Contrary to what was hypothesized, older adults did not make riskier decisions in any domain or in total. Hierarchical regression analyses showed that age did not account for significant variance in the risky decision making domains. Stepwise regression analyses revealed response time on the Tower of Hanoi as a predictor of risky financial decision making. Stepwise regression analyses also revealed Iowa Gambling Task scores, gender, extroversion, and errors on the Tower of Hanoi as predictors of nutritional risky decision making scores. They also revealed scores on the Iowa Gambling Task and average response time on the Tower of Hanoi to be predictors of overall risky decision making scores. Age was not a significant predictor of any of the domains of risky decision making, however moderated regression analyses revealed age-related influences on cognitive regulation components for risky financial decision making. It is hypothesized that aspects of cognitive dynamics (cognitive regulation and emotional regulation), along with age influences in the financial domain, are responsible for differences in risky decision making.

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CHAPTER I

INTRODUCTION

Statement of the Problem

Older adults are living longer and more autonomous lives (Vaupel, 2010), and the world population in general is getting older. Older adults are making more decisions for themselves and for others around them and the effectiveness of their decision making needs to be assessed. Processes involved in cognitive regulation (such as cognitive planning, executive functioning, and processing speed) have been theorized to affect decision making (e.g., Petrides, 1994; Owen, 1997; Löckenhoff, 2011) and age differences have been observed seen in these processes (e.g. Salthouse, 1996; Salthouse, Atkinson, & Berish, 2003; Parkin & Walter, 1991, 1992; Parkin, Walter, & Hunkin, 1995). In addition to cognitive regulation, there are theories that hypothesize that emotional regulation components (such as reappraisal and suppression) influence decision making, specifically risky decision making (e.g. Heilman, Crisan, Houser, Miclea, & Miu, 2010; Richards & Gross, 1999), and there have been age differences observed in components measuring emotional regulation (e.g., Baena, Allen, Kaut, & Hall, 2010; Bechara, 2004; Denburg, Tranel, & Bechara, 2005; Heilman et al., 2010; Carstensen & Mikels, 2005).   Finally, there is also some evidence that emotional arousal may influence decision making, as well, by influencing early stage processing (Mather & Sutherland, 2011) and age differences have also been recorded in emotional arousal

(Mather et al., 2004; Leclerc & Kensinger, 2008; Pollock, Khoja, Kaut, Lien, & Allen, 2012). From a theoretical standpoint there should be age differences in decision making due to these processes showing age differences. There is, however, no consistent data supporting this hypothesis.

Some decision making competence research has found age losses (e,g. Finucane & Guillion, 2010; Finucane, Mertz, Slovic, & Schmidt, 2005), while other research has found no age differences (Artistico, Cervone, & Pizzuti, 2003). A meta-analysis analyzing risky decision making found no consistent age differences and showed that the differences seen were usually due to the task (Mata, Josef, Samanez-Larkin, & Hertwig, 2011). On some tasks older adults were more risky than younger adults, and on others, younger adults were more risky. The fact that there are no consistent age differences observed on decision-making competency (DMC) and risky decision making tasks suggests that age may not be the determining factor.

Researchers have begun to look at other potential variables and factors along with age and how these other factors affect decision making competence (Finucane & Guillion, 2010). This has not however been applied to risky decision making. Risky decision making is defined as any decision an individual has to make that includes a component of risk. For example, risky decisions could involve the risk of losing money, risk of health problems, or risk of being unable to have adequate medical care. There is a spectrum of risk involved where individuals need to weigh possible benefits against possible negative outcomes. Decision making competence research investigates how correct individuals are in their decision making. Risky decision making research involves answers that weigh benefits versus costs. There is not necessarily a correct answer, and as such many different processes need to be recruited to make a decision.

Many studies have investigated potential individual factors and how they influenced risky decision making (see Mata et al., 2011 for review), but, to date, there has not been a single study of age differences in risky decision making that included measures of all three potential accounts of performance differences in risky decision making (i.e., cognitive regulation, emotional regulation, and emotional arousal). Consequently, the present study will test for age-related differences in risky decision making as well as assess performance on measures of cognitive regulation, emotional regulation, and emotional arousal.

Importance of the Study

A comprehensive test of all three potential constructs (cognitive and affective regulation, as well as emotional arousal) that likely drive risky decision making has never been done before. Therefore, conducting a study that will measure performance on cognitive regulation, emotional regulation, and emotional arousal across age groups is needed in decision making research. Applying this to risky decision making across age groups will have the potential to provide a better understanding of risky decision making in general, and the effect of increased adult age on this, in particular. Up until now research has studied one of these underlying factors in isolation but no single study has included measurements from all three possible factors. This study will make it possible to measure moderation and/or mediation of these factors with age and risky decision making.

A large meta-analysis of risky decision making research came to the conclusion there are no general age differences in risky decision making (Mata et al., 2011). They concluded that differences in risky decision making related to age were due to the task. This needs to be expanded upon by applying potential processes to the tasks. Identifying what processes may predict performance on risky decision making tasks may reveal the true nature of age-related differences in risky decision making. Consequently, this study will allow a more precise examination of the cognitive dynamics (cognitive and emotional regulation, and emotional arousal) of risky decision making, and as to how increased adult age is related to this system.

This is so critically important to the study of risky decision making, especially in older adults. Older adults are living longer more autonomous lives and are therefore making decisions for themselves and others that are critically important. These decisions could be as simple as what to eat or as complex as what healthcare plan to choose for themselves or their spouse. These decisions could be filled with risk, or somewhat risk free. Recent pushes to aid the older adult decision maker (Mata et al., 2012) have attempted to identify ways to assist decision making. Identifying useful strategies and environmental fit are a few of the ways decision making has been investigated, and this study will provide a better understanding of what processes may be used in certain situations.

Even if older adults do not show any risky decision making deficits, understanding the underlying cognitive nature of decision making can help individuals to make better decisions. This applies to both younger and older adults. If there truly is no impairment in risky decision making with age then this study will help to understand possible ways to promote good decision making by identifying cognitive components that are recruited for different risky decision making domains. If risky decision making is impaired in older adults then this research becomes even more critical. It is essential to have a comprehensive understanding of what processes contribute to risky decision making across multiple domains. Knowing when, and how, to help older adults is critical to decision making success in later life. If older adults are able to make efficient risky decisions then promoting their autonomy will promote even better outcomes. However, if they do show impairments it is absolutely essential to understand why and how they can be assisted. This study will allow a comprehensive understanding of risky decision making and the underlying cognitive dynamics related to it. Combining this comprehensive viewpoint with age will allow for a better understanding of how and if risky decision making differences with age and the best ways to assist individuals who struggle with risky decision making.

CHAPTER II

BACKGROUND AND SIGNIFICANCE

Older adults comprise a growing percentage of the total population because modern innovations make it possible to live longer and healthier (Vaupel, 2010). Individuals are living longer and are maintaining autonomy longer than in previous generations. The rising life span will lead to individuals working longer and making decisions that are complicated and difficult much later in life. Decisions about what healthcare options to pursue, what to invest in, and even decisions about diets are becoming increasingly important for older adults (Finucane et al., 2005). Aging is also associated with significant differences in many areas, such as cognitive (Salthouse, 1996; Salthouse et al., 2003) and emotional regulation (Baena et al., 2010; Bechara, 2004; Denburg et al., 2005), that are likely to affect decisions in predictable ways, and therefore, these factors should influence decision making and may influence any differences in decision making seen with age.

Cognitive Regulation

Decision making research incorporates a vast number of processes and sub-processes. It requires complex integration of many sources of information at one time to produce responses (Wood & Bandura, 1989). Some choices require split-second responses, while others may take much longer to process and decide upon (Löckenhoff, 2011). Much of the research into decision making is based upon different analytic components which may account for decision making differences, which are usually encompassed by the larger construct known as cognitive regulation. Cognitive regulation accounts for a large amount of constructs such as attention and executive functioning (Hutcherson, Plassmann, Gross, & Rangel, 2012). The executive functioning sub-construct also includes a variety of sub-processes as well. While notably hard to define, executive functioning has been thought to incorporate concepts such as attention, inhibition, working memory, processing speed, and cognitive planning (Salthouse et al., 2003). While cognitive regulation is a broader term, research refers to this construct as being synonymous with executive function. Cognitive regulation has long been thought to influence decision making because many of these sub-processes are directly responsible for tasks related to making decisions (Löckenhoff, 2011; Owen, 1997). While decision making strategies may vary under different conditions and amongst different domains, there are standard operations which go into making decisions.

The ability to process information quickly, especially in time-limited situations, is an integral part of decision making. Processing speed, or how quickly information is processed by the individual, is usually the process which this difference is attributed to. This concept of processing speed is understood to affect how quickly individuals weigh different options in decision making situations, and therefore plays a large role in decision making (Löckenhoff, 2011).

The ability to plan ahead is also a basic component of many complex behaviors and processes such as decision making (Owen, 1997). High level cognitive planning is commonly defined as the ability to organize cognitive behavior in both space and time (Owen, 1997). This process is necessary in cases where a series of steps are needed to be completed to achieve a goal, much in the same way that decision making is accomplished. As cognitive planning is a high order process it is influenced and interacts with many other processes too, such as working memory. Petrides (1994) postulated that there are two distinct pathways in which working memory influences higher order processes such as cognitive planning. One pathway is tasked with the active organization of explicit retrieval of information from short term memory, while the second-order pathway is recruited when active manipulation of information within working memory is required (Petrides, 1994). Functional neuroimaging research has identified the second-order pathway as the strongest influence on tasks which require cognitive planning (Owen, 1997). Cognitive planning requires the active manipulation of information within working memory. This makes sense from a decision making standpoint. Making decisions requires the manipulation of a substantial amount of information and the ability to hold and contemplate different responses. Cognitive planning has therefore been identified as a strong factor in decision making as well. Working memory has influences on decision making independent of cognitive planning too.

The larger concept of working memory is also thought to influence decision making. It includes several components such as short term storage, rehearsal, and other executive processes (Smith, 2000; Smith & Jonides, 1999). The ability to hold information in memory influences decision making greatly (Bechara & Martin, 2004). This allows individuals to make decisions faster and more accurately if they have access to more information at the present time. The central executive processes commonly attributed to working memory include the monitoring of mnemonic operations, as opposed to the short term storage components (Petrides, 2000). Shifting attention and response inhibition are also encompassed under this larger working memory concept as well (Bechara, 2004). It is easy to see how these may relate to decision making. The ability to inhibit responses which are negative and the ability to shift attention to more positive outcomes plays a large role in decision making. For example, if an individual was put in a situation where there was a dangerous item in view, any approach towards that item should be inhibited and safer options should be pursued. Any desire to approach that item would be a sign of poor impulse control, and is sometimes labeled as cognitive impulsiveness (Barratt, 1994). Response inhibition may act as an early process in decision making and may remove sub-optimal choices from response options.

There are several mechanisms included in the concept of response inhibition, such as motor impulsiveness, which also includes several forms (Evenden, 1999). Impulsiveness preparation, making a decision before all the information is gathered, and impulsiveness execution, or quick action without thinking (Evenden, 1999) are both aspects of motor impulsiveness. This idea also is split up into multiple sub-types. Motor impulsiveness is split into non-affective and affective, relating to whether the inhibited response is affective or not (Bechara, 2004). A final sub-type is known as perpetual impulsiveness, which relates to the ability to inhibit a perpetual thought held in working memory. The ability to inhibit responses, hold concepts in memory, shift attention between responses, and other components of working memory are thought to influence the way individuals make decisions.

Emotional Regulation

The overall construct of cognitive regulation and its many sub-components have been theoretically linked to decision making and its underlying processes. There is however another construct that is strongly linked with decision making from a theoretical standpoint. Emotional regulation is defined as the process which controls what emotions individuals consciously experience, when they have them, and how they express them (Gross, 2002). Contrary to past thinking (Neisser, 1967), emotions play a large role in decision making.

There are many different theories as to how emotions affect decision making. They have been associated with identifying how good or bad the responses are (Slovic, Finucane, Peters, & MacGregor, 2007), activating basic systems such as defensive systems (Bradley & Lang, 2007), or even associated with somantic markers related to current or past outcomes (Bechara, Damasio, & Damasio, 2000). There are a variety of processes relating to emotions that could influence decision making—especially risky decision making (Bechara et al., 2000).

When an individual experiences an emotion, he or she will try to use strategies to control that experience. This concept of emotion regulation therefore will become active during decision making as emotions are encountered. This component plays a large role in decision making, as individuals address emotional components and adjust. When a decision is uncertain and there is no absolute correct answer, emotions and beliefs both influence the potential outcome (Denburg & Harshman, 2010). Individuals have been theorized to be able to anticipate the potential emotional impact of potential decisions and adjust accordingly (Bechara, Damasio, Damasio, & Lee, 1999; De Martino, Kumaran, Seymour, & Dolan, 2006; Weller, Levin, Shiv, & Bechara, 2007). This can result in changes in decisions based on future consequences.

The concept of emotional regulation is oriented toward two different strategies. The first is that of antecedent-focused emotional regulation, or strategies that occur before emotions arise (Heilman et al., 2010). The second strategy is response-focused emotional regulation, which occurs after emotions arise (Gross & Thompson, 2007). Two specific strategies potentially linked to decision making are cognitive reappraisal and expressive suppression (Heilman et al., 2010). Cognitive reappraisal is an antecedent-focused emotional regulation strategy that alters the meaning of the situation and alters the trajectory of emotional responses (Heilman et al., 2010). The other strategy is expressive suppression, which is a response focused strategy that involves inhibiting emotional behaviors such as facial expressions or gestures (Gross, 2002). These strategies both decrease emotions but at notably different times. Reappraisal works at an early stage of processing while suppression works later in processing and requires constant effort (Gross, 2002). This increased effort with suppression can impair explicit memory (Richards & Gross, 2000). Suppression of negative emotions along with high arousal is also commonly linked with impulsive decision making (Leith & Baumeister, 1996).

It has been theorized that there are two routes to emotional regulation that affect decision making that orient around these strategies. The first route is an emotional route, and it operates at an emotional level and accounts for how well these strategies manage emotions (Heilman et al., 2010). Suppression is less effective at decreasing the experience of negative emotions than reappraisal is (Heilman et al., 2010). Some decision making components, especially risk related, are induced by emotional components (Heilman et al., 2010). This emotional regulation route may influence any decisions that are affected by these particular pathways. The other route that is attributed to emotional regulation is the non-emotional route (Heilman et al., 2010). This route accounts for the different levels of cognitive load accounted for by reappraisal and suppression. Suppression can decrease certain components of explicit memory due to the large amount of cognitive load needed (Richards & Gross, 2000). This aspect can influence the cognitive regulation component too (Richards & Gross, 2000), reaffirming the idea that they are not mutually exclusive and in fact interact with one another during decision making processes.

Emotional Arousal

A third construct related to risky decision making is emotional arousal. Any component which elicits an emotional response is related to emotional arousal. Emotions are linked to decision making processes and therefore emotional arousal can have an effect on decision making. A theory linked to this idea is the arousal-biased competition (ABC) theory, which theorizes that, during perception, an individual’s active mental representations compete with one another (Mather & Sutherland, 2011). By biased, it is meant that top-down attentional control settings emphasize a given emotion. Thus, after emotional arousal, any high priority information will be represented stronger in attention and working memory (Mather & Sutherland, 2011). This theory suggests that emotional arousal makes items that are perceptually salient stand out, and reduces processing of low-priority information (Mather & Sutherland, 2011). This can influence decision making, as emotionally salient items will be better represented in memory and easier to utilize. Once again the interaction occurs with cognitive regulation and emotional regulation as well.

The previous theory incorporates aspects of emotional arousal and emotional regulation. Other theories have postulated that differences in early emotional arousal may influence later processing (Allen et al., 2005; Pollock et al., 2012). Researchers found that early emotional arousal, associated with amygdalar activity (Cacioppo, Berntson, Bechara, Tranel, & Hawkley, 2011), influenced other components. Allen et al. (2005) hypothesized that older adults experiencing less emotional arousal may account for the patterns of age-related decline in episodic memory compared to the lack of age-related differences in semantic memory. This influence of emotional arousal on episodic and semantic memory may account for differences in decision making, particularly risky decision making as it may draw upon more emotional components. Pollock et al. (2012) found age differences in early emotional arousal too. The presence of age differences in emotional arousal may contribute to differences in decision making due to their influences on later processes such as regulation components.

These predominant theories as to what influences decision making offer insight into possible outcomes in decision making research. When applying these theories to age-related research, it is important to identify how these constructs may be influenced by age. The first construct that was discussed was cognitive regulation, which included the executive function construct. Executive function is repeatedly associated with the frontal lobes in the literature, and is therefore relevant to the Frontal Theory of Aging (West, 1996), where many age-related cognitive deficits are thought to be due to the deterioration of the frontal lobes. While it is unlikely that executive function has a one-to-one relationship with any neuroanatomical structure (e.g. Anderson, Damasio, Jones, & Tranel, 1991; Tranel, Anderson, Benton, 1994), the frontal lobes, particularly the prefrontal cortex, have been linked to executive processes. Therefore the large amount of evidence displaying frontal lobe deterioration in older adults (e.g., Albert & Kaplan, 1980; Andrés & van der Linden, 2000; Crawford, Bryan, Luszcz, Obonsawin, & Stewart, 2000; Daigneault, Braun, & Whitaker, 1992) implies that there may be some losses in executive functioning in older adults in general. These findings, combined with the previous findings indicating executive functioning declines on behavioral tasks in older adults (e.g., Salthouse, 1993; Salthouse, 1985; Salthouse, 1996), indicate that there may be decision making differences between younger and older adults.

Measures of Cognitive Regulation

Other tests have revealed executive functioning deficits in older adults. The Wisconsin Card Sorting Task (WCST), widely regarded as a good measure for executive functioning (Delis, Kramer, Kaplan, & Holdnack, 2004), is commonly used to measure cognitive flexibility, avoidance of pervasive tendencies, maintenance of the task set, and inhibition of prior responses (Salthouse et al., 2003). There have been repeated age-related deficits reported on this task as well (e.g. Fristoe, Salthouse, & Woodard, 1997; Parkin & Walter, 1991, 1992; Parkin, et al., 1995; Salthouse, Fristoe, & Rhee, 1996). The WCST has also been linked with perceptual impulsiveness, and preservation on this task may indicate a trend toward impulsiveness (Dias, Robbins, & Roberts, 1996). These findings indicate that overall executive functioning may be different in younger and older adults.

Specific executive function processes have shown documented losses with aging. One component linked with executive functioning is general cognitive slowing (Salthouse, 1996). Slowing with age is one of the best documented differences with aging, and is usually measured by simple tasks that allow isolate differences due to processing speed (Salthouse, 1996). Numerous findings have shown documented slowing in processing speed with age, including differences on the Digit Symbol Substitution Task (Salthouse, 1985), letter comparison and pattern comparison tests (Salthouse, 1993), and both longitudinally and cross-sectionally on the Finding A's and Identical Picture's Test (Schaie, 1989; Schaie & Willis, 1993). The robust data suggesting age-related slowing in processing speed may relate to potential differences in decision making, as old individuals may not be able to process information as quickly.

Cognitive flexibility differences with aging have also been reported on the differences between the Trail Making Test Part B and Part A, or the time it takes to complete the Trail Making Test Part B (e.g. Keys & White, 2000; May & Hasher, 1998). These tasks require the ability to switch between sequences when appropriate, which is theorized to be less effective in older adults. The lack of cognitive flexibility may result in a larger reliance upon heuristics and biases when dealing with decision making tasks.

Another aspect of executive functioning is that of cognitive planning, and tests that require the ability to develop and execute a plan which has a sequence of steps are usually used to measure this. The Tower of Hanoi and the Tower of London are two such tests that have commonly been used to measure cognitive planning (Goel & Grafman, 1995) or working memory (Welsh, Satterlee-Cartmell, & Stine, 1999). There have been reported age-related losses in performance on a variety of tower tests (e.g. Andrés & van der Linden, 2001; Gilhooly, Phillips, Wynn, Logie, & Della Salla, 1999; Vakil & Agmon-Ashkenazi, 1997). The ability to plan ahead and create a plan is an essential part of making decisions, and the losses seen with aging in the Tower of Hanoi/London tasks indicate an age-related difference in cognitive planning which may relate to differences in decision making.

Inhibition has also been identified as having age-related losses. Tests such as the Stroop Interference Test, whereupon individuals are asked to respond to the color of the word and inhibit what the word says, have shown age-related decline (e.g. West & Alain, 2000, Salthouse et al., 2003; McCabe, Robertson, & Smith, 2004). Older adults show greater interference effects that only increase with memory load. Data has shown that measures of executive function and working memory capacity account for unique variance of the errors seen in the responses in older adults (McCabe et al., 2004). These cognitive regulation problems seen in older adults can influence decision making, whether it is a planning, working memory, or executive functioning loss. Larger Stroop effects (subtraction of the response time for congruent tasks from the response time for incongruent tasks) are believed to be indicative of problems with inhibition (Bechara, 2004). This may play a role in problems with decision making, as past research has shown that the inability to inhibit impulsive responding has been shown to be related to riskier decisions (Frederick, 2005).

Age-related differences in working memory are also seen in research. In cases where working memory capacity is exceeded, there are definitive age-related losses (e.g. Anders, Fozard, & Lillyquist, 1972). Tests designed to measure working memory capacity, such as reading span tasks or computational span tasks, have shown age-related losses (Salthouse & Babcock, 1991; Salthouse, 1991). These measures of working memory have been strongly related to processing speed, and that accounts for some of the differences seen. Working memory capacity usually decreases with age (Salthouse & Babcock, 1991), and that can cause problems for decision making tasks as well as individuals cannot hold as much information in memory to use for the task.

The overall cognitive regulation component and the sub-processes it includes usually show some age-related differences, which may relate to potential age-related differences in decision making. Along with this component, emotional regulation has also been investigated in older adults.

Measures of Emotional Regulation

Older adults' ability to regulate their emotions has been investigated and compared to younger adults. Previous work in this area has included several behavioral measures indicating a difference in how older adults regulate emotion compared to younger adults (e.g. Wood, Busemeyer, Koling, Cox, & Davis, 2005; Grühn, Smith, & Baltes; 2005; Carstensen & Mikels, 2005).

A commonly used test of behavioral emotional regulation is The Iowa Gambling Task (IGT). This test is the only standardized, neuropsychological assessment of emotional decision making. It was developed by Bechara et al. (2000) when they observed that individuals with damage to their ventromedial prefrontal cortex (the "Phineas Gage effect") were much more risky in taking short-term gains rather than considering long-term effects. The IGT incorporates emotional decision making processes and has been used to assess emotional regulation (e.g. Bechara, 2004; Heilman et al., 2010). A subset of healthy older adults have shown poorer performance on the IGT (Denburg & Harshman, 2010) whereupon they choose options which were associated with short-term gratification and greater long-term punishment. These older adults have problems discriminating between advantageous and disadvantageous choices in later trials too (Denburg & Harshman, 2010). Other experiments have shown that both older adults and younger adults are successful on the task, but that their pattern of responses is different (Wood et al., 2005). In other cases older adults have performed very similar to younger adults and have shown no age-differences on the IGT (Kovalchik, Camerer, Grether, Plott, & Allman, 2005). Some older adults perform very well, while others perform poorly (Bechara et al, 2000).

Denburg et al. (2005) and Baena et al. (2010) also found an age decrement on emotional regulation tasks, while MacPherson, Phillips, & Della Sala (2002), using a different paradigm, failed to find any differences. MacPherson et al. (2002) did use the Faux Pas Task, which does have a heavy loading on semantic memory, which is maintained in older adults (Light, 1991). The pattern of emotional regulation may change with older adults, but there is no consistent direction.

The socioemotional selectivity theory (SST) of Carstensen and colleagues (Carstensen, Isaacowitz & Charles, 1999) hypothesizes that older adults show a bias toward positive emotions because with their life span perspective of having reduced life expectancy, they emphasize the positive aspects of life (Carstensen, Fung & Charles, 2003). Thus, SST predicts that older adults show greater emotional regulation than younger adults—filtering out negatively aroused emotions and concentrating on positively aroused emotions. The theory suggests that time-constraints in later life result in an increasing emphasis on goals associated with emotional well-being. Therefore older adults are more likely to encode positive information as opposed to negative information. Löckenhoff & Carstensen (2007) demonstrated this effect by having older adults and younger adults review positive, negative, and neutral choice criteria about health care plans and physicians. Older adults reviewed and remembered a greater portion of positive material than negative material compared with younger adults. These differences were negated when motivational manipulations influenced the information gathering process. There is considerable support for the assumptions that older adults show a positive bias in emotional processing, and that this is due to emotional regulation on the part of older adults (Carstensen & Mikels, 2005; LeClerc & Kensinger, 2008; Mather et al., 2004). These positivity effects in memory are likely by-products of changes in emotional regulation strategies (Mather & Knight, 2005) rather than the primary goal. However, they do act as emotional regulation strategies in their own right by altering mood (Pasupathi & Carstensen, 2003). This theory relates back to the concept of antecedent emotional regulation, indicating that older adults make different choices before emotions arise, and that may lead to differences in decision making by altering the environment.

In contrast to this theory other research has shown no positive bias in older adults (e.g. Grühn et al., 2005). There is reasonable support for the idea that the ventromedial prefrontal cortex, which shows decline in volume with age (Peters, Sethares & Moss, 1998; Fjell et al., 2009), may play a large role in emotional regulation (Denburg et al., 2005). This would suggest that emotional regulation may be affected in older adults, and there has been support on tasks such as the IGT confirming this idea (Baena et al., 2010). Any age-related decline in the ventromedial prefrontal cortex may result in less efficient emotional perception or emotional decision making (Baena et al., 2010). These findings suggest that there is a loss in emotional regulation in older adults, and that may compromise decision making in many different ways. For example, a compromised ventromedial prefrontal cortex may lead to less efficient regulation or suppression which may increase cognitive load and lead to less information being accounted for by the individual.

Measures of Emotional Arousal

In a similar manner to emotional regulation there have been age-related differences in emotional arousal. Research involving the perception of valenced faces has indicated a different pattern of responses for younger and older adults. Older adults show a differential response to emotionally valenced faces (Pollock et al., 2012). Specifically, younger adults show larger amplitudes in components related to emotional arousal for angry faces compared to happy faces while older adults do not demonstrate this (Pollock et al., 2012). Other studies have revealed no emotional arousal effect with age with regards to emotional words (Kensinger, 2008). Researchers have also shown that older adults show a bias for positively valenced words when compared to negatively valenced words, which was not seen in younger adults (Mather et al., 2004). This study showed greater brain activation in the amygdala, commonly linked with emotional arousal (Mather et al., 2004), for positive words compared to negative words for older adults. Younger adults did not show any difference. In accordance with the ABC theory referenced above, older adults may attend to high priority information differently than younger adults if they display differences in emotional arousal, and this could affect decision making. However, Kensinger (2008) and Mather et al. (2004) used fMRI methods to examine age differences in the BOLD response. It takes at least two seconds for the BOLD response to occur, yet emotional arousal occurs within 200 milliseconds of stimulus presentation. Thus, these earlier BOLD studies on amygdalar activation were not assessing emotional arousal, but rather, they were assessing later emotional regulation effects. The Pollock et al. (2012) study used event-related potentials (ERPs)—a method with millisecond precision. They observed that older adults did not show an emotionally valenced P1 effect (approximately 100 milliseconds after stimulus presentation) as younger adults did, and this P1 effect has been linked to top-down amygdalar modulation of the secondary visual cortex (Rotshtein et al., 2010). This ERP data led Pollock et al. (2012) to conclude that there are age differences in emotional arousal. Further evidence of this view was provided by Cacioppo et al. (2011) who found diminished arousal to negative stimuli in individuals with lesions to the amgydala. Cacioppo et al. (2011) did analyze individuals with brain damage and therefore their results may not be directly applicable, but they do suggest there is a possibility for age-related differences in emotional arousal due to amygdalar decline. Due to declines seen in the amygdala with age (Leigland, Schulz, & Janowsky, 2004; Fjell et al., 2009) these findings may suggest age differences in emotional arousal.

Decision Making Research

The research above indicates that there could potentially be differences in decision making with age. Cognitive regulation has shown age-related differences, in some cases there are differences in emotional regulation as well, and emotional arousal shows a different pattern of responses with age. These three constructs related to decision making, along with age-related differences in them, have led to research into age-related decision making differences.

Research into age-related decision making differences has focused on two areas of decision making. The first area is that of overall decision making competence. The second area is focused upon risky decision making. Both areas are very important and have been thoroughly investigated, but there are different interactions with the previous theories and different relationships with age.

Decision making competence (DMC) involves whether the correct decision was made in a certain situation (Finucane & Gullion, 2010). Much of the research into this area of decision making has focused on cognitive regulation. In order to attain the correct answer competent decision making requires the ability to understand information, the ability to integrate information, identify the relevance of the information in a decision making process, and inhibit any unnecessary information (Finucane & Gullion, 2010) This approach to DMC looks at it as reliant upon basic cognitive abilities such as processing speed, memory capacity, and executive functioning (Schaie & Willis, 1999). There are age-related differences observed in cognitive regulation, and therefore DMC should show similar characteristics to age-related differences in these areas.

Some research into DMC has shown this pattern. Older adults show greater comprehension errors and inconsistent practices, indicating a lower DMC (Finucane et al., 2002). In this study younger and older adults were asked to consider health plan options. Even when covariates were taken into account (gender, education, health, income, and decision style) there were still age-related differences in DMC. Another study into DMC used a similar approach and applied it to financial decisions, healthcare decisions, and nutritional decisions (Finucane et al., 2005). They also found age-related differences in comprehension and consistency with decision making across all three domains. In this study the researchers also reported that basic cognitive variables (vocabulary, memory span, speed of processing, and social variables (income, gender, education)) also accounted for a significant portion of the age-related variance (Finucane et al., 2005). They hypothesized that the age-related differences on comprehension and consistency were due to short term memory and speed of processing differences with age (Finucane et al., 2005). It was hypothesized that it may be due to the incorporation of less information before a decision was arrived at (Finucane et al., 2005).

A larger study investigating this relationship also revealed age-related differences in DMC (Finucane & Guillion, 2010). The authors identified different dimensions relating to decision making competency. A large factor was compiled cognition, which accounted for the effect of basic cognitive abilities such as crystallized and fluid intelligence, processing speed, and memory capacity in DMC (Schaie & Willis, 1999; Kim, Karlawish, & Caine, 2002). These factors have all seen age-related differences (Salthouse & Ferrer-Caja, 2003) and in turn were theorized to account for age-related variance in decision making competency. The decline in memory and processing speed seen with age may result in older adults using simpler problem solving strategies which may result in more inconsistent decision making (Finucane et al., 2005). They had individuals complete a series of decision making tasks relating to financial, healthcare, and nutritional domains. The researchers also collected data on social variables, health measures, basic cognitive skills, attitudinal measures, and numeracy. Structural equation modeling revealed significant pathways from DMC to three latent variables (crystallized intelligence, other cognitive abilities, and age) which indicated age-related differences in DMC (Finucane & Guillion, 2010). This supported the hypothesis that age-related differences in DMC would have similar patterns to age-related differences in basic cognitive abilities.

Other DMC research has shown conflicting results. Research has shown that older adults perform better on tasks oriented toward them than younger adults did on those tasks (Artistico et al., 2003). In this experiment researchers rerecorded self-efficacy and had younger and older adults complete decision making tasks with some oriented toward younger adults and others oriented toward older adults and a Tower of Hanoi Task. They found that younger adults had higher self-efficacy scores on the Tower of Hanoi Task and the younger adult decision task, and they performed better than older adults on both. Older adults had a higher self-efficacy score on the older-adult-oriented decision task and scored higher on it than the younger adults. DMC may therefore be influenced by experience and the extent to which decisions become automatic. The demands of daily life allow tasks to become automatic, and older adults may benefit from this in decision making (Baltes & Baltes, 1990; Salthouse, 1991). Other studies have replicated these results (Brown & Park, 2003). Declines in cognitive abilities led to older adults having trouble recalling novel medical information, but automatic processes and environmental cues helped older adults to make better decisions. This can also be detrimental to decision making as well as it could result in older adults relying more upon gist and believing familiar false statements to be true (Brown & Park, 2003).

Automaticity or experience may counter age effects in cognitive regulation and therefore may remove any age-related decision making differences (Salthouse, 1991). In some cases however the adverse effects of cognitive aging may dominate the positive effects of experience, as was seen in research on how well older investors made investments (Korniotis & Kumar, 2011). Older adults, even with years of experience being investors, still exhibited poorer investment skill. The research into DMC relies heavily upon cognitive regulation and how much it is affected by age. The research into risky decision making incorporates these ideas and includes others too. The research into age differences in risky decision making also includes emotional regulation and to some extent emotional arousal.

Researchers have suggested that environments that include risk and uncertainty are where the relationship between decision making and emotions is best evaluated (Heilman et al., 2010). Past research has included emotional regulation variables as well as cognitive regulation variables in order to account for these differences. Research has established conflicting theories and results related to age differences in risky decision making.

A meta-analysis comparing risky decision making between younger and older adults analyzed 29 separate age comparisons (Mata et al., 2011). They separated the behavioral assessments of risky decision making into two decision types. Decisions from experience, wherein no information about the probability of a risky versus safe response is provided and individuals must rely on experience through feedback, rely on the participant learning through the task (Mata et al., 2011). Tasks such as the Iowa

Gambling Task (IGT), where subjects choose between advantageous and disadvantageous decks, the Behavioral Assessment Allocation Strategy (BAAS), where subjects choose between good and bad stocks, and the Balloon Analogue Risk Task (BART), where subjects choose how many pumps to fill a balloon but are not sure how many will cause it to explode, are included in this decision type. Decisions from description rely on individuals' choices between gambles or lotteries where full probability and outcomes are provided (Mata et al., 2011). Tasks such as the sure thing vs. risky gamble, where subjects are asked to choose between a sure thing and a higher payout gamble, blackjack, or Cambridge Gambling Task (CGT), where subjects are asked to find the location of a hidden token, are included in this decision type.

There were age-related differences in decisions from experience, but it varied based on the task (Mata et al., 2011). Older adults were more risk seeking on the IGT and the BAAS than younger adults, but they were more risk averse on the BART than younger adults. Individual studies have not always replicated these results however. Healthy older adults have shown poorer performance on the IGT (Denburg & Harshman, 2010) whereupon they choose options which are associated with short-term gratification and greater long-term punishment. These older adults later have problems discriminating between advantageous and disadvantageous choices in later trials too (Denburg & Harshman, 2010). Other experiments have shown that both older adults and younger adults are successful on the task, but that their pattern of responses is different (Wood et al., 2005). In other cases older adults have performed very similar to younger adults and have shown no age-differences on the IGT (Kovalchik et al., 2005). Some older adults perform very well, while others perform poorly (Bechara et al, 2000). The meta-analysis indicated that in general older adults were more risk seeking than younger adults in decisions from experience, but there are conflicting results (Mata et al., 2011).

Decisions from description showed age differences as well. Younger adults were slightly more risk seeking for the sure/risky task and blackjack, and older adults were more risk seeking for the CGT (Mata et al., 2011). There are conflicting results here also. Some research had indicated that there are no age differences in regards to risky decision making. Dror, Katona, & Mungur (1998) asked individuals to perform a gambling task similar to blackjack. They found no age differences in regards to how risky individuals were, and found no speed of processing slowing with aging either (Dror et al., 1998). Deakin, Aitken, Robbins, & Sahakian (2004) applied the CGT and found that older adults were more risk averse than younger adults. The sure/risky gambling task also did not reveal any age differences in certain experiments (Sproten, Sharvit, Diener, Fiebach, & Schwieren, 2012). These inconsistent results are also shown in other lines of research into risky decision making as well.

The overall meta-analysis of risky decision making studies did not match previous predictions of general age-related differences in risky decision making (Mata et al., 2011). What was found was that the task characteristics determined whether older adults were riskier or not when compared to younger adults. This suggests that age is not the reason for the differences in decision making, and that cognitive or emotional processes which affect individual tasks may be the cause instead (Mata et al., 2011). For example, processes such as repression or suppression may influence the IGT as it is generally thought to be a good measure of emotional regulation. An older adult who shows impairment in one of these areas, not necessarily because they are older, may show deficits while another who has well-functioning emotional regulation may not.

The IGT has been used often in risky decision making research. There are numerous studies that have looked into age-related differences on the IGT. In some studies it is used as an outcome variable (Denburg et al., 2005), while in others it is used as a measurement variable for emotional regulation (Baena et al., 2010). It is important to note that impaired decision makers on the IGT do not necessarily make riskier decisions. Some studies have shown individuals with damage to decision making areas in the brain make impulsive and poor decisions, but they do not necessarily make risky ones (Miller, 1992).   There have not been consistent findings on the IGT between studies or even within studies. Denburg et al. (2005) found variable responses on the IGT within an older adult sample, which was hypothesized to indicate variable losses in areas of the brain attributed to emotional decision making (VMPFC). Neuroimaging research has been used not only to look at the IGT, but to look at other risky decision making tasks as well.

Older adults were shown to have an incomplete reward prediction error signal when performing a probabilistic reinforcement learning task (Chowdhury et al., 2013). Neuroimaging revealed that they did not have the proper neuronal response to the expected reward value. Another study analyzing reward values using a similar probabilistic reward learning task found decreased reward learning in older adults that was accounted for by white-matter integrity in thalamocortical pathways (Samanez-Larkin, Levens, Perry, Dougherty, & Knutson, 2012). Similar results were also seen when older and younger adults were asked to perform an immediate versus delayed gratification task (Eppinger, Nystrom, & Cohen, 2012). When performing the task older adults responded less impulsively and safer than younger adults. Functional magnetic resonance imaging (fMRI) revealed there was reduced reward sensitivity in older adults, which may account for the differences seen in impulsivity. This is consistent with the idea that older adults have differences in emotional regulation when compared to younger adults, but that the pattern of differences may not be the same as suggested by the SST (Carstensen et al., 1999). Another neuroimaging study analyzing immediate and delayed gratification found a shift in the reward system of the brain in older adults that is preferential for delayed gratification when compared to younger adults (Samanez-Larkin et al., 2011a). Similar studies looking at incentive processing have shown reduced activation for older adults during loss anticipation but intact activation during gain anticipation (Samanez-Larkin et al., 2007). This also supports the idea that older adults have differences in emotional regulation compared with younger adults, and supports SST (Carstensen et al., 1999). This may indicate that older adults have differential ways of processing gains and losses during incentive tasks, and may result in different decision making patterns.

Other neuroimaging studies using financial investment tasks have also shown age-related differences in financial risky decision making during risky asset choice (Samanez-Larkin, Kuhnen, Yoo, & Knutson, 2010). Financial risky decision making has also been analyzed through other neuroimaging studies, which found that proper activation in mesolimbic areas of the brain corresponded with more optimal financial decisions (Samanez-Larkin, Wagner, & Knutson, 2011b). A finding with implications for decision making from an extension of this study found that providing expected value information for the task improved financial decision making for both younger and older adults, and that it increased older adults' performance to younger adults' performance levels at baseline. This indicates that even providing some information can greatly improve older adults' performance on risky financial decision making tasks. This may be due to lowering constraints on certain cognitive regulation processes such as working memory by lowering cognitive load.

A great deal of neuroimaging studies have been done on risky decision making. In general there are losses in certain brain areas along with age differences in risky decision making. However, basic motivational processes associated with decision making and the corresponding brain areas are relatively maintained into later adulthood (Samanez-Larkin, Kuhnen, Yoo, & Knutson, 2010; Samanez-Larkin & Carstensen, 2011). These, amongst other neuroimaging findings, indicate that age alone may not account for all the differences in decision making (Samanez-Larkin & Knutson, 2014).

Other behavioral based studies have also expanded upon financial risky decision making in older adulthood. After completing a monetary incentive learning task, individuals who learned faster about gains had more assets, while individuals who learned faster about losses had less debt (Knutson, Samanez-Larkin, & Kuhnen, 2011). Individual differences in socioeconomic, cognitive, or risk preference variables could not account for these differences. These findings indicate that there are distinctive different financial risky decision pathways that occur in older adults that can alter their decision making entirely. This could be explained through the ABC theory in emotional regulation. Individuals who were more focused on loss due to emotional regulation systems led to less debt, while those that prioritized gains had more assets. This also indicates that not all older adults behave the same with regards to decision making, and that there are different pathways that they use. Yet again this indicates that perhaps it is not age that is the determinant of risky decision making safety.

Some research has identified low performance at younger ages and older ages and good performance in middle age on risky decision making tasks (Agarwal, Driscoll, Gabaix, & Laibson, 2009). When asked to perform an economic risk based decision task the middle aged adults made the fewest errors. The primary explanation for this was that middle age is the age in which the tradeoff between learning and the loss of cognitive ability is achieved (Agarwal et al., 2009). The tradeoff between experience and age-related losses is maximized at that particular age, and therefore individuals have the safest choices. This indicates that cognitive regulation also plays a large role in risky decision making.

Researchers have suggested that risk taking may be inherited in some form as well. Recent research has found that the short allele of a serotonin transport gene (5-HTTLPR) displayed less real world financial risk taking (Kuhnen, Samanez-Larkin, & Knutson, 2013). Mediation analysis of this relationship revealed that the allele was responsible for larger negative emotional reactions in the form of higher neuroticism, which prompted less risky financial decision making. Individuals avoided risky and complex financial choices due to negative emotional reactions. Other research has also suggested that conceptions of an individual's future self also may influence decision making. If the future self seems similar to the present self, when it is vivid and real, and when it is represented in positive terms individuals are willing to make sacrifices that will benefit them in the future (Hershfield, 2011). This indicates that delayed gratification may be a result of how individuals feel about themselves at the present time, and into the future, and may change decision making accordingly.

Emotional regulation and cognitive regulation both play a large role in these studies that have been indicated above. While there is substantial evidence supporting the idea that there are neurological differences with age that may affect how risky decisions are made, there are also numerous cases where there are no differences seen between younger and older adults on tasks designed to measure similar outcomes. Some studies have even suggested that naturally occurring negative emotions may increase risk aversion on tasks such as the BART, but the use of cognitive reappraisal on these emotions inhibits the effect (Heilman et al., 2010). Therefore the combination of both cognitive and emotional regulation may have a combined effect that is different than either one alone. Emotional arousal may also play a role, as if there is missed arousal activation it may influence any future processes oriented in cognitive or emotional regulation.

The research into DMC and risky decision making has inconsistent findings with regards to age. There are instances where there are no age differences in DMC or in risky decision making (e.g. Artistico et al., 2003; Kovalchik et al., 2005), and there are other instances where there are age-related differences (e.g. Denburg et al., 2005; Denburg et al., 2007. Finucane & Gullion, 2010; Finucane et al., 2005) Age-related differences in processes associated with cognitive regulation (e.g. Finucane & Guillion, 2010; Finucane et al., 2005) seen to dictate performance on DMC tasks, and age-related differences in cognitive regulation and emotional regulation (e.g. Kovalchik et al., 2005; Bechara et al., 2000) seem to dictate performance on risky decision making tasks. In some cases performance on tasks measuring these variables accounts for some of the age-related variance and in some cases it does not. The research does not necessarily support the idea that age determines DMC or risky decision making competency, or that age has no effect on it.

Even in the studies of DMC where older individuals had cognitive losses simple strategies were able to work well for decision making (Mata et al., 2012). The internalized strategies may vary with age and they may vary between individuals. Decision making does not only depend on internalized constructs but also depends on the domain as well. Salthouse hypothesized that experience could play a large role in compensating for age-related losses which may be related to the domain, and that could also be seen in decision making research (1991). Tasks such as healthcare decision making (such as selecting a health care plan), financial assessment (such as selecting a mutual fund), and nutrition (such as choosing among food products) are instrumental tasks that older adults need to carry out in their every-day functioning and require a comprehension of the information provided (Finucane et al., 2005). Many research studies have used these domains for decision making tasks as they are applicable to both young adults and older adults. In some cases the decision making competency may vary between domains, and it may be the same for risk based decision making. For example, when faced with medical decisions older adults are more likely to ask the doctor to make the decision than make it themselves (Cassileth, Zupkis, Sutton-Smith, and March, 1980; Curley, Eraker, & Yates., 1984). Older adults may be able to accurately understand the decision, but due to the desire to avoid the decision or due to the incorporation of less information they choose a riskier decision or make no decision at all.

In sum, there are theories that hypothesize that processes involved in cognitive regulation (such as cognitive planning, executive functioning, and processing speed) have an effect on decision making (e.g. Petrides, 1994; Owen, 1997; Löckenhoff, 2011). There are also theories that hypothesize that emotional regulation components (such as reappraisal and suppression) also influence decision making, specifically risky decision making (e.g. Heilman et al., 2010; Richards & Gross, 1999). There is also some evidence that emotional arousal may influence decision making by influencing early stage processing (Mather & Sutherland, 2011). Research into age effects in these areas has shown some age differences in cognitive regulation processes (e.g. Salthouse, 1996; Salthouse et al., 2003; Delis et al., 2004), emotional regulation (e.g. Bechara, 2004; Heilman et al., 2010; Carstensen & Mikels, 2005), and emotional arousal (Mather et al., 2004; Kensinger, 2008; Pollock et al., 2012). Age differences in these areas would therefore result in theoretical age differences in decision making. There is however no consistent data supporting this idea. Some DMC research has found age losses that correspond with cognitive regulation components (e,g. Finucane & Guillion, 2010; Finucane et al. 2005) and other research has found no age differences and that expertise in areas may mitigate any potential cognitive losses with age (Artistico et al., 2003). The research into risky decision making is conflicting also. A meta-analysis analyzing risky decision making found no consistent age differences and showed that the differences seen were usually due to the task (Mata et al., 2011). On some tasks older adults were more risky than younger adults and on others younger adults were more risky. Even on tasks such as the IGT, which is commonly used a behavioral measurement of risky decision making, there are conflicting results. Some researchers find age losses on the IGT (Denburg & Harshman, 2010) while others find no differences (Kovalchik et al., 2005) or even variable performance amongst older adults in the same study (Bechara et al, 2000). The fact that there are no consistent age differences seen on DMC and specifically risky decision making tasks suggests that age may not be the determining factor of performance. In order to truly test this all three theories must be applied to the same population and comparisons need to be drawn between younger and older adults.

The data above show a very fragmented view of decision making. Decision making competence research seems to be heavily influenced by cognitive regulation and experience factors, but risky decision making has no consistent study of the many different processes to establish an overall theory as to if and why there are age differences. In many cases there are different processes studied and very little application of a wide variety of possible predictors for age-related differences in decision making. There is a real need for incorporation of factors representing cognitive regulation, emotional regulation, and emotional arousal into one study of risky decision making. By conducting a study on age-related differences in risky decision making across a variety of decision making domains while incorporating these variables a true sense of how all the processes fit together can be established. Along with this a sense of whether there are any age differences in risky decision making can be established as well.

CHAPTER III

RESEARCH DESIGN, METHODOLOGY, AND RESULTS

Research Hypotheses and Questions

Research Hypotheses: Five hypotheses and four research questions have been developed for this proposed study. These hypotheses relate to the behavioral responses on the risky decision making tasks and the predictors of the scores on those tasks.

H1: Older adults will score lower than younger adults on the financial risky decision task, healthcare risky decision task, and nutrition risky decision task indicating riskier decision making.

H2: Older adults will have lower overall risky decision making scores indicating riskier decision making.

H3: Good performance on cognitive regulation tasks (Tower of Hanoi, Stroop Task, Change Discrimination Task) will predict safer decision making for financial risky decision making, healthcare risky decision making, nutrition risky decision making, and overall risky decision making.

H4: Good performance on the emotional regulation task (Iowa Gambling Task) will predict safer decision making for financial risky decision making, healthcare risky decision making, nutrition risky decision making, and overall risky decision making.

H5: Good performance on the emotional arousal task (facial affect perception task) will predict safer decision making for financial risky decision making, healthcare risky decision making, nutrition risky decision making, and overall risky decision making.

Research Questions: These research questions relate to other possible predictors of risky decision making.

Research Question 1: What factors besides age, cognitive regulation, emotional regulation, and emotional arousal will predict performance on the nutritional decision making task?

Research Question 2: What factors besides age, cognitive regulation, emotional regulation, and emotional arousal will predict performance on the financial decision making task?

Research Question 3: What factors besides age, cognitive regulation, emotional regulation, and emotional arousal will predict performance on the healthcare decision making task?

Research Question 4: What factors besides age, cognitive regulation, emotional regulation, and emotional arousal will predict overall performance on the risky decision making task?

Study Design and Procedure

The goal of this study was to analyze risky decision making and determine if age, cognitive regulation functioning, emotional regulation functioning, or emotional arousal functioning predicted performance. To accomplish this series of tasks relating to risky decision making and regulatory/arousal components were given to the participants and analyzed. The tasks that were given to participants were as follows: The Iowa Gambling Task (IGT), the Stroop Task, a facial affect judgment task, the Tower of Hanoi, and a change localization task. The IGT was used to measure emotional regulation which is supported by past research (Bechara, 2004; Heilman et al., 2010). Cognitive regulation was represented by the change localization task (Johnson et al., 2013), the Stroop Task (Bechara, 2004; Frederick, 2005), and the Tower of Hanoi (Goel & Grafman, 1995; Welsh et al. 1999) which was also supported by past research. Finally, emotional arousal was represented by the facial affect judgment task which has also been used for that reason in past research (Pollock et al. 2012; Baena et al., 2010).

In addition to these tasks participants were also asked to complete a packet containing a demographics form, a condensed version of the Mill Hill Vocabulary test, a modified version of the NEO Personality Inventory (NEO-PI), three decision making tasks, an impulsivity scale, and finally an emotional intelligence scale. Personality traits can be linked with decision making, and have been measured using the NEO Personality Inventory (Brand et al., 2005). Overall measures of intelligence such as the Mill Hill Vocabulary Test have also been used in previous decision making research (Sweitzer, Allen, & Kaut, 2008). Impulsivity measures have also been conducted in previous decision making research as there has been a relationship reported between it and some measures of decision making (Sweitzer et al., 2008). This is commonly measured using the Barratt Impulsiveness Scale (BIS-11) (Barratt, 1959).

All computerized tasks were created in E-Prime Professional 2.0 except for the change localization task, which was created in E-Prime 1.0. This was due to compatibility issues with the coding from the change localization task.

At the beginning of the experiment participants were informed that they would be participating in an experiment designed to assess their decision making. Following this they were provided with a consent form that informed that they were required to read through and sign to commence with the experiment. Following this participants were asked to fill out the demographics form on their packet. The demographics collected were name, age, gender, years of education, handedness, and whether they were a native English speaker. They were also given a participant number which would be used to record their responses in order to maintain anonymity.

Participants were then seated at a computer screen and asked to begin the IGT. The program used for this was designed by Bechara, Damasio, Tranel, and Damasio (1997). This program has been used to examine how emotion and cognition are integrated in a risk based decision making task. Participants were first asked to complete the demographics required for the IGT assessment within the program. These were gender, years of education, and birthdate. Following this the IGT began. The task consisted of

100 trials in which individuals were asked to select from any deck they wished. They were provided with constant update as to how much money they currently had and how much they had borrowed. Every time they clicked a deck of cards they would earn some money. Occasionally they would also lose some money. The task coded decks A and B to be riskier tasks where you would gain more but lose more. Decks C and D were coded to gain less but lose less as well. In order to gain money in task individuals would have to select from C and D more than A and B, as A and B resulted in a net loss. Deck A and deck C resulted in losses more often than B and D, but they also resulted in losing less than their respective counterparts. The 100 trials were separated into 5 blocks, each block comprising 20 trials. The first block was removed from the analysis as a practice block. The program used to complete this task provided by Bechara et al. (2007) provided two sets of output. One set was the raw score, which ranged from -70 to 70, and the other set was a standardized score controlling for demographics. The first raw score allowed for an interpretation of how risky an individual was, while the second score allowed for an interpretation of how risky they were compared to individuals with their same demographics. The display during the experiment is constant. It does not change unless the card is clicked on and feedback is given. The experiment lasted 100 trials, then the participant was prompted that they were complete.

The second task participants were asked to complete was a facial affect judgment task. This task was based on previous work in the area looking at judgments of emotions on faces (see Pollock et al., 2012 for example). Participants were seated at a computer and asked to strike different keys depending on what emotion the faces were displaying.

They were asked to strike the “V” key for angry faces, the “B” key for happy faces, and the “N” key for neutral faces. Participants were given a 30 trial practice block to get acclimated to the experiment and that data was not included in the final analysis. After the practice block individuals were allowed to rest if they wished. Once that was complete they participated in the trial. The trial comprised of 40 neutral faces, 40 happy faces, and 40 angry faces each balanced across difficulty, gender, and race. The faces were drawn from the NIM-STIM facial set (Tottenham et al., 2009) and they were varied in difficulty by molding faces which displayed emotions readily with neutral expressions to create more difficult identifications. The task provided average response times for angry, happy, and neutral faces. It also provided errors in each of the previous categories. An average total for the entire task was provided too. An example of the faces seen is provided in Appendix A.

The third task participants completed was the Stroop Task. The task was set up similar to a classic Stroop Task, whereupon individuals were asked to make judgments about the color of the word presented on the screen. In this task individuals were seated a computer screen and given instruction that they were going to be seeing colors written on the screen but that they color of the word will not necessarily be the same color the word is describing. They would be asked to identify the color of the word, not what the word says. The words that would be written on the screen were “blue”, “red”, “yellow”, or “green” and the colors the words may appear in would be the same. Participants were asked to strike the “A” key for blue, “S” key for red, “D” key for yellow, and “F” key for green. Participants completed an 18 trial practice block, with 9 congruent trials (where the color of the word and the word were the same) and 9 incongruent trials (trials where the color of the word and the word were different). The 9 incongruent trials were split amongst the 3 separate colors. They completed 60 congruent trials and 60 incongruent trials. The 60 incongruent trials were split into sets of 20 for each of the different colors it could be. The task provided average response time for congruent and incongruent trials. It also provided errors for both the congruent and incongruent trials.

The fourth task completed by participants was the modified Tower of Hanoi task. Each trial in the task had a picture of 3 pillars and disks arranged on them at the top on the screen, and the same 3 pillars at the bottom with the disks arranged in a different position. Individuals were given a certain amount of moves to direct the disks along the bottom to match the image at the top. Participants did this by clicking on the disk once and then clicking where they wanted it to go. There were two rules that applied to this task. Participants could not move a larger disk on top of a smaller disk, nor could they move a disk from a stack without first moving the top disk off the stack. The task consisted of 7 trials, with 2 practice blocks. Each trial was a separate stage with a different amount of moves which were displayed to individuals at the center of the screen. The first practice block consisted of one move, followed by a block consisting of two moves. The experimental blocks had 2, 3, 4, 5, 6, 6, and 7 moves respectively. If at any point a participant made a mistake they were informed by the task and the stage was reset to begin again. The minimum amount of moves to complete the experiment was 86 moves, and there was not a maximum set. The task recorded the amount of errors made, the amount of moves made, and the average response time for each move. An example of the display seen is provided in Appendix B.

The final computerized task participants completed was the change localization task, which was based on previous work in working memory capacity (Johnson et al., 2013). In this task participants were presented with a configuration of 4 colored blocks for 100 ms, each measuring $0.7 \times 0.7°$ of visual angle. After 900ms of only a fixation cross being shown the blocks reappeared in the same configuration and one of the blocks changed colors to a color not present in the original display. The blocks were randomly assigned colors from red, green, yellow, magenta, cyan, or blue. The blocks were arranged based on an invisible circle oriented around the fixation cross with a radius of 3° with a minimum of 30° between each block. Participants were asked to use a mouse to move the fixation cross to the block that they believed changed colors. Participants completed a practice block consisting of 15 trials, followed by an experimental block of 60 trials. The task recorded their amount of errors and their average response time. A visual representation of the task created by Johnson et al., (2013) is provided in Appendix C. Individuals were instructed to perform as accurately as possible for all the computerized tasks. They were informed that they were being timed, but that there was no limit to how much time they could take.

Following the computerized tasks participants were seated at a separate desk in order to complete the written forms. All of the written forms were provided in 14 point font in order to be accessible to all ages. The first form they were asked to complete was a modified Mill Hill Vocabulary Scale (Raven, 1965). Individuals were given 33 words and informed they had to identify the word that meant the same as that word from a choice of 6 separate words. The words increased in difficulty as the numbers increased. Individuals were scored on the number of words correct. If they did not fill in an answer it was marked as incorrect.

Following this task participants were asked to complete the modified NEO-PI. The task was shortened and only neuroticism and extroversion items were included. Participants were asked to rank statements about themselves from strongly disagree, disagree, neutral, agree, or strongly agree. Neuroticism and extroversion items were alternated, and the test comprised of 12 neuroticism and 12 extroversion items. The odd numbered items were neuroticism items, and the even numbered items were extroversion items. The task was scored from 0-4, with items 1, 6, 7, 12, 13, 18, 19 and 24 being reverse scored.

Participants were then asked to complete a risky decision making task based on a DMC task designed by Finucane & Gullion (2010). This task utilized sample problems from the previous DMC task to create risk based assessment tasks. The DMC task designed consistency measures (CON) where individuals were given a choice array of four or ten options depending on the complexity and individuals were asked to choose the best answer based on the information provided (Finucane & Gullion, 2010). The DMC task also contained dimension weighting (DW) tasks, where individuals were presented with a choice array in each item and they were asked to choose what item they weighed the highest (Finucane & Gullion, 2010). In those tasks participants were given 8 to 9 choices. For the present task a combination of both of these task were used and ranked in regards to riskiness as opposed to what was correct. Participants were asked to choose the best possible choice with the information provided. They were presented 1 task from the easy CON tasks for each of three separate categories – healthcare, financial, and nutrition. They were then presented a complex CON task from the same categories. Finally they were asked to complete a DW task from each of the categories. The CON easy task for healthcare had 5 answers and was scored from 1-5. The nutrition task had 4 answers and was rated 1-4. The financial task had 4 answers and was rated 1-4. The complex CON tasks all had 10 answers and were rated from 1-10. The DW task for nutrition had 9 answers and was scored from 1-9. The healthcare task had 8 answers and was scored from 1-8. The financial task had 9 answers and was scored from 1-9. The maximum score from any category was 23, with the minimum being 3. The risk ranking was done utilizing the scoring table from previous research (Finucane & Gullion, 2010) along with a mathematical analysis of the data included in each task. In each task participants were presented with a set of data that allowed them to assist in making their decisions. This data was weighted based on risk and was used to generate the scoring system. To maintain consistency a group of 10 younger and 10 older adults were asked to rank the scoring tables in order of risk. A subsection of 15 younger and 15 older adults who participated in the experiment were also asked at the end of the experiment to rank the answers based on risk. They were not informed that they were the same questions, and when asked following the experiment only 5 stated that they answered the same they did on the experiment, and that data was dropped. A composite rating system was generated based on responses from these 50 individuals, the mathematical weighting, and the previous scoring system (Finucane & Gullion, 2010).

Following this task participants were asked to complete a short emotional intelligence scale utilizing a scale (Schutte et al., 1998) based on a model postulated by Salovey and Mayer (1990). Participants were asked to rate the statements from strongly disagree, mildly disagree, neutral, mildly agree, to strongly agree as it pertained to them. Each question was scored from 1-5, with questions 5, 28, and 33 being reverse scored. There were 33 items total.

The final task participants were asked to complete was the Barratt Impulsiveness Scale (BIS-11) (Barratt, 1959). Participants were asked to indicate if they rarely/never, occasionally, often, or almost always/always did the statements presented. This scale was scored from 1-4, with items 1, 7, 8, 9, 10, 12, 13, 15, 20, 29, and 30 being reverse scored. There were 30 items total.

Following this task a certain subsection of participants were asked to rank the responses on the risky decision making task in order of risk as opposed to the best choice. Individuals were selected to complete this based on time available and availability of researchers. Following this participants were informed of the true nature of the experiment and had their computer based scores discussed with them if they so desired.

Younger adults were compensated 4 extra credit points attributed to their psychology courses at The University of Akron, and older adults were compensated $20 for their time and were asked to complete a receipt indicating that they had been paid.

Sample

The sample consisted of 80 participants from The University of Akron and the surrounding area. The younger adults were drawn from students taking undergraduate courses at the University of Akron, and they will receive extra credit in their chosen psychology course for participating in the study. The older adults were independent-living participants who report being in good health with no history of cerebrovascular disease. The older adults were drawn from a sample pool of individuals recruited for previous experiments from the Akron area who responded that they wished to be contacted for future studies. Older adults were also recruited from the Akron YMCA. They were compensated $20 dollars for the estimated 2 hours of work they were asked to complete.

All persons had normal or corrected to normal vision, normal or corrected to normal hearing, have no previous history of neurological or psychiatric illness and must not be taking any medication which is known to affect the central nervous system. They were asked to have English as their primary language. Written consent was obtained from any and all participants. Participants who wished to quit could do so at any time and their data will not be reported, but no participants exercised that option.

The younger adult sample comprised of 40 individuals, with an age range from 19-25 years. The sample included 10 males and 30 females. The years of education for this sample ranged from 12 to 16. The average age was 21.30 years of age and they had an average education level of 14.25 years of education.

The older adult sample comprised of 40 individuals, with an age range from 63-86 years. The sample included 13 males and 27 females. The years of education for this sample ranged from 12 to 18. The average age was 69.33 years of age and they had an average education level of 15.30 years of education. The demographic characteristics of both samples are presented in Table 1.

Analytic Plan

The data was gathered and organized into 30 different variables. The data collection was conducted for age, years of education, gender, handedness, overall Mill Hill vocabulary score, neuroticism score, extroversion score, impulsivity, and emotional intelligence based on the methods described above.

There was also data collected for nutritional decision making risk score, financial decision making risk score, and healthcare risk score. The total risky decision making score was gathered by totaling these together.   Lower scores indicated riskier decision making, and higher scores indicated safer decision making.

The IGT was recorded as two separate variables. The first variable was the raw score on the IGT, and the second was the standardized score on the IGT relative to demographics (age, gender, and years of education). Higher scores on the IGT task indicated safer decision making, and lower scores indicated riskier decision making. Raw scores on the IGT are able to be negative; a score of 0 is exactly balanced between risky and safe. The Stroop task was recorded as average congruent response time (ms) and number of errors. The incongruent aspect was also recorded in average response time (ms) and number of errors. The Stroop effect variable was calculated by subtracting the congruent response time from the incongruent response time.

The Tower of Hanoi variable was recorded as two variables. It was recorded as number of errors and average move response time (ms). The facial affect perception task was also split into average response time (ms) and number of errors. This was provided for angry, happy, and neutral faces, totaling six separate variables. The total average response time was obtained by totaling the average response time for the three emotions and averaging it. The average amount of errors was obtained in the same way. The change localization task was separated into two variables. It was recorded as average response time (ms) and total number of errors.

Statistical Analyses

All analyses were conducted using IBM SPSS version 21.0. The power analyses were completed using the SPSS plug-in Samplepower version 3.0. A loss of 15 data points for the impulsivity variable resulted in it being dropped from the analyses. All significance tests were reported as significant at a level of $p<.05$.

The first set of analyses conducted consisted of a series of one-way analyses of variance, with age as a between-groups factor, comparing the younger sample (ages 19-25) and the older sample (ages 63-86). To accomplish this a separate variable named group was created to separate the younger and older sample. The only variable excluded from the analysis was the impulsivity variable. The remaining variables were included on the dependent list and group was listed as the factor.

The second series of analyses conducted consisted of a correlation matrix, as well as a series of regression analyses. Stepwise regression analyses were conducted for nutrition decision making, healthcare decision making, financial decision making, and total decision making to determine possible predictors for the regression model. In order to establish the capability to determine these predictors a power analysis was conducted for each of the previous regression analyses. In the regression analyses, angry, happy, and neutral error and response time variables were dropped and only the total average response time and total errors were used for the facial affect perception task in order to reduce confounding variables.

Following identification of the stepwise regression models a hierarchical model was generated for nutrition decision making, healthcare decision making, financial decision making, and total decision making forcing age as a predictor to determine how much age-related variance exists for each factor. It also determined how much variance could be explained by the other variables generated from the stepwise model above and beyond age.

After these regression models the data was split based on age group (young vs. old) and stepwise regressions were conducted for both groups for each of the three domains of risky decision making and overall decision making. Following this, moderated regression analyses were conducted for each of the possible predictors with age included as a potential moderator.

Internal consistency measures were also created for the individual risky decision making predictor measures. Cronbach α's were generated for financial, nutritional, and healthcare risky decision making over and for young and older adults.

Results

Prior to conducting statistical analyses the data was tested for violation of assumptions related to the planned statistical tests. The first test was for significant outliers. A significant outlier was identified as a score 2.5 standard deviations above or below the mean (Osborne & Overbay, 2004). There was only one significant outlier, who scored above 2.5 standard deviations on the facial affect determination task. The participant was significantly above the response time for angry, happy, and sad faces. The following analyses were conducted including this participant and without this participant. Removing this participant did not change any results, and therefore the decision was made to keep this participant in the analysis. The dependent variables (risky decision making tasks) were also assessed for normality. Financial risky decision making had a Shapiro-Wilk statistic of .986 (p=.538), nutritional risky decision making had a Shapiro-Wilk statistic of .992 (p=.915), healthcare risky decision making had a Shapiro-Wilk statistic of .981 (p=.295), and total risky decision making had a Shapiro-Wilk statistic of .989 (p=.720). Therefore all dependent variables were normally distributed. A Levene's test for homogeneity of variances was conducted on the data as well with age as the between groups factor. Years of education was the only variable to have a significant score on the Levene's test ($F(1,78) = 5.816$, $p=.018$). Due to this violation a Welch's ANOVA was conducted for years of education. A Durbin-Watson statistic was generated for the regression analyses as well. In all cases the statistic indicated independence of observations. Further tests on the regression analyses also indicated approximately normally distributed residuals. There were no violations of assumptions for the regression analyses.

Analysis of Variance

The Tables referenced in the Results section are all provided in Appendix D. Table 1 shows the results of the between-groups One-Way ANOVA conducted on the data, with age as a between-groups factor. The demographics indicate that there were approximately equal percentages of females in the older age group (M=1.68, SD=.47) and the younger age group (M=1.75, SD= .44) ($F [1,78] = .54$, $p =.465$) There was no effect for gender when comparing the two groups (F [1,78] = .54, p =.465). There was also no effect for handedness (F [1,78] = .00, p =1.00). A Welch's ANOVA showed an effect for education, with older adults showing significantly higher education (M=15.30 years, SD = 2.48) than younger adults (M=14.25 years, SD = 1.40) (F [1,62] = 5.62, p =.02). Older adults also scored significantly higher (M=19.63, SD = 3.40) than younger adults (M=17.46, SD = 2.69) on the Mill Hill Vocabulary Test, F (1,78) = 39.77, p <.001, but older adults were significantly lower on Neuroticism scores (M=16.40, SD = 7.13) compared to younger adults (M=22.08, SD = 7.25) (F [1,78] = 12.45, p < .001). Younger adults scored significantly higher on emotional intelligence (M=132.85, SD = 15.07) compared to older adults (M=125.33, SD = 12.45) (F [1,78] = 5.93, p =.017).

Younger adults were also significantly faster (M=1148 ms, SD = 411.78) than older adults (M=2112 ms, SD = 662.23) on the average Stroop congruent response time (F[1,78] = 61.14, p < .001). Younger adults were also faster (M=1216.98 ms, SD = 432.15) than older adults (M=2229.23 ms, SD = 702.32) on the average Stroop incongruent response time (F[1,78] = 60.27, p < .001). Younger adults also responded significantly faster on average (M=1540.28, SD = 421.66) than older adults (M=2577.68, SD = 823.59) on the Tower of Hanoi task (F[1,78] = 50.28, p < .001).

These results were also seen for the facial affect perception task. Younger adults responded significantly faster (M=1089.23, SD = 255.97) than older adults (M=1379.55, SD = 324.73) for angry faces (F[1,78] = 18.43, p < .001), younger adults responded significantly faster (M=1001.05, SD = 233.78) than older adults (M=1304.23, SD =

293.07) for happy faces (F[1,78] = 27.04, p < .001). Younger adults also responded significantly faster (M=998.78, SD = 192.25) on average for neutral faces than older adults (M=1286.23, SD = 280.80) (F[1,78] = 28.54, p < .001), and younger adults also responded significantly faster (M=1029.65, SD = 209.40) than older adults (M=1323.33, SD = 271.16) overall on the affect perception task average response time (F[1,78] = 29.39, p < .001). Younger adults also responded significantly faster (M=1508.13, SD = 406.47) than older adults (M=2326.88, SD = 784.53) on average on the change localization task (F[1,78] = 34.35, p < .001). Younger adults also had significantly fewer errors (M=16.10, SD = 8.85) than older adults (M=25.58, SD = 6.64) on the change localization task (F[1,78] = 29.32, p < .001) .

There were no significant differences on any other variables when comparing the two age groups; however some values were approaching significance. Younger and older adults did not significantly differ on the nutrition risky decision task (F[1,78] = .02, p = .903), the healthcare risky decision task (F[1,78] = .02, p = .869), or the total risky decision task (F[1,78] = .68, p = .414). They also did not significantly differ on the financial risky decision task (F[1,78] = 3.36, p = .070), but it was approaching significance.

Correlation Matrix

Table 2 shows correlations of the three decision making tasks and the total score on the risky decision making tasks with all of the other task variables. Each task had a separate correlation table generated for it and was interpreted separately.

Scores on the financial risky decision task correlated significantly with age (r = -.223, p = .024), Mill Hill vocabulary scores (r = -.267, p = .008), extroversion (r = .186, p = .050), Iowa Gambling Task standardized scores (r = .195, p = .041), incongruent average response times on the Stroop task (r = -.218, p = .026), average response time on the Tower of Hanoi task (r = -.329, p < .001), average errors on the change localization task (r = -.275, p = .007), and average response time on the change localization task (r = -.249, p = .013).

Scores on the nutritional risky decision task correlated significantly with gender (r = .336, p < .001), extroversion (r = -.257, p = .011), Iowa Gambling Task raw scores (r = .304, p = .003), Iowa Gambling Task standardized scores (r = .342, p < .001), and average errors on the Tower of Hanoi task (r = .229, p = .021). Scores on the healthcare risky decision task correlated significantly with handedness (r = .199, p = .038)

Total scores on the risky decision tasks correlated significantly with gender (r = .263, p = .009), Iowa Gambling Task raw scores (r = .301, p = .003), Iowa Gambling Task standardized scores (r = .348, p = .001), the average Stroop effect (r = -.192, p = .044), average response time on the Tower of Hanoi task (r = -.255, p = .011), average errors on the change localization task (r = -.247, p = .014), and average response time on the change localization task (r = -.189, p = .047).

Power Analyses

Post-hoc power analyses were conducted for the stepwise regression models. The results are for financial risky decision making are provided in Table 3. The results for nutritional risky decision making are provided in Table 4. The results for healthcare risky decision making are provided in Table 5 and Table 6. The results for total overall risky decision making are presented in Table 7. The analyses were conducted with a two-tailed test, with alpha set at $p < .05$. The analyses were intended to reveal if a small effect was the cause of the lack of age differences in the preceding regression analyses. A power level of .80 is considered acceptable to reveal a small effect (Rosenthal & Rosnow, 1991). The financial risky decision making stepwise regression model power analysis indicated that with the 80 participants in this study, there would be a power of .98--which is enough to detect a small effect. The healthcare risky decision making stepwise regression model power analysis indicated that with the 80 participants in this study, there would be a power of .59 which is not enough to reveal a small effect. In order to determine the number of participants needed to detect a small effect for healthcare risky decision making, another power analysis was conducted to estimate the number of participants needed to obtain .80 power. This analysis revealed that 109 participants would be necessary. The nutrition risky decision making stepwise regression model power analysis indicated that with the 80 participants in this study, there would be a power of 1.00 which is enough to reveal a small effect. Finally the total risky decision making scores stepwise regression model power analysis indicated that with the 80 participants in this study, there would be a power of .98 which is enough to reveal a small effect.

Regression Analyses

A series of stepwise and hierarchical regressions were conducted for scores on the risky financial decision making, scores on the risky nutritional decision making task, scores on the risky healthcare decision making task, and total scores on the risky decision making task. Results of the regression analyses for financial risky decision making are summarized in Table 8. Results of the regression analyses for nutritional risky decision making are summarized in Table 9. Results of the regression analyses for healthcare risky decision making are summarized in Table 10. Results of the regression analyses for total risky decision making are summarized in Table 11. Stepwise analyses were initially conducted for each of the variables followed by hierarchical regression models adding age to the stepwise models.

The stepwise regression analysis using risky financial decision making scores as the dependent variable reported average response time on the Tower of Hanoi task to be the only predictor in the model. The results indicated that the average response time on the Tower of Hanoi task accounted for 10.8% of the total variance ($\Delta R^2 = .108$, $F[1,78] = 9.472$, $p = .003$), which was significant. Using risky financial decision making scores as the dependent variable hierarchical regression was used to add age into the regression model by itself first, followed by the Tower of Hanoi average response time variable. Age accounted for 5% of the total variance ($\Delta R^2 = .050$, $F[1,78] = 4.068$, $p = .047$), which was significant. Adding the average response time on the Tower of Hanoi task resulted in an additional 5.8% of the variance to be accounted for, which was significantly more ($\Delta R^2 = .108$, $F[1,77] = 5.074$, $p = .027$). The total variance accounted for by this model was 10.8%. One final hierarchical regression model was used to add the Tower of Hanoi average response time first followed by age with risky financial decision making scores as the dependent variable. The Tower of Hanoi average response time variable accounted for 10.8% of the total variance (ΔR^2= .108, F[1,78] = 9.472, p = .003), which was significant. Adding Age last in the hierarchical regression model resulted in an additional 5.8% of the variance to be accounted for, which was not statistically significant (ΔR^2= .000, F[1,77] = .003, p = .958).

The stepwise regression analysis using risky nutritional decision making scores as the dependent variable reported four predictors for the regression model. The results indicated that the first predictor was standardized Iowa Gambling Task scores (IGTstandardized) which accounted for 11.7% of the total variance (ΔR^2= .117, F[1,78] = 10.338, p = .042), which was statistically significantly. The second predictor was gender, which accounted for an extra 9.2% of the total variance (ΔR^2= .092, F[1,77] = 8.924, p = .004), which was also a significant portion. The third predictor was extroversion, which accounted for an extra 7.9% of the total variance (ΔR^2= .079, F[1,76] = 8.390, p = .005), which was significant also. The final predictor was total errors on the Tower of Hanoi Task (TOHER), which accounted for an extra 5.3% of the total variance (ΔR^2= .053, F[1,75] = 6.070, p = .016), which was also a significant portion. The entire model accounted for 34.1% of the total variance. Using risky nutritional decision making scores as the dependent variable hierarchical regression was used to add age into the regression model first, followed by the variables determined by the stepwise regression. Age accounted for 0.10% of the total variance (ΔR^2= .001, F[1,78] = .045, p = .833), which was not a significant portion. Adding the IGTstandardized variable resulted in an additional 11.8% of the variance to be accounted for, which was a significant increment (ΔR^2= .118, F[1,77] = 10.338, p = .002). Adding gender resulted in an additional 9.0% of the variance to be accounted for, which was also significantly more (ΔR^2= .090, F[1,76] = 8.646, p = .004). Extroversion was added next, which accounted for an additional 7.9% of the total variance to be accounted for, which was also significantly more (ΔR^2= .079, F[1,75] = 8.309, p = .005). The final predictor added was the TOHER variable, which accounted for an additional 5.7% of the total variance, which was significant as well (ΔR^2= .057, F[1,74] = 6.377, p = .014). The entire model accounted for 34.4% of the total variance.

The stepwise regression analysis using risky healthcare decision making scores as the dependent variable reported no predictors for the regression model. Using risky healthcare decision making scores as the dependent variable hierarchical regression was used to add age into the regression model by itself. Age accounted for 0% of the total variance (ΔR^2= .000, F[1,78] = .003, p = .959), which was not significant. The model accounted for 0% of the total variance. Thus, none of the predictors were successful in predicting risky healthcare decisions.

The stepwise regression analysis using total risky decision making scores as the dependent variable resulted in three predictors. The results indicated that the first predictor was standardized Iowa Gambling Task (IGTstandardized) scores, which accounted for 12.1% of the total variance (ΔR^2= .121, F[1,78] = 10.723, p = .002). The second predictor was the average response time on the Tower of Hanoi task (TOHRT), which accounted for an extra 6.9% increment in the total variance (ΔR^2= .069, F[1,77] = 6.548, p = .012), which was statistically significant. The third predictor was raw scores on the Iowa Gambling Task (IGTraw) which accounted for an extra 5.8% of the total variance (ΔR^2= .058, F[1,76] = 5.867, p = .018), which was significant also. The entire model accounted for 24.8% of the total variance. Using total risky decision making scores as the dependent variable, hierarchical regression was used to add age into the regression model first, followed by the variables determined by the stepwise regression. Age accounted for 1.2% of the total variance (ΔR^2= .012, F[1,78] = .918, p = .341), which was not a significant portion. Adding the IGTstandardized variable resulted in an additional 14.1% of the variance to be accounted for, which was significantly more (ΔR^2= .141, F[1,77] = 12.773, p = .001). Adding the TOHRT variable caused an additional 3.8% of the variance to be accounted for, which was not significantly more (ΔR^2= .038, F[1,76] = 3.525, p = .064). The final predictor added was the IGTraw variable, which accounted for an additional 5.9% of the total variance, which was significant (ΔR^2= .059, F[1,74] = 5.886, p = .018). The entire model accounted for 24.9% of the total variance.

Grouped Stepwise Regression Analyses

The data was split based on age group and then stepwise regression analyses were conducted for each age group for each risky decision making domain and overall risky decision making. The results for financial risky decision making are presented in Table 12. The results for nutritional risky decision making are presented in Table 13. The results for healthcare risky decision making are presented in Table 14. The results for overall risky decision making are presented in Table 15.

For younger adults the stepwise regression analysis using risky financial decision making scores as the dependent variable reported average response time on the Tower of Hanoi task and demographically controlled scores on the IGT to be the only two predictors. The results indicated that the average response time on the Tower of Hanoi task accounted for 26.0% of the total variance ($\Delta R^2 = .260$, $F[1,39] = 13.344$, $p < .001$). The second predictor was IGTdemo, which accounted for an additional 15.5% of the total variance ($\Delta R^2 = .155$, $F[1,39] = 9.795$, $p = .003$), which was statistically significant. For older adults the stepwise regression analysis using risky financial decision making scores as the dependent variable reported emotional intelligence be the only predictor in the model. The results indicated that the emotional intelligence accounted for 18.7% of the total variance ($\Delta R^2 = .187$, $F[1,39] = 8.763$, $p = .005$).

For younger adults the stepwise regression analysis using risky nutritional decision making scores as the dependent variable reported gender be the only predictor in the model. The results indicated that gender accounted for 17.8% of the total variance ($\Delta R^2 = .178$, $F[1,39] = 8.243$, $p = .007$). For older adults the stepwise regression analysis using nutritional risky decision making scores as the dependent variable reported average demographically controlled scores on the IGT, errors on the Tower of Hanoi, and extroversion scores to be predictors.. The results indicated that IGTdemo scores accounted for 26.6% of the total variance ($\Delta R^2 = .266$, $F[1,39] = 13.763$, $p < .001$). The second predictor was errors on the Tower of Hanoi, which accounted for an additional 12.7% of the total variance (ΔR^2= .127, F[1,39] = 7.751, p =.008), which was statistically significant. Finally, extroversion accounted for 12.1% of the total variance (ΔR^2= .121 F[1,39] = 8.958, p =.005), which was also significant.

For younger adults the stepwise regression analysis using risky healthcare decision making scores as the dependent variable reported no predictors. The stepwise analysis for older adults reported handedness as the only predictor. The results indicated that handedness accounted for 16.1% of the total variance (ΔR^2= .161, F[1,39] = 7.300, p=.010).

For younger adults the stepwise regression analysis using overall risky decision making scores as the dependent variable reported no predictors. The stepwise analysis for older adults reported IGTdemo as the only predictor. The results indicated that IGTdemo scores accounted for 20.4% of the total variance (ΔR^2= .204, F[1,39] = 9.761, p=.003).

Moderated Regression Analyses

Moderated regression analyses were conducted using each domain of risky decision making as the outcome variable and the variables generated in the age grouped stepwise regression models as the predictor variables. Age was included as a potential moderator. The results are presented in Table 16.

For financial risky decision making there was a significant Age x TOHRT interaction, and it accounted for 20.4% of the total variance in the model ($\Delta R^2 = .204$, $F[1,76] = 4.600$, $p=.035$). There was not a significant Age x IGTdemo interaction ($\Delta R^2 = .005$, $F[1,39] = .4217$, $p=.518$), and the Age x emotional intelligence interaction was approaching significance but it was not significant ($\Delta R^2 = .039$, $F[1,39] = 3.339$, $p=.072$).

For nutritional risky decision making there were no significant interactions. There was not a significant Age x Gender interaction ($\Delta R^2 = .017$, $F[1,76] = 1.526$, $p=.220$), Age x IGTdemo interaction ($\Delta R^2 = .014$, $F[1,39] = 1.202$, $p=.276$), Age x TOHER interaction ($\Delta R^2 = .002$, $F[1,39] = .1239$, $p=.723$), or an Age x extroversion interaction ($\Delta R^2 = .003$, $F[1,39] = .2826$, $p=.597$).

For healthcare risky decision making there was a significant Age x Handedness interaction, and it accounted for 4.7% of the total variance in the model ($\Delta R^2 = .047$, $F[1,76] = 6.370$, $p=.014$).

For overall risky decision making there were no significant interactions. There was not a significant Age x IGTdemo interaction ($\Delta R^2 = .002$, $F[1,76] = 1871$, $p=.667$).

Internal Consistency of Predictor Measures

Internal consistency (Cronbach's α) measures are presented in Table 17. Cronbach's α was .77 for financial risky decision making (.77 for younger and .77 for older adults).

Cronbach's α was .57 for nutritional risky decision making (.53 for younger and .60 for older adults). Cronbach's α was .56 for healthcare risky decision making (.54 for younger and .59 for older adults). Internal consistency for financial risky decision would be rated as acceptable, nutritional risky decision making would be rated as poor, and healthcare risky decision making would be rated as poor (George & Mallery, 2003). However, previous work into this domain has reported Cronbach α's of greater than 0.5 as a measure of good internal consistency (Finucane & Guillion, 2010; Finucane et al., 2005).

Discussion

The primary goal of this research was to determine what factors predicted risky decision making, in general, and, in particular, whether older adults would show more risky decision making than younger adults. It was theorized that increased adult age, cognitive regulation, emotional regulation, and emotional arousal would all be predictors of risky decision performance in multiple risky decision making domains. The three risky decision making domains tested in the present study were: financial, nutritional, and healthcare risky decision making based upon the methods used by previous studies (Finucane & Guillion, 2010; Finucane et al., 2005). Previous research has been divided in the area of age differences in risky decision making, with some research showing no differences (Kovalchik et al., 2005; MacPherson et al., 2002) and others showing differences for older adults in certain areas (Baena et al., 2010; Denburg et al., 2001, 2005). The present research was designed to look at multiple domains of decision making and to extend upon previous research by investigating if risky decision making was influenced by age, cognitive regulation, emotional regulation, or emotional arousal and how these factors influenced one another.

The primary hypothesis of the present study was that older adults would become riskier with their risky decision making relative to younger adults because of age-related differences in cognitive and emotional regulation, as well as emotional arousal (Baena et al., 2010; Cacioppo et al., 2011; Denburg et al., 2005). However, it was observed via ANOVA analyses that there were no age main effects in overall risky decision making, or in any of the three domains of risky decision making (i.e., all p's > .05). However, additional moderated regression analyses (that allowed an examination of joint effects) did reveal a significant Age x Tower of Hanoi reaction time interaction for risky financial decision making. Younger adults who performed the Tower of Hanoi task quickly made safer decisions, while younger adults who performed slowly made riskier decisions. The response time on the Tower of Hanoi did not influence how well older adults did on the financial risky decision task. Therefore, age differences were observed for financial risky decision making, in spite of the fact that no main effect for was observed for financial decision making. Age does have an influence on financial risky decision making. Age moderates the influence of tasks measuring cognitive regulation (TOHRT; Welsh et al., 1999) for financial risky decision making tasks. However, older adults did not show riskier scores than younger adults on any of the domains of risky decision making or overall risky decision making.

Furthermore, it was observed that Tower of Hanoi errors (i.e., TOHER) and Iowa Gambling Task (i.e., IGT, Bechara et al., 2000) predicted performance in the nutritional domain and Tower of Hanoi response time (i.e., TOHRT) predicted performance in the financial domain. Because TOHRT is commonly associated with cognitive regulation/executive function—especially planning (e.g., Welsh et al., 1999) and IGT is commonly associated with emotional decision making that is the most common clinical assessment of emotional regulation (Baena et al., 2010; Bechara, Tranel, & Damasio, 2000; Denburg et al., 2005), this suggests that individual differences in cognitive and emotional regulation performances are related to risky decision making. Finally, even though there were no main effects of age in risky decision making, there were age differences on a number of tasks associated with cognitive regulation/control as well as the emotional facial discrimination task (thought to measure emotional arousal). This, combined with the moderated regression analysis indicating differential moderation of cognitive regulation with age, indicates that cognitive regulation (along with age influences) and emotional regulation play a large role in risky decision. In the following sections, I will provide possible explanations for the observed pattern of results.

The results discussed above support previous findings for age differences in cognitive regulation. Previous findings have supported the idea that older adults show worse performance than younger adults on tower tasks such as the Tower of Hanoi (e.g. Andres & van der Linden, 2001; Gilhooly et al., 1999; Vakil & Agmon-Ashinazi, 1997), thought to measure cognitive regulation/executive functioning (e.g. Welsh et al., 1999; Goel & Grafman, 1995). Significant differences on the change localization task errors and response time are also consistent with previous research which has found age-related differences in working memory capacity (Salthouse & Babcock, 1991; Salthouse, 1991), also thought to play a role in cognitive regulation and decision making (Smith, 2000; Smith & Jonides, 1999). The moderated regression analysis indicated that cognitive regulation had a differential influence on financial risky decision making depending on the age of the participant. Younger adults benefited in the financial risky decision making domain from good performance on tasks measuring components of cognitive regulation (TOHRT; Welsh et al., 1999) and they were negatively influenced by poor performance. Older adults showed no difference on financial risky decision making relative to performance on the TOHRT task. This, along with the previously mentioned age differences on the cognitive regulation tasks, indicated that there were differences in cognitive regulation with age and that these differences were differentially moderated by age with regards to financial risky decision making.

One possible explanation for the failure to observe age main effects in risky decision making is the relatively high level of education in the older-adult sample. It is important to note that years of education are considered to be a good predictor of the level of cognitive reserve (Stern, 2009). The older adults that participated were highly educated, having significantly more years of education (an average of 15.30 years of education) than the younger adult sample, which averaged 14.25 years of education. The older adult sample also scored significantly higher on the Mill Hill Vocabulary test, a common test of crystallized intelligence (Baddeley, Emslie, & Nimmo-Smith, 1993), and another predictor of cognitive reserve (Stern, 2009). The older adults in this sample were very-high functioning and likely had high levels of cognitive reserve that could have resulted in an especially high level of risky decision making performance in this group. This theory may be supported by the Age x TOHRT significant interaction in financial risky decision making. Older adults did not show any benefit from good performance on the TOHRT relative to the financial risky decision making task, while younger adults did. They also did not show any main effects of age for the financial risky decision making task. Oder adults may have been relying on their cognitive reserve to compensate for the cognitive regulation losses recorded in this sample. Therefore it makes sense that they were able to perform similarly while younger adults were negatively influenced by poor cognitive regulation performance. Younger adults may not have the cognitive reserve capacity to compensate for these losses, and therefore did poorer than their peers who showed better cognitive regulation performance.

The older adults in the experiment were also members of the young-old category, ranging from 65-74 years of age (Finucane & Guillion, 2010). Only five of the older adults met the criteria for old-older. Previous research into decision making has indicated larger effects for old-older adults than young-older adults (Finucane & Guillion, 2010). The present study did find age differences in cognitive regulation (TOH, change discrimination task) and emotional arousal (emotional facial discrimination) for the present sample of older adults, but these differences in executive function and emotional arousal did not result in main effects of age in risky decision making. However, cognitive regulation components were influenced by age in regards to financial risky decision making. Therefore, while there were no age differences on the scores on the financial risky decision making task, there were age differences overall through the influence of age on the TOHRT variable. Even given these results, it is possible that combined with the younger-old designation and the higher functioning that this sample of older adults differs from a typical sample of older adults.

The domain that was the closest to showing a significant age difference was risky financial decision making. Indeed, when using age as a continuous variable, there was a significant correlation between age and risky financial decision making. However, hierarchical regression analyses showed that this correlation effect was co-linear with other variables, and that age did not account for significant unique variance. Later moderated regression analyses did indicate a significant Age x TOHRT interaction for financial risky decision making. While, as reported above, there was no main effect of age for financial risky decision making there were age differences. Namely, younger adults who showed faster response times on the Tower of Hanoi were safer financial decision makers, while those who showed slower response times were riskier. Older adults showed no difference relative to their Tower of Hanoi performance. Therefore, while age was co-linear with other factors and didn’t directly influence financial risky decision scores, it did influence cognitive regulation components which were predictive of financial risky decision performance. It is possible that high levels of education in the older-adult sample resulted in their willingness to take more chances. Younger adults who have less access to financial experience with money may be more likely to be safer with investments, and a large weighted portion of the assessment oriented around investment opportunities. However, a more likely explanation is that older adults, who were already significantly worse in cognitive regulation components, were not able to benefit from good performance and instead had to rely on compensatory mechanisms to assist them with making risky financial decisions. This allowed them to score similarly to poorly regulating younger adults, but the younger adults who showed good cognitive regulation performance were able to make safe decisions. Older adults did not benefit from the same relationship between cognitive regulation and financial risky decision making. Older adults did display the same level of efficiency of cognitive regulation with regards to financial risky decision making that younger adults did.

As reported above, the sample of older adults was highly functioning but they were significantly different in certain conditions when compared to younger adults. The most notable of these was the effects seen on response time. Older adults were significantly slower on the Tower of Hanoi average response time, the facial affect perception time average response time, the change localization average response time, and the Stroop task average response time. All of these tasks are commonly accepted measures of cognitive regulation/executive function. The were no significant age differences on any of the total number of errors apart from the change localization task, whereupon they had significantly more errors than younger adults. The change localization task is designed to measure working memory capacity, an area that has shown differences with age (Salthouse & Babcock, 1991). The results on that particular task are in agreement with previous research. Older adults showed no other significant differences for errors but they did have much slower response times, which indicates that they can make the correct decisions but that it takes them significantly longer.

This sample of older adults was able to perform just as well as the younger adults on tasks that would normally show age effects except at a slowed response rate. The results do seem to indicate that there is some loss even in this highly functioning sample. The response time deficits appear to show an executive functioning deficit. Executive functioning research has indicated that it plays a role in the relationship between age and cognition (Salthouse et al., 2003). In this case the idea that older adults showed deficits in classic executive functioning tasks such as the Stroop task (Bechara, 2004) and the Tower of Hanoi (executive planning) (Welsh et al., 1999) suggest that there may be a general loss in an executive functioning construct in this sample. One possibility is that the older adults showed a loss in processing speed, as older adults were significantly slower in responding on all the executive functioning components. However, the present risky decision making tasks were not timed. Instead, the key issue of interest was the riskiness of the decisions. While this highly functioning sample of older adults still showed some signs of loss in cognitive processing areas, it is possible that they were able to compensate for slower processing speed by taking longer to complete the decision making tasks. These compensatory mechanisms help to explain how older adults scored similarly to younger adults on the financial risky decision task while not showing any benefit to good cognitive regulation. The data indicate that even with these losses older adults still maintain their ability to make safe decisions across different domains.

Age-Related Increases in Skill

The present results of age-related sparing of risky decision making yet with observed age decrements in cognitive regulation and emotional arousal could possibly be explained by earlier work on wisdom and expertise gains throughout the lifespan. Experience gains have also been shown to mitigate cognitive losses during risky decision making (e.g. Agarwal et al., 2009). There have also been other examples of older adults compensating for losses in processing speed using their higher levels of skill in other areas. It has been hypothesized that aging consists of processes that show decrements (e.g., processing speed) as well as increases in skill (e.g., lexical access) (Allen et al., 2002). This has been termed the decision complexity advantage applied to aging. That is, "chunking" information into larger units on the basis of more skill (e.g., holistic encoding of words into multi-letter units (e.g., Allen et al., 2002)), or using schema-level representations of text rather than smaller units such as propositions (Stine-Morrow, Miller, & Hertzog, 2006), can compensate for age-related slowing. Another example of age-related increases in skill compensating for age-related decreases in processing speed has been observed in the divided-attention literature. This was an especially surprising finding because aging researchers have claimed that age differences in processing speed may be due to age-related decreases in attentional capacity/attentional resources (Craik & Salthouse, 1992). Yet Allen et al. (2002) and Lien et al. (2006) found replicated evidence of this using a psychological refractory period, divided attention task. They observed that older adults could begin lexical access for Task 2 while simultaneously completing response selection for Task 1, but that younger adults could not do so. Further evidence of this interpretation was presented by Ruthruff, Allen, Lien, & Grabbe (2008). They used the same task as Lien et al. (2006), except they tested their younger adults on a standardized reading test and showed that younger adults at the 90th percentile rank in reading proficiency showed the same slack effects for word frequency that the older adults have exhibited in the two earlier studies—suggesting that individual differences in reading ability allow more efficient parallel processing of Task 1 response selection and Task 2 lexical access. Consequently, older adults' increased skill (relative to most younger adults) in lexical access can allow then to have more efficient parallel processing skills than younger adults. This increase in skill allowed the older adults to overcome their deficit in processing speed. In summary, as multiple results across different research paradigms suggest, age differences in processing speed may not necessarily generalize to age differences in everyday performance.

Contrary to the hypothesized prediction that older adults would show deficits in cognitive regulation components, emotional regulation measurements such as the IGT (Baena et al., 2010; Bechara et al., 2000; Denburg et al., 2005) did not show any age differences. Similar patterns have been on the IGT have been reported in some cases (e.g. Kovalchik et al., 2005) but not in others (e.g. Denburg & Harshman, 2010), so there is extant support for these results. It is possible that there is no consistent difference in emotional regulation with age, and that it may be variable between samples. Theoretically some older adults should show losses, while others will not. Previous research has supported this idea (Bechara et al, 2000). The older adults in this sample could have well maintained emotional regulation. This hypothesis is expanded upon relative to each domain below.

The emotional arousal component, the facial affect perception task, did show age differences in the speed at which older adults responded. Older adults were significantly slower in response to the faces displayed for angry, happy, and neutral faces when compared to younger adults. They did not however show any differences in the amount of errors, or in the pattern of responses. That is to say both younger and older adults responded the slowest to angry faces, followed by happy faces, and finally neutral faces. This pattern of response is replicated in some studies (Baena et al., 2010) and is not in others (Pollock et al., 2012). The age differences seen in this task could potentially be due to emotional arousal, in the sense that missed activation in early stage emotional arousal may result in a setback in the time it takes to process the faces. More in depth analysis of these responses are addressed below.

The goal of this research was to identify predictors of the risky decision making scores across the different domains. Age, cognitive regulation, emotional regulation, and emotional arousal were hypothesized to be predictors for risky decision making.

Financial Risky Decision Making

Data Connections

The financial risky decision making task was generated using the system described above. The components which were labeled the riskiest were as follows. The largest determinant of riskiness was investment size. Individuals labeled large initial investments as the most risky, and lowest initial investments as the least risky. Following this overall satisfaction also determined riskiness as well. Plans which included individuals who were very satisfied were labeled as least risky. Another component which was involved in riskiness was account management fees. Plans with high account management fees were also labeled as risky. Overall these were the largest determinants of risky choices, but a composite score was created using pilot data and data collected from individuals who were asked to report it.

The first analysis on the correlation matrix indicated a large number of significant correlations for financial risky decision making. The correlations were analyzed to identify possible relationships and guide later analyses, not to imply causality. The significant negative correlation with age indicated that there was a relationship between the two variables, and that as age increased financial risky decision making tended to increase. The results of the one-way ANOVA indicated that there was no age difference in this domain. Also, while age did show a significant negative correlation with financial risky decision making, this effect was due to the fact that age showed co-linear effects with Mill Hill Vocabulary performance, extraversion, and IGT performance. When age was entered last in a hierarchical regression equation, this predictor was no longer significant—indicating that it failed to account for unique variance. There were however significant age effects indicated by the moderated regression analysis. A significant Age x TOHRT interaction indicated that scores on the financial risky decision making task were influenced by TOHRT performance for younger adults, but not for older adults. Younger adults who performed faster on the TOHRT task made safer decisions, while those that performed slower made riskier decisions. Therefore while the One-Way ANOVA indicated that there were no age effects on financial risky decision making it was not a factorial design and did not include potential interactions. The moderated regression analysis analyzed these interactions and found that there were age differences for financial risky decision making, even if there were not main effects of age.

The significant negative correlation with the Mill Hill Vocabulary scores also indicated that crystallized intelligence played a role in how safe someone is in financial decision making. As their Mill Hill Vocabulary score increased they scored lower on the risky decision making task, indicating overall riskier decision making. This may be a result of a higher income which could result in riskier choices with money. The Mill Hill Vocabulary score did not correlate with any of the other decision making domains, so this is most likely to be the case. Significant positive correlations between scores on the risky financial decision making task and extroversion and emotional intelligence indicated a relationship there. Extroverted individuals or individuals who were high in emotional intelligence tended to be safer decision makers. A significant positive correlation was also seen between standardized IGT scores and scores on the risky financial decision making task. Standardized scores on the IGT represented how well individuals should score relative to their age, gender, and years of education. Participants who scored higher on this variable were safer decision makers. The fact that the IGT is commonly used as an assessment of risky decision making validates this correlation (Kovalchik et al., 2005). Individuals who do well relative to their demographics (age, gender, and years of education) on the IGT should make safer decisions. The largest correlation for financial decision making was average response time on the Tower of Hanoi (TOHRT). A significant negative correlation implied that individuals who took longer on the TOHRT also tended to be riskier decision makers. There were also significant negative correlations between the scores on the decision making task and change localization errors, change localization average response time, and the Stroop task incongruent average response time. Individuals who did worse on these variables tended to also be the riskier decision makers. This indicated that perhaps cognitive factors such as inhibition, working memory capacity, or the overarching executive functioning factor that was discussed earlier may play a role in how individuals make risky financial decisions. The moderated regression analysis indicated that age may influence these factors as well in financial risky decision making.

Due to the large amount of significant correlations and the fact that the contributions of these various predictors are not necessarily independent of one another a stepwise regression analysis was conducted to estimate the relative influence of the predictors. The stepwise regression analysis identified average response time on the Tower of Hanoi task (TOHRT) as the only predictor in the model. TOHRT accounted for 10.8% of the variance in scores on the financial risky decision making task on its own. The classical Tower of Hanoi task has shown in the past to measure aspects of executive functioning such as working memory and cognitive planning (Salthouse et al., 2003). The results in this experiment indicate that performance on these tasks, and perhaps performance in those executive functioning areas, may result in safer or riskier financial decision making. Individuals who are able to plan ahead (cognitive planning) or are able to work through a lot of information in a short period of time (working memory) would likely do very well in financial decision making situations. Investment techniques require the ability to appraise the situation and plan ahead, which is exactly what the Tower of Hanoi task requires participants to do. The amount of total errors on the Tower of Hanoi Task may not plot onto the same basic cognitive process and therefore it was not identified as a predictor in the model, or it may be that how long it took to process the situation and cognitively plan ahead mattered more than how well individuals did at planning ahead. In summation, it appears that some aspect of executive functioning plays a role in how safe or risky individuals are for financial decision making.

The stepwise regression analysis did not reveal age as a predictor of financial risky decision making scores, supporting the findings of no age main effects on this task identified by the earlier one-way ANOVA. In order to accurately test whether age would cause the model to have a better fit hierarchical regression was used to force age into the model. The analysis indicated that when age was forced as the first predictor that it did account for a significant portion of the variance (5%). Adding the TOHRT variable added 5.8% variance above and beyond age, also a significant portion. This finding was unexpected as age had not shown to be a significant predictor for any domain thus far. After identifying that age and the TOHRT had a very significant correlation ($r=.689$, $p<.001$) an issue of co-linearity was theorized. To test this theory a second hierarchical model was generated with TOHRT as the first predictor followed by age. In this model the TOHRT accounted for 10.8% of the variance, and age accounted for 0% of the variance. It is theorized that age being a significant predictor in the first hierarchical model was due to the co-linearity with the TOHRT variable, and not due to any significant relationship with the scores on the financial risky decision making task. In order to test this theory a structural equation model or path analysis will need to be conducted.

The original stepwise model accounted for 10.8% of the total variance, and age did not add anything to this model according to the hierarchical models. In both cases 10.8% of the total variance was still accounted for and there were two predictors instead of one. Post-hoc power analyses allow us to suggest that these results are due to no age effect. The variable that did predict the scores on the financial risky decision making task was the average response time on the Tower of Hanoi task, indicating that there may be some relationship between executive functioning measurements such as cognitive planning and working memory and how risky someone is when they make financial decisions.

The significant age x response time on the Tower of Hanoi interaction in the moderated regression analysis indicated that response time on the Tower of Hanoi influenced younger adults' scores on the financial risky decision making task, but it did not influence older adults. The coefficients indicated that younger adults who performed better on the Tower of Hanoi made safer decisions, while those that performed worse made riskier decisions. This indicated that while there is not a main effect of age on financial risky decision making, there is still an influence of age.

Theoretical Connections

A cognitive regulation variable (TOHRT) did predict performance on the financial risky decision making task, but no emotional regulation components did. One theory explaining this is that while it was a risk assessment test, the financial decision making component of this assessment contained many aspects of a DMC test. While it still involved risk, it also involved many of the same components that DMC tests also include, such as the ability to analyze the potential responses using mathematical knowledge. There was not as many emotional components in this assessment, and it involved mostly calculating the best outcomes. This outcome could either be interpreted as the safest outcome or the most profitable, and that is where the risk assessment is applied. In many cases the most profitable outcome required some investment of risk, and therefore was not necessarily the safest outcome. The basic analysis of the problem came down to finding out how much money each response would earn, and the choice would represent how much risk the individual was displaying. This would involve primarily cognitive regulation, which is represented in the results.

The regression analysis revealed the TOHRT variable as the only predictor, which is commonly used as a measure of cognitive regulation/executive functioning (e.g. Welsh et al., 1999; Goel & Grafman, 1995). The time it takes an individual to respond and make a move on Tower of Hanoi task can be directly related to a large amount of cognitive regulation components, such as cognitive planning, processing speed, or working memory (Welsh et al., 1999). The regression analysis suggests that in this sample cognitive regulation performance was indicative of financial risky decision making.

Individuals relied on processes associated with cognitive regulation, such as working memory and cognitive planning, to make decisions on the financial risky making task. Many financial tasks require the ability to work with substantial amounts of data and be able to effectively plan ahead. Many of the questions on this assessment included investment techniques, which are heavily grounded in planning. The TOHRT variable was the only predictor for financial risky decision making, indicating that individuals heavily relied on cognitive regulation components to make their financial decisions in this task. Older adults were slower on the TOHRT variable however, but there were no age main effects for financial risky decision making.

The age by response time on the Tower of Hanoi significant interaction did indicate age differences in financial risky decision making. Namely, younger adults who have better performance on the Tower of Hanoi (cognitive planning, Welsh et al., 1999) generally made safer decisions. Younger adults who had slower performances generally made riskier decisions. The older adults however did not show any differences in performance on the financial risky decision task relative to their performance on the Tower of Hanoi. This, combined with the grouped stepwise regression analysis showing performance on the Tower of Hanoi to be a predictor for younger adults and not for older adults, indicates that older adults perform similarly on the financial risky decision task to younger adults who had slower TOHRT scores. However, older adults are still significantly slower than the group of younger adults with slower scores on the Tower of Hanoi. Therefore, it is possible that the previously hypothesized compensation is enough to mitigate some losses in cognitive regulation but it is not enough to bring them to the same level as highly performing younger adults. The compensation utilized can mitigate differences between poorly performing younger adults and older adults, but the younger adults who perform well on cognitive functioning tasks will still score better on financial risky decision making tasks. It can be theorized that younger adults have more effective cognitive regulation for financial risky decision making tasks when it is performing well.

The lack of age main effects in financial risky decision making is best explained through experience. Older adults may show differences on cognitive regulation /executive functioning tasks such as the Tower of Hanoi (Andrés & van der Linden, 2001; Gilhooly et al., 1999; Vakil & Agmon-Ashinazi, 1997) which was replicated here. Other cognitive regulation tasks such as the change localization task and the Stroop task also showed age differences, which was probably associated with processing speed and working memory. There is evidence supporting the idea that expertise in areas such as finances may help to account for the losses seen in cognitive regulation components (e.g. Agarwal et al., 2009). In some cases skill gain (e.g. lexical access) can partially mitigate losses in processing speed seen through the lifespan (e.g. Allen et al., 2002). Therefore the best explanation for the lack of age differences in this case is that older adults were showing compensation through other means. They displayed slowing on the TOHRT task, which predicted performance on the financial decision making task, but they showed no overall losses on the financial decision making task. Due to the fact that this sample was collected from highly performing older adults, it is possible that their some form of compensation is occurring for losses seen in cognitive regulation areas. This compensation allowed for older adults to perform similarly to younger adults, even after showing losses in executive functioning.

This study supports the idea that cognitive regulation performance, specifically executive functioning, primarily predicts how safe an individual will be on financial risky decision making tasks. It is reasonable to assume that this is because many financial risky decision making tasks incorporate aspects that rely heavily on cognitive components such as working memory, processing speed, cognitive planning, or overall executive functioning. The reason that older adults did not show no main effects on the financial risky decision making task even after showing losses in cognitive regulation components can be attributed to increased skill or expertise throughout their lifespan. While main age effects are not seen, age-related differences on financial risky decision making scores can be seen Younger adults who display poorer cognitive functioning show reduced scores on the financial risky decision making task, similar to how the older adult sample scored. It is theorized that compensation for losses in cognitive functioning can bring older adult's performance up to the level of younger adults who do not show good cognitive regulation performance.

Nutritional Risky Decision Making

Data Connections

The nutritional risky decision making task was generated as described above. The largest determinant for risky responses was high scores in the "bad" component areas. This includes options that had high scores for fat, sodium, and carbohydrates. In general the choices that were labeled the riskiest were high in these components. Generally speaking the plans that were low in these components were labeled safer.

The analysis conducted on the correlation matrix for nutritional decision making identified a large number variables that were significantly correlated with scores on the nutritional risky decision making task. The correlations were analyzed to identify possible relationships and guide later analyses, not to imply causality. The largest correlation was between the scores on the task and standardized scores on the IGT. As individuals did better on the IGT relative to individuals sharing their demographics they tended to make safer decisions on the nutritional risky decision task. This is also shown with the significant correlation between raw scores on the IGT and scores on the nutritional risky decision making task. How well individuals performed on the IGT and how well they performed respectively, taking into account their demographics, both seem to have a relationship with how risky individuals are with their nutritional decisions. Positive correlations between both indicate that individuals who had safer scores on the IGT tasks also had safer scores on the nutritional risky decision making task. Another strong correlation seen in the matrix is between the scores on the task and gender. Women tended to have safer scores on the nutritional risky decision making task. Extroversion had a significant negative correlation with scores on this task, indicating that individuals who were more extroverted tended to be riskier nutritional decision makers. The final significant correlation was between the scores on the nutritional risky decision making task and total errors on the Tower of Hanoi task (TOHER). This correlation was negative and indicated that individuals who made more errors on the Tower of Hanoi task had riskier scores on the nutritional risky decision making task.

Once again due to the large amount of significant correlations and the fact that the contributions of these various predictors are not necessarily independent of one another a stepwise regression analysis was conducted to estimate the relative influence of the predictors. The stepwise regression analysis identified four predictors in the model. The first predictor was standardized scores on the IGT task. It accounted for 11.7% of the total variance. This makes sense, as the IGT acts as a measurement of risky decision making (Bechara et al., 2000) and individuals who score higher than expected would make safer decisions. The second predictor to come out of the model was gender. It accounted for another 9.2% of the total variance. The analyses indicated that females were more likely to have safer scores on the nutritional decision making task. There are three possible reasons for this. The first is that women are in general safer nutritional decision makers. They care about their nutrition more than men do and therefore make safer decisions regarding it. The second is that there was a much larger sample of women than men in the sample. This larger sample size may have resulted in a skewed ratio of responses. This does not seem to be the case however as gender did not predict any of the other decision making domains, nor did it significantly correlate with any of them. It is unlikely that the ratio of women to men in the sample had a role in this result. Finally, it could be that the nutritional risky decision making task was scored in a way that women would likely be safer than men. It was scored by taking into account the information which individuals were told to avoid and weighing it against those that they were told to increase. It is possible that decision making patterns vary between men and women with regards to how they prioritize nutrition and the scoring reflected that. Gender does play a role, and is a significant predictor of scores on this task, and women tended to score safer than men. The third predictor generated in the model was extroversion, which accounted for an additional 7.9% of the variance. The analyses revealed that individuals who scored higher on extroversion tended to be risker in nutritional decision making, which is supported by past research indicating that individuals who are higher in extroversion tended to make riskier decisions (Rim, 1982). Eysenck and Eysenck (1985) also found that individuals who were high in extroversion exhibited more impulsivity and poorer self-control. This would support the idea that they make riskier nutrition decisions as eating healthy requires a large amount of self-control. The final predictor in the model was TOHER, which accounted for 5.3% of the total variance. Individuals who exhibit poor self-control tend to have problems with cognitive planning tasks, such as the Tower of Hanoi. They show more errors, which is indicated here. Individuals who had more errors on the Tower of Hanoi task had riskier decisions on the nutritional risky decision making task, which is supported by the idea that they had poorer cognitive planning abilities and poorer self-control.

The stepwise regression analysis did not reveal age as a predictor of nutritional risky decision making scores, supporting the findings of no age differences on this task identified by the earlier one-way ANOVA. In order to accurately test whether age would cause the model to have a better fit hierarchical regression was used to force age into the model. When forced into the model as a predictor age only accounted for 0.1% of the total variance, which was not significant. Adding in the rest of the variables from the stepwise model brought the total variance accounted for up to 34.4%. The original stepwise model accounted for 34.1% of the total variance. This hierarchical regression model indicates that adding age to the model does not add anything. Post-hoc power analyses allow us to suggest that these results are due to no age effect. The variables that did significantly predict performance on the task were standardized scores on the IGT, gender, extroversion, and total errors on the Tower of Hanoi task. Based on these variables it appears that there is some relationship between factors such as cognitive planning, gender, and self-control and how risky someone is with their nutrition decision making.

The non-significant interactions in the moderated regression analysis indicated that there is no significant difference in how age influences the relationship between the factors and nutritional risky decision making. Therefore, it can be assumed that the factors or variables described influence nutritional risky decision making the same regardless of age. Unlike financial risky decision making, there were no age effects on nutritional risky decision making.

Theoretical Connections

The regression analyses of the nutritional risky decision making scores revealed connections to both cognitive and emotional regulation components. The primary predictor revealed in the hierarchical regression analysis was standardized scores on the IGT. Because the IGT is commonly associated with emotional regulation (Baena et al., 2010; Bechara et al.,, 2000; Denburg et al., 2005) this data indicates that emotional regulation components play a role in nutritional decision making. This is in contrast with financial decision making, which did not display any emotional regulation components in the regression analysis. Therefore nutritional risky decision making must include some form of emotional regulation, while this is not necessarily the case in financial risky decision making. The variable that was generated in the regression analysis was standardized scores on the IGT, which represented how well an individual did compared to demographically matched controls. This indicates that how well components of emotional regulation are working predict how well an individual will do on the nutritional risky decision making task.

Along with emotional regulation components nutritional risky decision making also relies on cognitive regulations components also. The amount of errors on the Tower of Hanoi task also predicted scores on the nutritional risky decision making task. As previously reported, the Tower of Hanoi is commonly used to measure cognitive regulation/executive functioning (e.g. Welsh et al., 1999; Goel & Grafman, 1995). The amount of errors on the Tower of Hanoi task was what predicted nutritional risky decision making, and that may represent a cognitive planning or working memory component. In order to make the fewest errors on the task individuals would have to plan ahead and be able to utilize other executive functioning components. These components must come into play for nutritional risky decision making as well. The questions on the nutritional risky decision making task oriented around eating healthy and minimizing poor choices with food, so individuals who plan ahead would make better choices. It also utilizes other aspects of executive functioning, such as working memory or processing speed.

The lack of age differences on the nutritional risky decision making task also need to be addressed from a theoretical perspective. Older adults did not show any age-related losses or gains on the nutritional risky decision making task. They also did not show any significant differences from younger adults on the IGT (standardized or raw). Therefore older adults had similar performance in emotional regulation components as younger adults. Based on the IGT scores there should be no age differences on nutritional risky decision making. Age-related differences on the IGT have been reported in some cases (e.g. Denburg & Harshman, 2010) but not in others (e.g. Kovalchik et al., 2005) so there is support for these results. It is possible that emotional regulation does not consistently decline in older adults, and that it may be variable between samples. Therefore some older adults show losses, while others don't. Previous research has supported this idea (Bechara et al, 2000). The older adults in this sample had well maintained emotional regulation.

There were also no age differences on the errors for the Tower of Hanoi task. They showed no significant differences from younger adults in the amount of errors they made. It is possible that the amount of errors on the Tower of Hanoi task represents a component of executive functioning that is well maintained in this sample of older adults, or that they may compensate for losses in this particular area. They show losses in the response time on the task, indicating losses in certain areas of executive functioning (potentially processing speed or cognitive planning), but do not show any significant higher amount of errors. Older adults may compensate for their losses using selective optimization with compensation (Baltes & Baltes, 1990). This theory suggests that older adults understand potential losses and problems and optimize through other means. In this case, older adults may know that they cannot process the information on the Tower of Hanoi quickly enough, and instead of rushing in with less information they take their time and make fewer mistakes. This style of responding may also allow them to perform well on the nutritional risky decision making task.

Gender and extroversion are also predictors in this model. These factors may influence the use of cognitive regulation factors or emotional regulation factors to the extent that it allows for better or poorer performance on the nutritional risky decision making task.

This study supports the idea that both cognitive regulation performance and emotional regulation performance predict how safe an individual will be on nutritional risky decision making tasks. There were no age-related differences recorded on the tasks representing emotional regulation (IGT). As previous research has been divided on this task, it is theorized that there is no consistent direction of differences in emotional regulation. There were also no age differences for the task representing cognitive regulation (TOHER) that predicted performance on the nutritional risky decision making task. It is theorized that older adults may show some executive functioning losses but that they compensate for them using selective optimization with compensation (Baltes & Baltes, 1990). This pattern of compensation may assist them in making better choices on nutritional risky decision making tasks. Overall, both emotional and cognitive regulation components influence nutritional risky decision making, validating the need for a more comprehensive look at nutritional risky decision making incorporating both of these regulation components.

Healthcare Risky Decision Making

Data Connections

The healthcare risky decision making task was generated as described above. As opposed to the nutritional and financial risky decision making tasks, there was not a complete consensus on what was labeled as risky. In general satisfaction with the plan was the largest component of risk. Plans which had high satisfaction were labeled as least risky, while those with low satisfaction were labeled as risky. After this component cost was the next factor. Some individuals labeled high cost as high risk, while others labeled high cost as low risk. Therefore this could actually be a confound for this particular component, and may explain the results.

The analysis conducted on the correlation matrix for healthcare decision making identified two variables that were significantly correlated with scores on the healthcare risky decision making task. The correlations were analyzed to identify possible relationships and guide later analyses, not to imply causality. Handedness and extroversion both had significant correlations with scores on the healthcare risky decision making task. These correlations were not very strong, so further regression analyses were done to determine if they were significant predictors.

A stepwise regression analysis was conducted to estimate the relative influence of the predictors. The stepwise regression analysis revealed no significant predictors. In order to test the hypothesis that age was a significant predictor of healthcare risky decision making scores age was forced into the equation as a predictor using hierarchical regression. Age accounted for 0.0% of the variance in this model. A post-hoc power analysis revealed that with 80 participants this model did not have enough power to estimate a small effect. Due to a too few participants being collected it cannot be proven that age had or did not have an effect on the scores on the healthcare risky decision making task. In order to make this declaration another power analysis revealed that 109 participants would be needed.

The significant Age x Handedness interaction in the moderated regression analysis indicated that handedness influenced older adults' scores on the healthcare risky decision making task, but it did not influence younger adults. The coefficients indicated that left handed older adults made riskier decisions, while right handed older adults made safer decisions. The interpretation of this result is questionable due to a low amount of power due to too few participants and no main effects.

Due to a low amount of participants there was very low power for the healthcare analysis. This led us to suggest that there were no age differences in healthcare risky decision making, but that more participants would be necessary to confirm.

Theoretical Connections

The previous results indicated that neither emotional regulation, cognitive regulation, nor emotional arousal predicted healthcare risky decision making. This could have been a problem with the task itself in that it did not tap into any of the previous processes. The significant Age x Handedness interaction is possibly due to the large majority of right handed individuals in the data set. It is possible that the six older adults who were left handed were much more risky. Due to a skewed sample of right versus left handed individuals, the lack of power, and no main effects, this interaction should not be interpreted. The lack of power and lack of significant results do not allow any theoretical connections to be drawn from this task due to too few participants.

Total Scores on Risky Decision Making

Data Connections

The analysis conducted on the correlation matrix for total risky decision making scores identified a large number variables that were significantly correlated with scores on the nutritional risky decision making task. The correlations were analyzed to identify possible relationships and guide later analyses, not to imply causality. The largest correlation was between the scores on the task and standardized scores on the IGT. As individuals did better on the IGT relative to individuals sharing their demographics they tended to make safer decisions overall. This is also shown with the significant correlation between raw scores on the IGT and overall risky decision making scores. How well individuals performed on the IGT and how well they performed compared to demographic controls both seem to have a relationship with how risky individuals are in decision making. There was also a significant negative correlation between average response times on the Tower of Hanoi task and overall risky decision making scores. As response time increased on the Tower of Hanoi task individuals had riskier scores overall. A significant negative correlation between errors on the change localization task and overall decision making scores also indicated that individuals who were riskier had more errors on the change localization task. This may be indicative of a working memory capacity issue, where individuals are not able to hold enough information in memory to make safer decisions. The change localization task has been shown to measure working memory capacity, and therefore supports this theory (Johnson et al., 2013). A significant negative correlation between the response time on the same task and overall risky decision making supports the same conclusion. The final significant correlation was a negative correlation between the Stroop effect and overall risky decision making scores. Individuals with a larger Stroop effect showed riskier decision making overall. A larger Stroop effect has been used as a marker of decreased inhibition (West & Alain, 2000). This supports the idea that individuals would have a harder time making safer decisions if they could not inhibit certain aspects of the data at hand.

Once again due to the large amount of significant correlations and the fact that the contributions of these various predictors are not necessarily independent of one another a stepwise regression analysis was conducted to estimate the relative influence of the predictors. The stepwise regression analysis identified three predictors in the model. The first predictor was standardized scores on the IGT task. It accounted for 12.1% of the total variance. The IGT acts as a measurement of risky decision making (Bechara et al., 2000) and individuals who score higher than expected would make safer decisions. Therefore it stands to reason that it would act as a predictor of overall risky decision making. The second predictor was average response time on the Tower of Hanoi task (TOHRT), which accounted for 6.9% of the variance. This supports the idea that some aspect of executive functioning plays a large role in decision making. Cognitive planning, indicated by how long individuals took to plan their moves on the TOH task, seems to be strongly predictive of how risky someone is overall. This supports the theory that individuals who have poorer cognitive planning functioning tend to make riskier decisions. They do not have the capacity to plan ahead to make the correct choices. The final predictor was raw scores on the IGT task, which accounted for 5.8% of the total variance. This was expected as the IGT is a known measure of risky decision making and raw scores on it should predict overall risky decision making scores. This does provide validation for the use of this performance-based risky decision making task, as both variables associated with the IGT were seen as predictors of overall scores on the risky decision making tasks.

The stepwise regression analysis did not reveal age as a predictor of total risky decision making scores, supporting the findings of no age differences on this task identified by the earlier one-way ANOVA. In order to accurately test whether age would cause the model to have a better fit hierarchical regression was used to force age into the model. When forced into the model as a predictor age only accounted for 1.2% of the total variance, which was not significant. Adding in the rest of the variables from the stepwise model brought the total variance accounted for up to 24.9%. With age added to the model the

TOHRT variable did not cause a significant change in variance accounted for. The original stepwise regression model accounted for 24.8% of the variance. These results indicate that adding age did not add anything to the model, and cause the TOHRT variable to not be a significant predictor. Post-hoc power analyses allow us to suggest that these results are due to no age effect. The variables that were significant performance predictors were the IGT standardized scores, the Tower of Hanoi average response time, and the IGT raw scores. Performance on the Iowa Gambling Task, along with the TOHRT variable, did predict overall performance on the risky decision making tasks.

The non-significant interactions in the moderated regression analysis indicated that there is no significant difference in how age influences the relationship between the factors and overall risky decision making. Therefore, it can be assumed that the factors or variables described influence nutritional risky decision making the same regardless of age. Even though the overall scores included scores on the financial risky decision making task, age did not have the same moderating influence on regulation components that it did for financial risky decision making.

Theoretical Connections

Total scores on the risky decision making tasks were predicted by both emotional regulation and cognitive regulation components. Both scores on the IGT (raw and standardized) and response time on the Tower of Hanoi acted as predictors for total scores on the risky decision making tasks. This validates the original concerns of a lack of research incorporating multiple components and how they may relate to risky decision making.

As hypothesized emotional regulation components do predict total risky decision making scores. Individuals' raw scores on the IGT and how well they performed relative to demographic controls are both considered good measurements of emotional regulation (Baena et al., 2010; Bechara et al., 2000; Denburg et al., 2005). The lack of age differences on these variables in this study lends support for the idea that emotional regulation does not have a consistent pattern of decline into old age. Older adults in this sample may have well maintained emotional regulation processes that are associated with the IGT. This may also be a partial reason for the lack of age differences in overall risky decision making. These individuals may rely on these well maintained emotional regulation processes to make decisions similar to how younger adults did.

The cognitive regulation component that predicted overall risky decision making scores was response time on the Tower of Hanoi. As referenced above, this represents aspects of cognitive regulation/executive functioning (e.g. Welsh et al., 1999; Goel & Grafman, 1995). Contrary to the IGT scores, there were age differences on this particular task. This is consistent with previous findings that do see age-related losses in executive functioning tasks such as the TOH (e.g. Andrés & van der Linden, 2001; Gilhooly et al., 1999; Vakil & Agmon-Ashinazi, 1997). While these age differences were present in cognitive regulation there were no age differences in overall risky decision making. The best explanation for this is expertise in certain areas or skill gains in others. This particular sample of older adults, while displaying losses in tasks measuring cognitive functioning including the Tower of Hanoi, were able to perform just as well as younger adults on risky decision making tasks overall. This could be due to their expertise in the areas measured (such as financial expertise) (e.g. Agarwal et al., 2009) or due to skill gain which may offset losses in cognitive regulation components such as processing speed (e.g. Allen et al., 2002). It is also possible that older adults are cognizant of their losses and selectively optimize and compensate (Baltes & Baltes, 1990). According to this theory, this sample of older adults did not try to rely on cognitive regulation components which may result in insufficient data, and instead they opt to either rely on other components (such as emotional regulation components) or simply take more time analyzing the data at hand. The reasoning for no effect could be any of these reasons, or a combination of them. More research into this area would need to be conducted to identify the possible cause.

The fact that the grouped stepwise model did not indicate TOHRT as a potential predictor for young and not for old as it did in financial risky decision, along with the lack of significant interactions indicated by the moderated regression analysis, indicates that age did not have an influence on the scores on overall risky decision making. It appears that while age may moderate cognitive regulation components on financial risky decision making tasks, when other components, such as nutrition and healthcare decision making, are included these age effects are no longer seen. While age did not have any main effects on the scores on risky decision making tasks, there were still age effects on financial risky decision making. This highlights the need to investigate risky decision making from multiple domains and with multiple influences. Grouping together scores on risky decision domains y removes age-related influences. Therefore it could be difficult to distinguish exactly when and where age has an effect if multiple domains are combined into one.

This study supported the idea that emotional regulation and cognitive regulation components influenced how safe individuals were on risky decision making tasks. The overall predictors of safety on risky decision making tasks were the TOHRT (executive functioning/cognitive regulation) (Welsh et al., 1999; Goel & Grafman, 1995) and the IGT (emotional regulation) (Baena et al., 2010; Bechara et al., 2000; Denburg et al., 2005). The presence of both emotional regulation and cognitive regulation components as predictors validated the need for assessment of risky decision making tasks using measurements of both regulatory components. The removal of age effects in the financial risky decision domain highlights the need to analyze risky decision making from different domains. The lack of emotional arousal components is noted, and possible reasons are expanded upon below.

Overall

Three of the four theoretical influences on risky decision making were confirmed in this experiment. Total risky decision making scores were predicted by emotional regulation components (IGT) (Baena et al., 2010; Bechara et al., 2000; Denburg et al., 2005) and cognitive regulation components (TOHRT) (Welsh et al., 1999; Goel & Grafman, 1995). Age also influenced cognitive regulation components for financial risky decision making, indicating age effects. This study was designed to highlight the importance of utilizing measurements for multiple possible influences on risky decision making, including both emotional and cognitive regulation. The data supports the idea that this was a necessary concern, as both regulatory components predicted overall scores on the risky decision making task. This study also highlighted the need to research risky decision making domains independently, as grouping domains together into one cumulative score removes potential age influences (as was seen here with financial risky decision making).

The fourth theoretical component that did not act as a predictor for any domain of risky decision making was emotional arousal (although there were age differences in emotional arousal). There are two potential reasons for this. The first reason is simply that the facial affect perception task did not effectively measure emotional arousal. However, similar tasks in the past (Baena et al., 2010) have found distinct loadings from very similar tasks onto emotional perception, which is linked to emotional arousal—and the present study did observe age differences in emotional arousal. It could potentially be that in this study, with this sample, the facial affect perception task did not elicit the same results. Participants could have potentially taken more time to analyze the task, instead of relying on implicit resources, which would not have recruited emotional arousal as clearly. The second potential reason is that emotional arousal, or tasks that measure it, simply does not influence risky decision making. It is possible that the majority of decision making, especially in complex tasks such as these, requires higher order processing which is not influenced to a great degree by changes in emotional arousal. Indeed, as reported by Carstensen and colleagues (Carstensen et al., 1999), older adults, in particular, inhibit certain types of bottom-up emotional activation. It was theorized earlier that missed activation in early emotional arousal may result in a loss that cannot be mitigated by later processes, but this would not explain why emotional arousal was also not a predictor for younger adults. In spite of the fact that there were age differences in arousal, there were no age differences on emotional regulation. Therefore it can be assumed that either differences in emotional arousal do not affect the emotional regulation components necessary to score well on the IGT and do well on risky decision making, or that there were no age differences in emotional arousal.

The multiple domain approach to risky decision making also revealed differing results. Risky financial decision making relied solely on cognitive regulation components which were influenced by age. Emotional regulation components did not play a role at all. Emotional regulation components and cognitive regulation components both influenced nutritional decision making however. Therefore it may be best to not visualize risky decision making as a universal concept. It appears that individuals, both young and old alike, rely on different mechanisms of regulation to make risky decisions in different domains. Whilst they may rely mostly on cognitive regulation components for financial risky decision making (which influence scores differently for both age groups), nutritional decision making also recruits emotional regulation components also. Therefore a single universal concept of risky decision making should not necessarily be proclaimed. This is increasingly important because as when scores were totaled into one cumulative score of risky decision making age influences into individual domains were removed. Financial risky decision making showed age influences, which while they did not influence overall scores, still showed a very important moderation of cognitive regulation.

This is also supported by the finding of age-related differences in performance on the financial risky decision making task relative to cognitive regulation. Younger adults who showed poorer performance on the Tower of Hanoi showed performance similar to older adults on the financial risky decision making task, while those who displayed good performance on the Tower of Hanoi showed significantly better performance. This finding was not shown in any of the other domains or for overall risky decision making. It is possible that older adults may compensate for losses in cognitive regulation to allow them to perform similarly to younger adults on financial risky decision making tasks. However, as this relationship doesn't exist for nutritional or overall risky decision making it appears that younger adults and older adults show no age-related differences in those areas and that younger adults do not overtly benefit from better cognitive regulation performance in either of those two areas. This stresses the need for investigation of risky decision making at domain levels using multiple factors, as there are different relationships as seen here.

Mata et al. (2011) hypothesized that differences on risky decision making tasks may be due to the task measuring them, and that they were not due to age. This study shows no age main effects in risky decision making and that the differences seen were in fact due to emotional and cognitive regulation components and, therefore, the present results appear to be consistent with the predictions of Mata et al. (2011). Whilst there were still age influences on financial risky decision making, there were no age main effects in risky decision making scores. It is possible that the tasks previously hypothesized to be responsible for differences on risky decision making tasks may recruit different regulatory components, which in turn influence responses. This may also explain potential age differences in risky decision making, as some tasks may draw upon cognitive regulation components and the scores on the task may be different due to an age moderation of cognitive regulation influences. Another possibility for varying results in risky decision making research is the variety of risky decision making domains. As shown here there is a marked difference in the regulation components used across different decision making domains. While overall risky decision making utilizes both cognitive and emotional regulatory components, the individual domains do not necessarily all recruit the same processes. They are also not influenced the same by age. Age differences were reported in financial risky decision making but not in the other two domains nor in overall risky decision making. It may be unwise to label risky decision making as an overarching concept and instead address risky decision making in different domains.

Whilst older adults showed losses in cognitive regulation components, they did not display any age main effects in risky decision making overall or even in domains solely reliant upon cognitive regulation (financial risky decision making). As suggested above this is likely due to experience or skill, and would explain potential varying performances by older adults on previous risky decision making tasks. Some older adults may have a buildup of knowledge/experience which allows them to mitigate losses in cognitive regulation (e.g. Agarwal et al., 2009) or an innate buildup of skill which allows for at least partial mitigation of losses in components such as processing speed (Allen et al., 2002). Their performance similar to poorly regulating younger adults on the financial risky decision making task supports this idea.

The results of this study indicating no age main effects in risky decision making, while at the same time showing cognitive and emotional regulation influences into domains of risky decision making, extends the meta-analysis by Mata et al. (2011) by showing that age differences in specific types of cognitive and affective processing do not necessarily lead to age differences in risky decision making. In cases where there are age differences, such as financial risky decision making, there are still no age main effects in risky decision making. Therefore even age influences on cognitive regulation in certain risky decision making domains do not result in overt age differences on scores on risky decision making domains. This idea is supported by the present research which suggests that there are no age main effects, and in fact that different domains of risky decision making may recruit different regulation components. In as such, there may be varying levels of differences in risky decision making depending on the task used, or the domain measured. Consequently, risky decision making needs to be measured by domain and with a variety of regulatory components to truly understand the influences, and it appears that individual differences needed to predict risky decision making only include increased adult age in the financial risky decision making domain. Even then age influences do not result in overt differences in risky financial decision making. It appears age does not influence risky decision making as long as this decision making does not need to be completed within a fixed (short) time period. Perhaps the present results should not come as a surprise given that the average age of corporate CEOs is close to 60 years of age—yet these individuals are known to have excellent decision-making skills.

Implications

Theoretical Implications

The major contribution from this study from a theoretical standpoint is identifying the relationship between different regulatory components and different domains of risky decision making. The results from this study show that there are distinctively different components that influence different domains of decision making, and that age only influences financial risky decision making. Even then age influences do not change overall safety in decision making.

The results of this study indicate that financial risky decision making is reliant upon aspects of cognitive regulation, such as cognitive planning or executive functioning. The present study also observed age effects on these regulatory components. Many previous studies looking into financial risky decision making have hypothesized that decrements in cognitive regulation may influence overall scores (Löckenhoff, 2011; Owen, 1997) but few have implemented behavioral tasks that measured components such as cognitive planning or executive functioning. In future tasks of financial risky decision making, especially tasks comparing age groups, measures of cognitive regulation (such as the

Tower of Hanoi) should be given as well in order to see if there are any age differences or if they are caused by other factors such as cognitive regulation.

The presence of emotional regulation and cognitive regulation components as predictors for nutritional risky decision making and overall risky decision making also indicate the need for more comprehensive analyses on these domains of risky decision making. The influences of both factors need to be addressed in future research, as they both act as predictors for performance. The fact that overall risky decision making was predicted by performance on variables thought to represent emotional regulation (IGT, Baena et al., 2010; Bechara et al., 2000) and cognitive regulation (TOH, Welsh et al., 1999) indicates the need to account for possible variations in these factors in future risky decision making tasks. The lack of age as a predictor has theoretical implications also.

Mata et al. (2011) hypothesized that there were no age differences in risky decision making and that they were in fact due to other factors such as the task. The results of the study did indicate age-related differences in how cognitive regulation influences financial decision making. There were however no age main effects for any of the decision making domains or overall risky decision making, supporting the conclusions of Mata et al. (2011) that there are no age differences in risky decision making. Studies looking into risky decision making and how it relates to aging need to account for other potential variables, as there are no consistent age differences seen. Even age differences in specific types of affective and cognitive processing, as shown in this study, do not necessarily lead to age effects in risky decision making, and therefore careful analyses need to be conducted to conclude there are truly age effects in any risky decision making study.

Policy Implications

Recent work done to aid the aging decision maker has highlighted the importance of identifying specific situations that benefit from improvements to cognition and how it relates to decision making (Mata et al., 2012). The researchers hypothesize that improvement in certain areas such as fluid abilities may result in improvements to improvements in decision quality in environments that require integration of many pieces of information.

The results of this experiment benefit the application of the notion of ecological rationality (Mata et al., 2012). This notion suggests that improving the strategy-environment fit is key to improving decision making. One way to do this is to train individuals on the use of certain strategies in particular environments, or by adjusting demands of the task to assist the fit (Mata et al., 2012). The results of this study support this idea and apply it to the domains of risky decision making.

Lowering the cognitive load of the task for risky financial decision making may assist older adults. While there are no age main effects for financial risky decision making in this study, the results do indicate that cognitive regulation components predict overall risky financial decision making and that there was an age influence on these tasks. By lowering the cognitive load through different means (ranking options, lowering information provided) better financial risky decision making can be facilitated. This applies to younger adults as well as older adults. The younger adults in this experiment who had poorer cognitive regulation showed poorer financial risky decision making, and therefore could benefit also. The implementation of assistance to lower cognitive load could assist in risky decision making across all domains.

Limitations

There are several limitations of this study. The first limitation is the fact that I used convenience samples. I did not sample many old-older adults and therefore the results may not generalize to a broader population. The sample that was obtained was highly functioning which may also not generalize to the broader population. The sample had a large number of older adults who were highly educated, and the older adult sample was significantly more educated than the younger adult sample. The results were supportive of past research into this area (Mata et al., 2011). The hypothesis of age-related differences was only supported for financial risky decision making. Past research has also not found age differences. There has been research indicating potential decision making differences between young-old and old-old adults (Finucane & Guillion, 2010) and therefore there may be differences there, but overall the sample obtained her can be used as a branching off point for more research.

A second limitation of the study was that the research did not address areas of expertise and other potential confounding variables. Levels of income or previous experience in the domains measured were not recorded and could be potential confounds. It was hypothesized that expertise or skill played a large role in compensating for age-related cognitive losses. Therefore this particular limitation is influential. By establishing expertise or wisdom measures a more thorough conceptual and factual relationship between expertise and scores on risky decision making tasks could have been created. It is entirely possible that scores on an expertise task could moderate influences of cognitive or emotional regulation variables on risky decision making. The inclusion of a variable to account for this should have been established, and not having it causes any connections to be purely conceptual. In addition to expertise, health-risk behaviors, such as smoking or drinking, could also have been assessed to obtain a measure for risky lifestyle choices. There is considerable variation in lifestyle choices in both younger and older adults, with some older adults displaying a risky lifestyle while others do not (Patterson, Haines, & Popkin, 1994). It would have been interesting to analyze lifestyle choices to see how they varied with risky decision on the present task. It would have generated some validity for the use of this particular task as a risky decision making task if the results were similar.

A third limitation of the study was the loss of the impulsivity variable, which could play a large role in decision making. Including it in the model may have changed the overall outlook of certain relationships and therefore the absence of it limited the breadth of the design. Impulsivity has been linked with changes in decision making (Wittman & Paulus, 2008) and not having it as a variable removes that potential confound.

A fourth limitation is the lack of power in the healthcare risky decision making model. The inability to detect effects in the model due to a loss of power is a definite limitation, and removes a whole domain from the design. A confirmed non-effect of age on healthcare risky decision making could not be obtained due to this limitation. While this is a limitation, conclusions could still be drawn from the data. The lack of power due to the lack of significant correlations which is due to too few participants. The lack of correlations does not allow us to theorize that there is a non-effect of age. Therefore the larger limitation may be that the task does not measure healthcare risky decision making, as indicated by the lack of correlations. It is also possible that risk is not necessarily labeled accurately in this task, as indicated by the risk rankings that were not completely clear. The entire theory behind this study was that cognitive regulation, emotional regulation, and emotional arousal components influence decision making. The fact that this was not the case with healthcare decision making but was the case with the other domains indicates that there is potentially a problem with this task. While the Cronbach α's were not necessarily low, it may be that it did not represent risky healthcare decision making.

A sixth limitation of the current study is the lack of a decision making competency assessment tool. Risky decision making was assessed but overall competency was not, and it would have distinguished this task as a risk assessment task instead of a competency test. This particular limitation is applicable mainly to financial risky decision making. It contained many similar components to decision making competency tasks and therefore being able to analyze the responses on a competence level could have alleviated this concern. It also could have established a relationship between risky decision making and decision making competence that could have been assessed.

Finally, the cross-sectional rather than longitudinal design may cause cohort effects to be interpreted as developmental changes. A longitudinal design would offer better control and would allow for age changes to be measured, but it is not fiscally sound.

Future Directions of Research

The most straightforward direction of research to move forward is using structural equation modeling (SEM) to plot the relationships of the theorized latent constructs with the measurement of risky decision making scores. Previous researchers have used SEM to plot relationships between latent constructs and decision making competency (Finucane & Gullion, 2010). Other studies have also used SEM to look for age-related effects on cognitive variables (Salthouse & Ferrer-Caja, 2003). These models allow for latent constructs to be plotted with the risky decision making construct, and the theoretical connections between executive functioning and risky decision making suggested by the previous research can also be tested. The regression models did a great job of establishing what variables affect risky decision making, but any theoretical connections with latent factors such as executive functioning or cognitive planning must be established with SEM or another high level modeling design. There is a lot of potential for more research into this area using models such as SEM.

Separate models could be created for different decision making domains to identify exactly what potential latent variables influence each domain and how large the influence is. For example, financial risky decision making could be analyzed based on factors contributing to cognitive regulation such as working memory or cognitive planning. Additionally other aspects such as processing speed could be investigated in regards to how they relate to the other higher order processes and risky financial decision making all together. Age could also be looked at in regards to how it influences these aspects of cognitive regulation. As it was identified as differentially affecting younger and older adults' cognitive regulation in financial risky decision making, a very interesting line of research would be identifying what component of cognitive regulation it affects.

These lines of research could also really expand upon the knowledge base for how emotional regulation, cognitive regulation, and emotional arousal components influence each other in risky decision making. This study showed that emotional regulation and cognitive regulation both influence risky decision making but the intricate connections could be generated and identified with SEM. An analysis with a higher order modeling system could analyze the potential influences of one factor on another to determine exactly what influences what. Baena et al. (2010) investigated this as a part of age differences and Finucane & Guillion, (2010) applied this to decision making competency, but it has yet to be applied to risky decision making on such a large scale.

Another future direction of research is to replicate this research with a different sample. Collecting a sample of old-older adults and obtaining their data on these tasks would be very interesting and may produce different results. As was described above this sample was high functioning, and it is very possible that other samples may not produce the same results. If they do not produce the same results their performance on the individual tasks may depict why that is and what affects their performance on the risky decision making tasks.

More research does need to be completed into age differences in risky decision making. As Mata et al. (2011) explained there are no consistent age differences in risky decision making in the literature. This study lends support for the hypothesis that age is not the cause for differences in risky decision making, but more research is needed to support that idea. Age-related sparing of risky decision making is seen in the literature both here and in previous research (see Mata et al, 2011) and it is extremely important that research into this area continues to look for the potential causes. This particular study supports the idea of cognitive and emotional regulatory influences, but it is a theoretical connection that needs more support.

CHAPTER IV

CONCLUSION

The goal of this study was to create a more precise examination of the cognitive dynamics (cognitive and emotional regulation, and emotional arousal) of risky decision making, as well as to how increased adult age is related to this system. This study accomplished that goal. There were no age main effects seen in the scores on financial, nutritional, healthcare, or overall risky decision making tasks. However, age differences were identified in the financial risky decision making domain. Moderated regression analyses indicated that performance on a cognitive regulation task (Tower of Hanoi (TOH), Welsh et al., 1999) differentially affected younger adults but did not affect older adults. Specifically, younger adults who performed better on the TOH task were less risky in their decision making than were younger adults who did not perform as well on the TOH task. However, individual differences in older adults' TOH performance were not related to the riskiness of their decision making. These results imply that older adults may not always have as efficient of cognitive regulation of decision making as do younger adults. Therefore it can be concluded, in support of previous research (Mata et al., 2011), that there are no age main effects in risky decision making, although the present study does suggest that age does influence financial risky decision making as a moderator.

There was a direct relationship between emotional and cognitive regulation components and the risky decision making tasks. Performance on an emotional regulation task (IGT, Baena et al., 2010; Bechara et al., 2000; Denburg et al., 2005) predicted performance on nutritional risky decision making and overall risky decision making. Performance on a cognitive regulation component (TOHRT) (Welsh et al., 1999; Goel & Grafman, 1995) predicted performance on financial and overall risky decision making tasks. In both cases better performance on the regulatory task resulted in safer decisions on the risky decision making tasks.

The absence of age main effects and the presence of cognitive and emotional regulation effects lend support for the idea that age is not the cause of differences in risky decision making (Mata et al., 2011). However, age-related differences in cognitive regulation components in the financial risky decision making domain indicate that age still influences these components in some risky decision domains. The results lead me to theorize that components that change with age, such as cognitive regulation, may be more influential than age itself on risky decision making. However, even age-related cognitive losses (such as was seen here) did not result in risky decision making losses (except for financial decision making). It is theorized that older adults compensate for losses in these areas through gains in expertise or skill throughout the lifespan.

There were no age differences on a task measuring emotional regulation (IGT; Baena et al., 2010; Bechara et al., 2000) but the IGT still predicted overall risky decision making and nutritional risky decision making. Therefore increasing age may not be a predictor of performance on risky decision making tasks, but components measuring emotional regulation are.

Previous research has suggested that age is not related to risky decision making and that differences must be due to other factors (Mata et al., 2011). This study provides support for the idea that cognitive regulation and emotional regulation play a large role in risky decision making, but that age still has a moderating influence in the financial risky decision making domain. More research is needed to investigate the potential relationships between these two factors, along with age influences, and how they may be used to assist decision makers.

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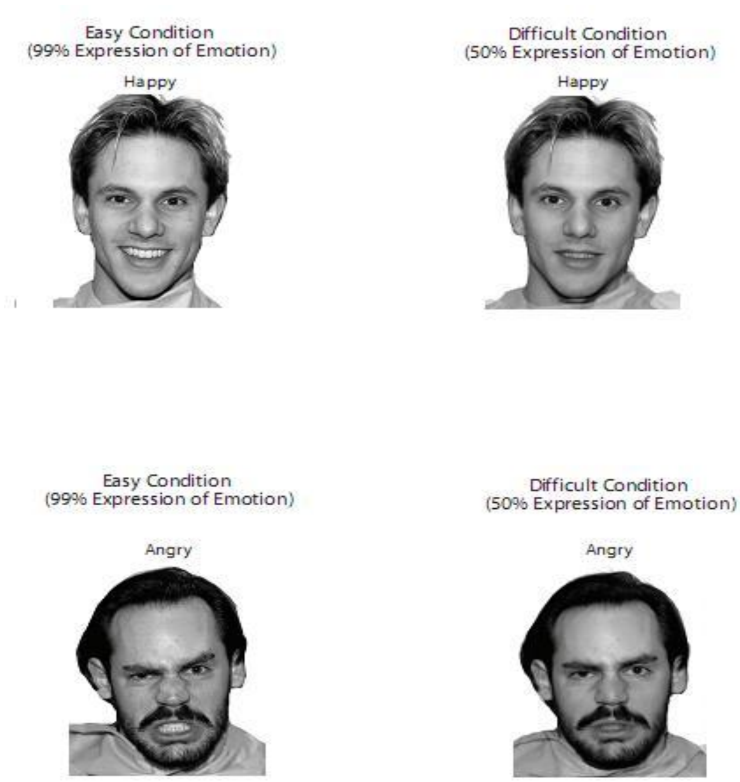
APPENDICES

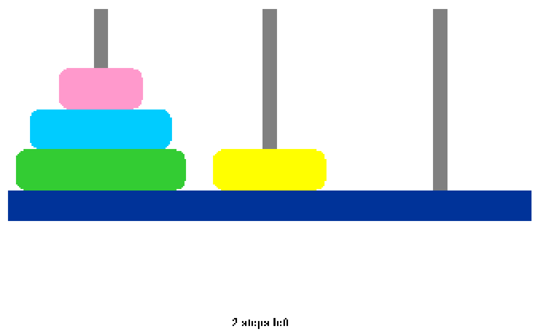
APPENDIX A

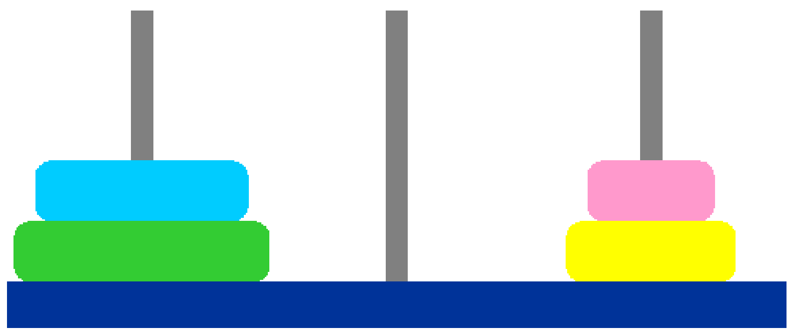
NIM-STIM FACIAL SET



APPENDIX B

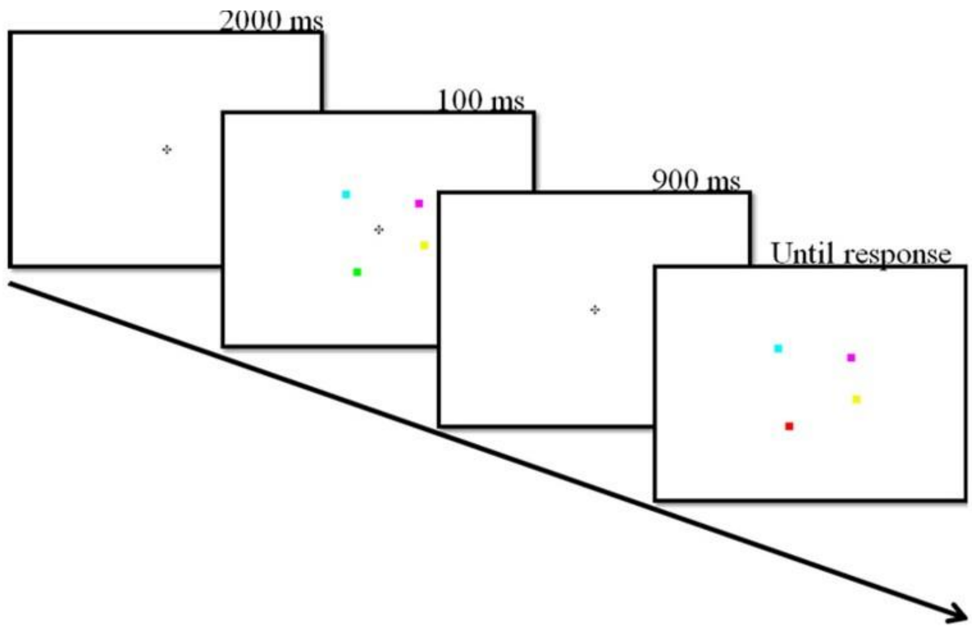
TOWER OF HANOI DISPLAY





APPENDIX C

CHANGE LOCALIZATION TASK



APPENDIX D

TABLES

Table 1.

Means (standard deviations) on individual-difference measures and tests of significant differences among age groups using one-way ANOVA

	Overall	Young	Old	Significance Test
Demographics				
Education	14.78 (2.04)	14.25 (1.40)	15.30 (2.43)	F(1,62)= 5.62, p= .02
Gender (Male=1, Female=2)	1.71 (.46)	1.75 (.44)	1.68 (.47)	F(1,78)= .54, p = .465
Handedness (Right = 1, Left =2)	1.15 (.36)	1.15 (.36)	1.15(.36)	F(1,78)= .00, p = 1.00
Paper Tests				
Mill Hill Vocab	15.30 (3.74)	17.46 (2.69)	19.63 (3.40)	F(1,78)= 39.77, p < .001
Neuroticism	19.24 (7.69)	22.08 (7.25)	16.40 (7.13)	F(1,78)= 12.45, p < .001
Extroversion	29.48 (5.39)	29.67 (5.35)	29.28 (5.51)	F(1,78)= .11, p = .743
Emotional Int.	129.09 (14.25)	132.85 (15.07)	125.33 (12.45)	F(1,78)= 5.93, p = .017
Risky Decision Making				
Nutrition DM	15.25 (3.62)	15.20 (3.88)	15.30 (3.40)	F(1,78)= .02, p = .903
Financial DM	11.36 (5.53)	12.08 (3.63)	10.65 (3.31)	F(1,78)= 3.36, p = .070
Health DM	15.65 (3.39)	15.60 (3.14)	15.70 (3.67)	F(1,78)= .02, p = .869
Total DM	42.26 (6.66)	42.88 (6.63)	41.65 (6.70)	F(1,78)= .68, p = .414
Iowa Gambling Task				
IGT Raw	9.50 (29.79)	5.40 (24.73)	13.60 (33.95)	F(1,78)= 1.53, p = .221
IGT Standardized	46.85 (10.13)	44.95 (8.47)	48.75 (11.34)	F(1,78)= 2.88, p = .094

Table 1. Continued

Means (standard deviations) on individual-difference measures and tests of significant differences among age groups using one-way ANOVA

Stroop Task				
Congruent Errors	.44 (.78)	.55 (.75)	.33 (.80)	F(1,78)= 1.69, p = .197
Incongruent RT	1723.10 (771.43)	1216.98 (432.15)	2229.23 (702.32)	F(1,78)= 60.27, p < .001
Incongruent Errors	3.20 (4.81)	3.15 (3.32)	3.25 (5.99)	F(1,78)= .01, p = .927
Stroop Effect	93.29 (209.76)	69.20 (107.44)	117.38 (276.40)	F(1,78)= 1.06, p = .307
Tower of Hanoi				
TOH errors	7.23 (5.95)	6.80 (6.82)	7.65 (4.98)	F(1,78)= .41, p =.526
TOH RT	2058.98 (833.71)	1540.28 (421.66)	2577.68 (823.59)	F(1,78)= 50.28, p <.001
Facial Affect Perception				
Angry errors	.60 (.89)	.68 (.89)	.53 (.91)	F(1,78)= .56, p =.457
Angry RT	1234.39 (334.18)	1089.23 (255.97)	1379.55 (342.73)	F(1,78)= 18.43, p <.001
Happy Errors	.563 (1.00)	.70 (1.02)	.43 (.98)	F(1,78)= 1.51, p = .223
Happy RT	1152.64 (300.66)	1001.05 (223.78)	1304.23 (293.07)	F(1,78)= 27.04, p <.001
Neutral Errors	.44 (1.39)	.53 (1.15)	.35 (1.59)	F(1,78)= .32, p = .575
Neutral RT	1142.50 (279.44)	998.78 (192.25)	1286.23 (280.80)	F(1,78)= 28.54, p <.001
Total Errors	1.59 (2.37)	1.90 (2.04)	1.28 (2.66)	F(1,78)= 1.39, p = .242
Total RT	1176.49 (282.45)	1029.65 (209.40)	1323.33 (271.16)	F(1,78)= 29.39, p <.001
Change Localization				
Change Errors	20.84 (9.12)	16.10 (8.85)	25.58 (6.64)	F(1,78)= 29.32, p <.001
Change RT	1917.50 (745.07)	1508.13 (406.47)	2326.88 (784.53)	F(1,78)= 34.35, p <.001

Table 2.

Correlations of financial risky decision making, nutritional risky decision making, healthcare risky decision making, and total risky decision making with demographic variables and individual difference measures

	Financial RDM		Nutritional RDM		Healthcare RDM		Total RDM	
	r	p	r	p	r	p	r	p
Demographics								
Age	-.223	.024	.024	.416	-.006	.480	-.108	.170
Education	-.077	.250	-.100	.188	-.143	.102	-.168	.068
Gender (Male = 1, Female = 2)	.160	.078	.336	<.001	-.009	.470	.263	.009
Handedness (Right = 1, Left = 2)	-.103	.181	-.107	.173	.199	.038	-.011	.460
Paper Tests								
Mill Hill	-.267	.008	.007	.475	.073	.261	-.100	.188
Neuroticism	.015	.449	-.062	.292	-.018	.437	-.035	.378
Extroversion	.186	.050	-.257	.011	.190	.046	.055	.313
Emotion Int.	.223	.023	.089	.216	-.015	.447	.159	.079
Iowa Gambling Task								
IGTRaw	.163	.074	.304	.003	.096	.199	.301	.003
IGTStandardized	.195	.041	.342	<.001	.113	.158	.348	<.001
Stroop Task								
CongRT	-.180	.055	.018	.437	.057	.306	-.056	.310
CongER	.163	.074	.118	.149	-.042	.356	.129	.127
NoCongRT	-.218	.026	.003	.491	.017	.439	-.105	.176
NoCongER	-.059	.302	.085	.227	-.017	.442	.007	.477
Stroop Effect	-.175	.060	-.054	.318	-.137	.113	-.192	.044
Tower of Hanoi								
TOHER	.032	.390	-.229	.021	-.111	.164	.085	.227
TOHRT	-.329	<.001	-.067	.278	-.088	.220	-.255	.011
Facial Affect Percept.								
TotalER	-.030	.395	-.039	.364	-.078	.246	-.077	.248
TotalRT	-.183	.052	-.163	.075	.009	.467	-.181	.054
Change Localization								
ChangeER	-.275	.007	-.138	.111	-.051	.327	-.247	.014
ChangeRT	-.249	.013	-.091	.212	-.014	.449	-.189	.047

Table 3.

Power analysis for the regression model with financial risky decision making scores as the dependent variable with number of participants set to 80

		Increment to R-Squared			Cumulative R-Squared		
		Number Variables in Set	Increment to R-Squared	Power for Increment	Cumulative Number Variables	Cumulative R-Square	Power for Cumulative R-Squared
1	TOHRT	1	0.110	0.89	1	0.110	0.89
2	Variables	20	0.270	0.91	21	0.380	0.98

Alpha= 0.05

Designated sets (1 to 2), Number variables = 21, Increment= 0.380
N Cases = 80, Power= 0.98

Power computations: Non-central F, Model 2 error

Table 4.

Power analysis for the regression model with nutritional risky decision making scores as the dependent variable with number of participants set to 80

		Increment to R-Squared			Cumulative R-Squared		
		Number Variables in Set	Increment to R-Squared	Power for Increment	Cumulative Number Variables	Cumulative R-Square	Power for Cumulative R-Squared
1	IGTstandarized	1	0.117	0.93	1	0.117	0.93
2	Gender	1	0.092	0.86	2	0.209	0.99
3	Extroversion	1	0.079	0.80	3	0.288	1.00
4	TOHER	1	0.053	0.63	4	0.341	1.00
5	Variables	17	0.080	0.36	21	0.421	1.00

Alpha= 0.05

Designated sets (1 to 5), Number variables = 21, Increment= 0.421
N Cases = 80, Power= 1.00

Power computations: Non-central F, Model 2 error

Table 5.

Power analysis for the regression model with healthcare risky decision making scores as the dependent variable with number of participants set to 80

		Increment to R-Squared			Cumulative R-Squared		
		Number Variables in Set	Increment to R-Squared	Power for Increment	Cumulative Number Variables	Cumulative R-Square	Power for Cumulative R-Squared
1	Variables	21	0.19	0.59	21	0.19	0.59

Alpha= 0.05

Designated sets (1 to 1), Number variables = 21, Increment= 0.19
N Cases = 80, Power= 0.59

Power computations: Non-central F, Model 2 error

Table 6.

Power analysis for the regression model with healthcare risky decision making scores as the dependent variable with power requirement set to .80

		Increment to R-Squared			Cumulative R-Squared		
		Number Variables in Set	Increment to R-Squared	Power for Increment	Cumulative Number Variables	Cumulative R-Square	Power for Cumulative R-Squared
1	Variables	21	0.19	0.80	21	0.19	0.80
	Alpha= 0.05	Designated sets (1 to 1), Number variables = 21, Increment= 0.19 N Cases = 109, Power= 0.80					

Power computations: Non-central F, Model 2 error

Table 7.

Power analysis for the regression model with total risky decision making scores as the dependent variable with number of participants set to 80

		Increment to R-Squared			Cumulative R-Squared		
		Number Variables in Set	Increment to R-Squared	Power for Increment	Cumulative Number Variables	Cumulative R-Square	Power for Cumulative R-Squared
1	IGTstandarized	1	0.121	0.92	1	0.121	0.92
2	TOHRT	1	0.069	0.72	2	0.190	0.97
3	IGT Raw	1	0.058	0.64	3	0.248	0.99
4	Variables	18	0.130	0.55	21	0.378	0.98

Alpha= 0.05

Designated sets (1 to 4), Number variables = 21, Increment= 0.378
N Cases = 80, Power= 0.98

Power computations: Non-central F, Model 2 error

Table 8.

Stepwise and hierarchical regressions with R^2 and increment in R^2 from a series of regression models with financial risky decision making scores as the dependent variable

Independent Variable	ΔR^2	Total R^2	Adj. R^2	F Test of ΔR^2
Analysis 1 - Stepwise				
Step 1: TOHRT	.108	.108	.097	F(1,78) = 9.472, p = .003
Analysis 2 - Hierarchical				
Step 1: Age	.050	.050	.037	F(1,78) = 4.068, p = .047
Step 2: TOHRT	.058	.108	.085	F(1,77) = 5.074, p = .027
Analysis 3 - Hierarchical				
Step 1: TOHRT	.108	.108	.097	F(1,78) = 9.472, p = .003
Step 2: Age	.000	.108	.085	F(1,77) = .003, p = .958

Table 9.

Stepwise and hierarchical regressions with R^2 and increment in R^2 from a series of regression models with nutritional risky decision making scores as the dependent variable

Independent Variable	ΔR^2	Total R^2	Adj. R^2	F Test of ΔR^2
Analysis 1 - Stepwise				
Step 1: IGTstandardized	.117	.117	.106	F(1,78) = 10.348, p = .002
Step 2: Gender	.092	.209	.188	F(1,77) = 8.924, p = .004
Step 3: Extroversion	.079	.287	.259	F(1,76) = 8.390, p = .005
Step 4: TOHER	.053	.341	.306	F(1,75) = 6.070, p = .016
Analysis 2 - Hierarchical				
Step 1: Age	.001	.001	-.012	F(1,78) = .045, p = .833
Step 2: IGTstandardized	.118	.119	.096	F(1,77) = 10.338, p = .002
Step 3: Gender	.090	.209	.178	F(1,76) = 8.646, p = .004
Step 4: Extroversion	.079	.288	.250	F(1,75) = 8.309, p = .005
Step 4: TOHER	.057	.344	.300	F(1,74) = 6.377, p = .014

Table 10.

Hierarchical regressions with R^2 and increment in R^2 from a regression model with healthcare risky decision making scores as the dependent variable

Independent Variable	ΔR^2	Total R^2	Adj. R^2	F Test of ΔR^2
Analysis 1 - Hierarchical				
Step 1: Age	.000	.000	-.013	$F(1,78) = .003, p = .959$

Table 11.

Stepwise and hierarchical regressions with R^2 and increment in R^2 from a series of regression models with total risky decision making scores as the dependent variable

Independent Variable	ΔR^2	Total R^2	Adj. R^2	F Test of ΔR^2
Analysis 1 - Stepwise				
Step 1: IGTstandardized	.121	.121	.110	F(1,78) = 10.723, p = .002
Step 2: TOHRT	.069	.190	.169	F(1,77) = 6.548, p = .012
Step 3: IGTraw	.058	.248	.218	F(1,76) = 5.867, p = .018
Analysis 2 - Hierarchical				
Step 1: Age	.012	.012	-.001	F(1,78) = .918, p = .341
Step 2: IGTstandardized	.141	.152	.130	F(1,77) = 12.773, p = .001
Step 3: TOHRT	.038	.190	.158	F(1,76) = 3.525, p = .064
Step 4: IGTraw	.059	.249	.209	F(1,75) = 5.886, p = .018

Table 12.

Age-grouped stepwise regressions with R^2 and increment in R^2 with financial risky decision making scores as the dependent variable

Independent Variable	ΔR^2	Total R^2	Adj. R^2	F Test of ΔR^2
Model 1 – Younger Adults				
Step 1: TOHRT	.260	.260	.240	$F(1,39) = 13.344$, $p < .001$
Step 2: IGTDemo	.155	.415	.383	$F(1,38) = 9.795$, $p =.003$
Model 2 – Older Adults				
Step 1: Emotion	.187	.187	.166	$F(1,38) = 8.763$, $p = .005$

Table 13.

Age-grouped stepwise regressions with R^2 and increment in R^2 with nutritional risky decision making scores as the dependent variable

Independent Variable	ΔR^2	Total R^2	Adj. R^2	F Test of ΔR^2
Model 1 – Younger Adults				
Step 1: Gender	.178	.178	.157	$F(1,39) = 8.243$, $p = .007$
Model 2 – Older Adults				
Step 1: IGTDemo	.266	.266	.166	$F(1,38) = 13.763$, $p < .001$
Step 2: TOHER	.127	.393	.383	$F(1,37) = 7.751$, $p = .008$
Step 2: Extro	.121	.514	.383	$F(1,36) = 8.958$, $p = .005$

Table 14.

Age-grouped stepwise regressions with R^2 and increment in R^2 with healthcare risky decision making scores as the dependent variable

Independent Variable	ΔR^2	Total R^2	Adj. R^2	F Test of ΔR^2
Model 1 – Older Adults				
Step 1: Handedness	.161	.161	.139	$F(1,38) = 7.300$, $p = .010$

Table 15.

Age-grouped stepwise regressions with R^2 and increment in R^2 with total risky decision making scores as the dependent variable

Independent Variable	ΔR^2	Total R^2	Adj. R^2	F Test of ΔR^2
Model 1 – Older Adults				
Step 1: IGTDemo	.204	.204	.183	$F(1,38) = 9.761$, $p = .003$

Table 16.

Moderated Regression Analysis Interactions with R^2 and increment in R^2 with the independent variables identified

Independent Variable	ΔR^2	Total R^2	F Test of ΔR^2
Financial Decision Making			
Age x TOHRT	.051	..159	F(1,76) = 4.600, p =.035
Age x IGTDemo	.005	.113	F(1,76) = .4217, p =.518
Age x Emotion	.039	.117	F(1,76) = 3.339, p =.072
Nutrition Decision Making			
Age x Gender	.017	.133	F(1,76) = 1.526, p =.220
Age x IGTdemo	.014	.133	F(1,76) = 1.202, p =.276
Age x TOHER	.002	.054	F(1,76) = .1239, p =.723
Age x Extroversion	.003	.117	F(1,76) = .2826, p =.597
Healthcare Decision Making			
Age x Handedness	.047	.114	F(1,76) = 6.370, p =.014
Overall Decision Making			
Age x IGTdemo	.002	.154	F(1,76) = .1871, p =.667

Table 17.

Cronbach's coefficient alpha for financial, nutritional, and healthcare risky decision making indices for each age group

	Cronbach's α		
	Overall	Younger	Older
Financial Risky Decision Making	0.77	0.77	0.77
Nutritional Risky Decision Making	0.57	0.53	0.60
Healthcare Risky Decision Making	0.56	0.54	0.59