THE ROLE OF EXECUTIVE FUNCTIONS ON AMBIVALENCE IN DECISION-MAKING

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ABSTRACT

This study investigated the age difference in ambivalence as a function of information search style, instruction conditions, and EFs using two separate decision-making paradigms: Car-purchasing scenario and Charity scenario. This study found a significantly heightened ambivalence level in older adults relative to young adults. There was no significant moderating effect of EFs on the relationship between age and information search style, or significant mediating effect of information search style on relation between age and ambivalence. This study found divergent patterns of information search styles and ambivalence as a function of instruction conditions, age, EFs, and types of scenarios, which suggests various elements that influence the level of ambivalence and decision-making difficulties.

DEDICATION

I dedicate this work to everyone who encouraged me to persevere through this journey.

LIST OF ABBREVIATIONS AND SYMBOLS

a	Cronbach's index of internal consistency
β	Beta: standard regression coefficient
F	Fisher's *F* ratio: A ration of two variances
M	Mean: the sum of a set of measurements divided by the number of measurements in the set
N	Sample Size
η_p^2	Partial eta squared: measure of effect size
p	Probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value
r	Pearson product-moment correlation
R^2	R-squared: coefficient of determination; proportion of the variation in the dependent variable that is predictable from the independent variable
SD	Standard deviation: value of variation from the mean
<	Less than
>	Greater than
=	Equal to

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INTRODUCTION

Every day, people of all ages make various types of decisions (Wansink & Sobal, 2007); hence it is crucial to maintain good decision-making skills throughout one's lifespan. Many studies indicate that as people age, they go through significant cognitive and affective changes that can impact the process and outcome of decision-making. Therefore, it is imperative that we understand how individual's cognitive and affective differences influence decision-making processes throughout the lifespan, especially with respect to older adults. The goal of the current study is to examine ambivalence as a function of age, and a role of cognitive faculties, such as executive functions, on age differences in ambivalence.

Ambivalence refers to a psychological distress of being torn between two opposing options that are conflicting (Schneider et al., 2015; van Harreveld, van der Plight, & de Liver, 2009). Per definition, ambivalence is accompanied by an experience of a negative affect for most decision-makers; due to this negative affect, most decision-makers often try to avoid the emotional distress by either avoiding the difficult decision altogether or by using heuristics (e.g., Chen, Ma, & Pethtel, 2011; Luce et al., 1997; Luce, 1998).

The evidence indicates that older adults are especially likely to delay or forgo making a decision as a way of coping with ambivalence (Chen, Ma, & Pethtel, 2011). However, elderly people are confronted with a number of complex time-sensitive decisions and taking an avoidant approach could yield disastrous consequences (e.g., decisions concerning possible cancerous tumors). For instance, some decisions are life-changing for an older adult and require careful deliberation of all options, such as relocating to a care facility, a decision on various insurances,

or a decision on retirement budgeting that can impact one's quality of life. It is imperative that researchers understand decision-making processes and the role that ambivalence plays in the decision making of older adults, as the growth in the number of older adults is unprecedented; between 2020 and 2060, the number of older adults is projected to increase by 69 percent, from 56.0 million to 94.7 million (Mather & Kilduff, 2020). This aging of the population is affecting all aspects of American life; it even has an impact on the demographic composition of the United States government. For example, the average age of the members of the house and senate of the United States Congress, is 57.6, and 62.9 respectively (Carey, 2020). These older adults who serve in congress face critical decision-making situations (e.g., whether to support new legislation). In fact, our current president is the oldest president to be elected in American history.

In this current study, I will be investigating age differences in the experience of ambivalence and how it is influenced by heuristic usage and levels of executive functioning. The purpose of this study is to examine the way in which executive functions influence decision making when decision makers are choosing only one of multiple options, when each option is associated with highly valued attributes.

Trade-Off Difficulty and Loss-Aversion in Decision-Making and Ambivalence

Decision-making is a complex cognitive process that consists of multiple basic cognitive processes. The quality of the decision is dependent upon the degree to which the decision-maker is able and willing to expend cognitive resources (Del Missier, Mantyla, & Bruine de Bruin, 2010). The expenditure of resources is especially imperative when the decision is complex and/or involves tradeoffs of highly valued attributes (Fletcher, Marks, & Hine, 2011).

Admittedly, cognitive resources are not as important when the process of choosing an option, or an alternative, is easy. For instance, when one sees an obviously superior alternative

for a given situation, one will choose that optimal option without much difficulty. Frequently decision makers are in situations that seemingly present more than just one optimal option. That realization makes the decision-making process more challenging. Luce et al., (1999) operationalized difficult decision-making situations as instances in which an individual is presented with several alternatives with highly valued attributes, and the individual is tasked with selecting an option that is most closely associated with one's core values (Luce, Bettman, & Payne, 1997). Hereafter, I will adopt Luce's definition of difficult decisions. Thus, when I use the term *difficult decision making*, I will be referring to decisions that force the decision-maker to make tradeoffs between two or more attributes that are highly valued by the decision-maker. The aforementioned type of difficult decisions are the ones most likely to result in ambivalence.

Ambivalence places one in a conflicted state, causing psychological conflict while being torn between options (Schneider et al., 2016). Many theories such as cognitive dissonance theory (Festinger, 1964) and balance theory (Heider, 1946) point out that people are intrinsically driven to minimize internal discrepancies like ambivalence, because such discrepancies can make people feel uncomfortable (Zanna & Cooper, 1974), and therefore lead to experiencing more pronounced negative affect (McGregor, Newby-Clark, & Zanna, 1999; Nordgren, Van Harreveld, & Van Der Pligt, 2006). The mechanism for such an unpleasant feeling of ambivalence can be explained through Luce and her colleagues' (1999) emotional trade-off difficulty hypothesis (Luce, Payne, & Bettman, 1999).

Emotional trade-off difficulty hypothesis suggests that when an individual is facing a situation that requires him to choose one option among many, the need for a choice implies that there will be an exchange of gain and loss; that is, in order to gain one alternative as the final choice, there must follow a form of sacrifice of letting go of all the other alternatives. Thus, the

act of choosing itself results in a trade-off and thereby elicits a sense of loss that can be unpleasant (Luce et al., 1999). Many well-renowned studies have pointed out the unpleasant nature of loss-aversion, suggesting that losses bring out stronger emotional reactions than gains and that negative emotional experiences tend to affect individuals more than positive emotional experiences (e.g., Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Rozin & Royzman, 2001; Tversky & Kahneman, 1979; Vaish, Grossmann, & Woodward, 2008).

Loss aversion can loom within the context of trade-offs in decision-making tasks. For example, let's say one is in dire need of a car and finds out that a local dealership carries two cars with different qualities (i.e., attributes). Car A is beautifully designed and equipped with modern technology while its pollution emission is quite bad. Meanwhile Car B is quite boxy and unsophisticated in design but is environmentally friendly due to its minimal pollution emission.

In this scenario, if one places a high value on both the style of the car and its impact on the environment, making a decision becomes quite difficult because one must forego at least one highly favored attribute to commit to the final choice. This realization of losing one attribute elicits a sense of loss, and due to loss aversive tendencies, trade-offs are inherently unpleasant.

Dual Process Theory in Decision-Making Paradigm

Dual process theory states that thoughts, including decisions, can arise through two different systems, known as system 1 and system 2 (Kahneman, 2003). The processes that fall under system 1 involve implicit and unconscious processes that occur automatically. The other group of cognitive processes fall under system 2, which are more explicit and conscious and require more cognitive resources (Kahneman, 2003). Often, many researchers refer to system 1 as heuristics— mental shortcuts that are often based on intuition or a rule-of-thumb, and system 2 as deliberative processes that involve careful thinking and planning.

The most representative theory of the deliberate decision-making model is the normative decision-making theory. This theory is based on economic and statistical theories (Edwards, 1954), which involve deliberate evaluation and appraisal of all options relevant to making a decision. In the past, this normative decision-making model used to be accepted by economists and behavioral scientists as the norm and had been considered to be the best strategy that leads to the most accurate decision outcome (e.g., Einhom & Hogarth, 1981; Vroom & Yetton, 1973).

According to normative theory, a decision maker is assumed to utilize rationality at all times so that she can find an option that yields the highest expected value (Eiser & van der Pligt, 2015). For instance, within the frame of normative decision-making model, a decision-maker should evaluate all options by examining every attribute and then weigh all available options by considering every consequence and probability, in order to select the one with the best value or best possible outcome. However, individuals often lack time, motivation, and working memory capacity to implement normative decision-making strategies in everyday life. Because of these constraints, individuals sometimes opt to use heuristics rather than normative decision-making strategies (Gigerenzer & Todd, 1999; Tversky & Kahneman, 1979).

Heuristics allow individuals to quickly make a decision without taxing cognitive resources (Payne, Bettman, & Johnson, 1992). As indicated earlier, in dual process theory, heuristics are often subsumed under system 1 within dual process theory (Gigerenzer, 2008). Initially many studies pointed out the flaws of heuristics because they can easily lead to biases and inaccurate assessments of risks and probabilities (Cheung & Mikels, 2011; Kahneman & Tversky, 2000; Lerner & Keltner, 2001), suggesting that a heuristic-based approach would lead to a poor decision outcome compared to a deliberative approach (Kahneman, 2011). However, some studies pointed out the adaptive and useful nature of heuristics in that they allow people to

make judgments and decisions quickly and frugally, without compromising accuracy (e.g., Bechara & Damasio, 2005; Gigerenzer, 2008; Gigerenzer & Gaissmaier, 2011; Gigerenzer & Todd, 1999). For instance, individuals who have acquired a high level of expertise tend to rely on gut feelings yet still perform well. Also, when individuals become overwhelmed from too many options, they often use heuristics to pare down their list of options (Reyna & Lloyd, 2006). As shall be discussed in the next section, people sometimes use heuristics to minimize the negative affect associated with ambivalence.

Heuristics, Emotions, and Decision-Making

Heuristics can be overarchingly described as any mental shortcuts one employs in order to make a decision quickly. Thus, some emotion-based strategies can be subsumed under the category of heuristics because in some instances, people rely on a visceral emotional reaction to make a decision rather than engaging in deliberation. For example, in some instances, decision makers use the affect heuristic, which refers to picking an option that elicits a positive affect in the decision-maker.

One of the strong early proponents of the role of emotions in decision-making was Zajonc (1980), who recognized that often the very first reactions toward any given scenarios are affective reactions. He classified these immediate affective reactions as heuristics, that occur automatically to guide the way people perceive and process information for making decisions. What made the role of heuristics more widely recognized was Damasio's somatic marker hypothesis (Damasio, 1994, 1996). Somatic markers are physiological responses that evoke gut instincts and provide affective information that help decision-makers to make a choice based on the instinctive preferences or aversions signaled by physiological responses. In other words,

somatic markers may be considered to be one of the precursors of quick and heuristic-based judgments and decisions.

As indicated earlier, decision-makers may use heuristics for various reasons such as lack of working memory capacity, or emotional distress over the decision. It has been demonstrated that people tend to mitigate ambivalence by simplifying their decision-making process, particularly when the ambivalece stems from two conflicting options or ideas. For example, individuals use heuristic shortcuts (e.g.,, comparing just one attribute that stands out instead of considering all attributes) rather than using normative strategies (i.e., examining all options and attributes objectively) to reduce the agony associated with emotional ambivalence when having to choose between two options. (Luce, 1998; Luce et al., 1997; Luce, Payne, & Bettman, 2000).

Deliberation and Ambivalence

Several studies have pointed out the significant associations between increased deliberative thinking and ambivalence (Hanze, 2001; Jonas et al., 1997; Maio et al., 1996). That is, those who tend to mull over both sides of the decision tended to show more elaborative processing of the decision-relevant information compared to those who showed clear preference of just one side (Jonas et al., 1997; Maio et al., 1996). This behavioral observation was supported in a neuroimaging study as well. In one study, participants who had to make a decision that evoked ambivalence tended to show more heightened activities in the prefrontal cortex, which is often responsible for system 2 processing, relative to those who made a decision in a non-ambivalent scenario (Nohlen, van Harreveld, Rotteveel, et al., 2014).

There have been some researchers who have examined the possibility of a relationship between a preferred mode of cognitive processing, (i.e,. systematic analyses or heuristic processing), and a likelihood of experiencing ambivalence. For instance, some studies found a

positive relationship between the utilization of system 2 and the level of ambivalence (Rudolph, 2011; Rudolph & Popp, 2007). That is, the more an individual deliberates on the topic, the more likely the person will experience ambivalnece. To elaborate further, Rudolph and Popp (2007) measured need for cognition (NFC), which is "an individual's tendency to engage in and enjoy effortful cognitive endeavors" (Cacioppo, Petty, Feinstein, & Jarvis, 1996, p.197) as a proxy measure for deliberation in decision-making, and found that those with high NFC showed higher ambivalence when making decisions.

As indicated from the aforementioned research, there are a subgroup of individuals who have the cognitive resources and the motivation to use systematic thinking to resolve ambivalence. These individuals at least have the ability to engage in careful deliberation to make sure that they will not make a hasty decision that they will later regret (Hanze, 2001; Luce et al., 1997). However, not everyone has the requisite level of cognitive resources or motivation to engage in deliberative processing when confronted with a difficult decision that is accompanied by ambivalence.

Executive Functions and Ambivalence

Decision-making has been understood as a complex cognitive process that involves an interplay of various higher-level cognitive processes such as option generation, evaluation of options and decision consequences (e.g., Baron, 2008; Hastie & Dawes, 2001). Executive functioning (EF) is a higher-level cognitive process that plays a vital role in decision making is. Originally, the first model of EFs developed by Miyake (2000) suggested that there were three subcomponents of EFs: inhibition of prepotent responses, updating and monitoring information in working memory, and shifting between mental sets and goals (Miyake et al., 2000). However, recently Friedman and Miyake have updated the EF framework and reconfigurated the

subcomponents of the EFs. Within this new conceptualization called unity/diversity framework, the inhibition component of EFs is subsumed under an overarching general EF ability and renamed as a common EF. This common EF component represents the general regulatory functions of EFs that underlie all EF tasks (Friedman & Miyake, 2017). While the inhibition component was lost within unity/diversity framework, shifting and updating components were maintained as two specific components within EFs (Friedman & Miyake, 2017).

In Friedman and Miyake's (2017) new representation of EFs, the common factor refers to individual differences in the ability to manage goals and the ability to "use the goals to bias ongoing processing." Thus, in a decision-making task, the common EF factor would be associated with the decision-maker keeping his/her primary goal active while dampening any thoughts or information inconsistent with the primary goal. Friedman and Miyake (2017) argue that goal maintenance is common in all tasks that involve EFs, in that optimal performance is dependent upon keeping the main goal active and suppressing prepotent responses or irrelevant information that could impede progress in reaching the primary goal.

Many studies report the decision-making benefits from the common factor described in Friedman and Miyake's (2017) model. For instance, within any decision-making situation, one needs to prioritize information by paying attention to relevant information and dampening less relevant information (Hasher & Zacks, 1988; Luce, 1992; Simpson & Kellas, 1989). It is also frequently necessary to update working memory when making decisions (Del Missier et al., 2013; Oscar-Berman & Marinković, 2007; Tranel, Anderson & Benton, 1994). As one obtains additional information or additional insight, one must update working memory with accurate information and hold that information during the decision-making process (Del Missier et al., 2010; Del Missier et al., 2013; Wang & Ruhe, 2007).

The link between EFs and decision-making has been demonstrated by several studies that suggest a positive relationship between various components of EFs and the ability to make optimal decisions (e.g., Brand et al., 2008; Del Missier, Mantyla, & Bruine de Bruin, 2010; Hinson, Jameson, & Whitney, 2003; Rasmussen, McAuley, & Andrew, 2007; Syngelaki et al., 2009; Toplak et al., 2010). For example, a recent study examined the impact of cognitive resources such as working memory on the ability to appropriately apply decision rules (Rosi, Bruine de Bruin, Del Missier, Cavallini, & Russo, 2019). Specifically, Rosi et al., examined older adults' ability to process information about to-be-purchased products and to make choices based on a preestablished set of criteria (Rosi, Bruine de Bruin, Del Missier, Cavallini, & Russo, 2019). For example, Rosi et al., instructed participants to follow decision rules to pick the best option in purchasing a DVD player (e.g., get as many frills as possible but don't spend over certain amount). The participants were presented with options associated with multiple attributes. The decision rules varied across decision-making tasks. Older adults did not perform as well as younger adults and working memory mediated the relation between age and decision-making performance.

Aging, Executive Functions, and deliberative processing

Executive functions (EFs) are important for decision making, particularly the type of decisions that take place in late adulthood. For example, older adults have to make important financial decisions and financial decision making is associated with the common factor in the newest EF model (Friedman & Miyake, 2017), which involves maintaining relevant goals (e.g., staying within budget) and using these goals to bias information in a decision task (e.g., suppressing information an advertiser has used to entice customers into spending more money). Unfortunately, however, the structural changes in older brains in various regions such as the

prefrontal cortex leads to poor performances on tasks that require EFs. Thus, due to the aforementioned structural neurological changes, EF diminishes with age (Greenwood, 2000; Moscovitch & Winocur, 1995; Salat et al., 2004; West, 1996).

Thus, one reason that older adults may not engage in deliberative thinking with respect to decision making is because they lack the requisite resources to employ EFs. However, another factor that contributes to age-related changes in deliberative thinking is that older adults are not always intrinsically motivated to engage in prolonged deliberative thinking unless they find it absolutely necessary (Hess & Emery, 2012). When older adults are not motivated to use EF, they are more likely than younger adults to use heuristics.

Hess and Emery (2012) have argued that older adults selectively engage cognitive resources because the age-related changes in cognitive resources makes the deployment of these resources disproportionately burdensome. Hess and Emery have found that older adults as a group will deploy cognitive resources necessary to engage in deliberative processing when the decision-making process is self-relevant, such as when they will be required to justify their decision or the issue surrounding the decision is such (social security) that it elicits a high level of personal involvement from older adults (Hess & Emery, 2012).

Another issue that may decrease the likelihood of older adults engaging in systematic objective thinking when presented with a difficult decision is the positivity bias. The positivity bias refers to a tendency to place an emphasis on positive information and feelings. It is associated with socioemotional selectivity theory and the realization that there is limited time in life with relatively few years left to live. Both positivity bias and socioemotional selectivity impact older adults in feeling motivated to focus on the positive to enhance the quality of the time that they have left to live. The positivity bias can be viewed as a form of emotion regulation

that allows people to steer away from negative thoughts and feelings by focusing on positive ones. Mather and Carstensen (2005) found that the positivity bias was more prominent in older adults who had more cognitive resources, and that the positivity bias was diminished after they engaged in a cognitively taxing task which expended their cognitive resources. (Mather & Knight, 2005).

The Mather and Knight (2005) study is especially relevant to my work. If older adults actually expend resources to maintain a positive affect and to avoid experiencing negative emotions, then their default reaction would be to suppress or avoid any situation with the potential to evoke negative emotions. A decision-making task designed to induce a high level of ambivalence might be that situation. Thus, when confronted with a difficult decision (e.g., taking away a loved one's autonomy vs. making sure loved one is safe), older adults might use heuristics to avoid experiencing the emotional turmoil that is activated when choosing between the two opposing values. My current study will investigate the relationship between EFs, and cognitive styles within ambivalence-evoking decision-making situations.

Heuristic Usage as a Function of Age

There have been several studies that pointed out the increased reliance on heuristics as people age (Mutter & Poliske, 1994; Peters, Dieckmann, & Weller, 2011; Tversky & Kahneman, 1974; Yates & Patalano, 1999). Specifically, there was one study that found more use of heuristics in older adults, relative to younger adults, which led to poorer decision quality in everyday problem-solving and decision-making (Besedeš, Deck, Sarangi, & Shor, 2012), which demonstrates a tendency to utilize heuristics within older population.

One of the reasons older adults show a higher likelihood of using heuristics is that a lifetime of experience has allowed them to learn ways of performing a task more efficiently so

that they can avoid onerous computations when performing a familiar task (Wayde, Black, & Gilpin, 2017). These shortcuts can serve as compensatory mechanisms that allow efficient performance despite age-related changes in processing speed, deliberative thinking, and working memory. That is, compensatory mechanisms can be implemented in order to counter the decrement in cognitive capacity that occurs as a function of age (Mata, Schooler, & Rieskamp, 2007; Pachur, Mata, & Schooler, 2009).

Heuristics can be practical in situations requiring an immediate resolution of problems because it is less cognitively taxing and time-consuming than deliberative processing. But this does not guarantee the best outcome since it bypasses deliberation which allows more careful surveillance and evaluation of all options (Kahneman, Slovic, Slovic, & Tversky, 1982; Nisbett & Ross, 1980). As mentioned previously, older adults tend to rely on heuristics that have worked in the past. Based on past experience, they can rely on hunches or mental shortcuts; however, reliance on mental shortcuts is associated with a downside.

There is empirical evidence that sometimes when older adults rely on heuristics, they make less than optimal choices (Brand & Markowitsch, 2010). In a recent study, younger and older adults were presented with the pros and cons of controversial issues, and were told to make a decision based solely on the evidence and to put aside any preconceived viewpoints with regard to the issue (Choi, 2019). Despite the instructions, older adults self-reported relying on preestablished opinions more than younger adults, indicating a reluctance to engage in systematic processing. Choi (2019) study also found that older adults experienced less ambivalence than younger adults. In the previous study, the lead investigator speculated that older adults experienced less ambivalence because they bypassed the deliberative processing phase of decision making and made decisions based on heuristics.

In this current study, one of the aims is to further the previous findings on ambivalence reported within older adults and assess more objective use of heuristics in searching information and investigate how this use of heuristics affects levels of ambivalence across the lifespan within a difficult decision-making paradigm.

Heuristic and Deliberative Processing and Information Search in Decision Making

The way in which I will be operationalizing deliberative and heuristic processing in the current study is through the type of information search strategy that participants use. I am basing my operationalization of deliberative vs. heuristic processing on past studies that have used the same method of distinguishing deliberative vs. heuristic information searches. There is a plethora of studies that have found that older adults examine less information than younger adults but spend more time examining information deemed important for the decision-making process (Carpenter & Yoon, 2015; Mata & Nunes, 2010; Queen et al., 2012; Weller et al., 2019). They often come to the same decision as younger adults, despite examining less information. For example, Johnson and Drungle (2000) found that older adults were able to make decisions just as well as young adults even though they used less information to come to a conclusion. Frequently, this truncated information search strategy is an adaptive strategy for older adults, especially when they have a great deal of experience within a domain (Mata & Nunes, 2010; Wayde, Black, & Gilpin, 2016). For example, Mata and Nunes (2010) conducted a meta-analysis and concluded that although older adults frequently engaged in an information search that was less extensive than younger adults, it did not hurt decision quality because of their expertise.

More recently, a study found that EFs mediated the relation between age and the type of information search favored (Fatima, Khan, Rosselli, & Ardila, 2020). Fatima et al., (2020) queried participants about the way in which they make decisions and conducted analyses to

elucidate the way in which EF affected decision style preference. Fatima et al., (2020), found that EFs were negatively correlated with styles labelled "dependent" and "avoidant." The avoidant style refers to not seeking information to make the optimal decision and essentially avoiding deliberation about the decision. The dependent style refers to seeking help from others in making a decision. Age was negatively correlated with Efs and as would be expected, older adults preferred the dependent and avoidant styles over the styles that required systematically processing and deliberating over all of the information.

Finally, Ma and Chen (2015) used a paradigm very similar to the paradigm that I plan to use in my dissertation. They based their research paradigm off of the work conducted by Luce and colleagues (Luce, Bettman, & Payne, 1997). Ma and Chen (2015) presented older and younger participants with decision scenarios that varied in emotional difficulty. They used a Mouselab software package that allowed them to trace information search strategies. They found that in instances in which the decision was emotionally difficult, older participants engaged in an attribute-based search (associated with heuristic usage) while younger adults engaged in an alternative-based search (associated with deliberative strategy).

Instructions to Manipulate Information Searching Style

Thus far, I have discussed older adults' reluctance to use deliberative processing strategies with regard to decision making because of several factors: age related declines in EFs, because of their wealth of experience, and because of their tendency to avoid difficult decisions that would force them to experience ambivalence. However, as indicated earlier, there have been studies that have shown that older adults are capable of using deliberative processing strategies when they see the need to engage in them. There is also research that shows that older adults will

engage in a systematic search when they are prompted or encouraged to do so by an experimenter (Lockenhoff & Carstensen, 2007).

Lockenhoff and Carstensen (2007) found that when older adults were not given explicit instructions to focus on all of the information, they only focused on positive information, demonstrating a positivity bias. However, when older adults were prompted to focus on all factual information, the positivity bias was minimized (Lockenhoff & Carstensen, 2007). That is, older adults were less likely to demonstrate a positivity bias in a decision-making paradigm during the information search process and showed less of a retrieval bias when recalling information (Lockenhoff & Carstensen, 2007). This shows how older adults can dampen their preference of positive information when instructed. More importantly, the Lockenhoff and Carstensen (2007) study shows that older adults can use deliberative information search strategies when instructed to do so. In the current study, I would like to use instructional manipulations similar to the ones used by Lockenhoff and Carstensen (2007). In some instances, participants will be encouraged to carefully process all of the information and in other instances, participants will be told to focus on the important information.

Need for Study

Ambivalence can elicit unpleasant emotions that can lead people to postpone making decisions via procrastinating and other avoidance mechanisms to keep unpleasant feelings at bay. Unfortunately, the aforementioned options are not the best way to address decision-making situations, considering there are many incidents where timely decision-making may be necessary. Therefore, a further investigation of its impact on decision-making is necessary. Understanding the mechanisms underlying decision making and ambivalence can help to suggest a less

emotionally and cognitively taxing way of making decisions, and thereby reduce the decision-related anxiety and discomfort.

Research Hypotheses

This study planned to investigate aging effects as well as the way in which individual differences (e.g., EFs) play a role in determining levels of ambivalence during the decision-making process. Instruction conditions were manipulated across participants. There were three instructional groups: All-Information, Selective-Information, and No- instruction (Control condition) group. After participants received instructions about how to process information associated with the various options, the options will be presented via the Mouselab software discussed earlier. This software allowed tracing the style of information search (i.e., alternative-based vs. attribution-based information search style) that participants adopted. After participants choose an option or make a decision, they will be asked to rate their level of ambivalence. My predictions centered around two dependent variables in this study: information searching style assessed via the Mouselab and felt-ambivalence measured via self-report ratings. The first set of predictions focused on information search style and then the next set of hypotheses focused on ambivalence.

First, I hypothesized that overall, older adults would be more likely to engage in deliberative processing than younger adults. I also predicted that EF would moderate the age effect on the use of heuristics. I expected that older adults with higher EF would be more likely to engage in a systematic information search and integrate the information gleaned from such a search. As indicated earlier, some studies have found an Age x EF interaction with regard to information search decision tasks (e.g., Weller, King, Figner, & Denburg, 2019).

Second, with regard to deliberative processing, I predicted an Age x Instruction interaction. I anticipated that age difference in deliberative processing would be attenuated in the All-Information condition relative to the No-instruction and the Selective-Instruction Conditions. I also predicted that EF would moderate the effect of Instruction on Age. That is, I was expecting to see older adults with high levels of EF engaging in deliberative processing more in the All-Information condition than older adults with lower levels of EF. Thus, the degree to which Age effects were attenuated in the All-information condition would be dependent upon the EF of older participants. In short, when considering hypotheses 1 and 2, I was predicting an Age x Instruction Condition x EF interaction with regard to deliberative processing. My next two hypotheses would be focused on ambivalence.

Third, I predicted that heuristic usage would mediate the relation between age and ambivalence. This third prediction was based on the findings that deliberation is associated with ambivalence (Choi, 2019) and that the propensity to deliberate decreases with age (Hess, 2014). I expected to observe the majority of older adults using heuristic processing across conditions and thereby experience less ambivalence than young adults.

Fourth, based on the previous work, I predicted that younger adults would self- report experiencing more ambivalence than older adults. Earlier work has provided evidence that the level of ambivalence is dependent upon the degree to which individuals engage in systematic deliberative processing (Choi, 2019). Because younger adults are generally more likely to engage in systematic processing than older adults, I predicted that young adults would experience more ambivalence than older adults, assuming that heuristics is the mediating factor.

Fifth, I predicted that there would be more ambivalence in the All-Information Condition than in the Selective-Information or the No-Instruction Conditions. I believed that my

instructions to process all of the information would increase the probability that participants would engage in deliberative information processing and that there is evidence that deliberative thinking increases the likelihood of ambivalence.

Sixth, I predicted that instruction condition would moderate the strength of age effects with regard to ambivalence. I also predicted that the instructions would have a bigger impact on older adults than younger adults because older adults tend to be cognitive misers and selectively engage cognitive resources (Emory, 2012). More specifically, I predicted more ambivalence in the All-Information Condition than in the No-instruction or the Selective-Instruction Conditions for older adults. In addition, for older participants, I predicted that EF would moderate the degree to which the instruction conditions affect ambivalence. Within the All-Information and Control conditions, I predicted that older adults with less EF capacity would experience less ambivalence than those with high EF capacity. I predicted that the converse would also be true. Older adults with higher EF capacity would be more likely to experience ambivalence than those with lower EF capacity within aforementioned two conditions. The relationship among variables is illustrated in Figure 1 below.

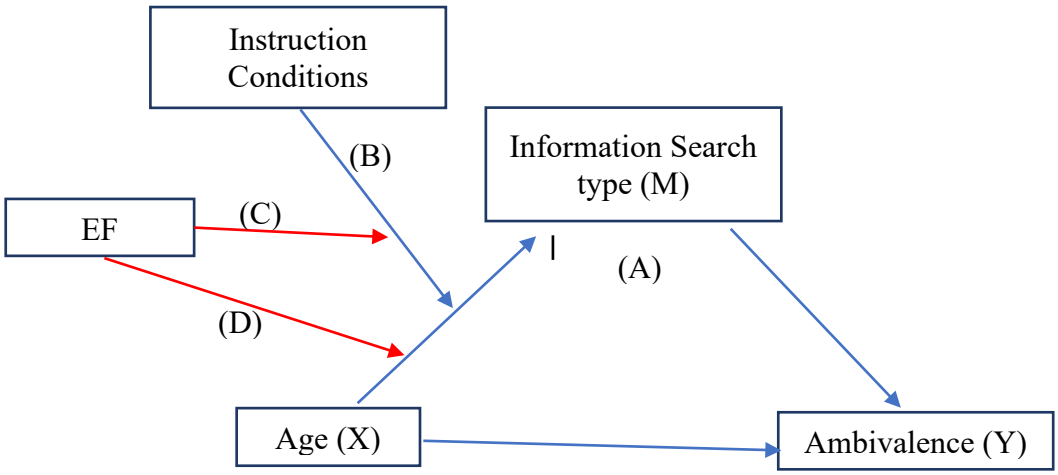

Figure 1: Hypotheses. (A) Age differences in ambivalence would be mediated via heuristic usage. (B) Instruction condition would moderate the relation between Age and heuristic usage. More specifically, there would be an increase in use of deliberative processing among the older population in the All-Information Condition relative to the No instruction than the Selective Instruction Conditions. (C) EF would affect the degree to which Instruction Conditions moderate the relations between age and heuristic usage. (D) EF would determine the degree to which older adult engage in a heuristic versus deliberative information search.

METHODS

The main study included two decision-making scenarios. The first scenario involved a Car-purchasing decision-making situation, and the second scenario involved a Charity related decision-making situation. There were four attributes, determined via pilot study, tied to each alternative presented in the car purchasing paradigm, and five attributes to the charity scenario paradigm. The main study asked participants which of the alternatives was the most appropriate decision given the attributes tied to options. The dependent variables included measures of ambivalence (i.e., conflictedness), and information search style (i.e., alternative-based vs attribute-based search).

Pilot Study

Prior to the main study, a pilot study was conducted to evaluate how important each attribute was to participants, and how much loss aversion each attribute evoked. Identifying the perceived importance as well as how much loss aversion individuals perceived for each attribute was important in creating scenarios that evoke ambivalence. For instance, an attribute associated with high loss aversion and high importance should be more difficult to give up compared to an attribute deemed to be less important and less associated with loss aversion. When forced to choose one alternative among many, especially when there are some alternatives that consist of attributes that are highly valued (i.e., high loss aversion and high importance), then having to choose one and forego the other alternatives would become challenging due to emotional discomfort that stems from loss aversion. Because my intention was to create the most

emotionally salient stimuli to maximize ambivalence, this pilot study provided an insight into the types of attributes that were perceived the most important and associated with the highest level of loss aversion.

Following Luce et al.'s (1998) paradigm, this pilot study also presented various criteria that could be considered when choosing an automobile and charity donation. The participants viewed one attribute at a time and then responded to a brief survey regarding their perceived importance and loss-aversion. The end goal of this pilot test was to gain information on the degree of loss aversion and the level of importance of each attribute, in order to construct alternatives or options that will evoke the most ambivalence.

Pilot Test Participants and Procedure

A total of 20 participants, 10 older adults and 10 young adults, were recruited. The experiment was conducted online through Qualtrics, an online survey platform. Young adult participants were recruited through the Psychology Department subject pool experiment portal and older adults were recruited through MTurk. Young adults were compensated with one course credit for their participation and older adults were compensated with three dollars for their participation. During the pilot test, participants received a list of attributes that people frequently consider in two decision-making situations mentioned above (i.e., car-purchasing, charity donation).

Two questions were posed to participants for each attribute. These two questions were from Ma and Chen (2015), that were asked to sort out attributes that participants generally find most valuable and difficult to let go. Again, the purpose of my pilot study was to create situations where participants have to choose one of the alternatives and thus give up a highly valued attribute. Based on the extant research, this type of scenario should evoke a high level of

ambivalence in part because giving up a highly valued attribute that is associated with loss aversion.

The first question established the value that participants from each age group placed on certain attributes. For example, participants were instructed to assume that they would be purchasing a car and they would be given a form that lists various attributes tied to a car (e.g., trunk space, recyclability, survival rate, etc.). Afterward, participants were asked to rate the importance of each attribute on a scale ranging from 1 (not important at all) to 7 (very important) if they were to purchase a new car. The purpose of this first question was to assess the level of importance participants perceived from each attribute.

The second question asked participants to imagine that they initially had the best value for each attribute, but then they are asked to rate how reluctant they would feel to give up a best value for a worst value of each attribute. The scale of this measure ranged from 1 (not reluctant at all) to 7 (very reluctant). The purpose of this second question was to assess the level of loss aversion associated with each attribute.

For the car purchasing scenario, I replicated the pilot study conducted by Luce et al. (1998), where they administered a pilot test to narrow down to a total of four attributes from all 13 attributes, with two most valued (i.e., high loss aversion and high importance) and two least valued (i.e., low loss aversion and low importance) attributes. Like Luce et al's (1998) study, I presented participants with only those four attributes within the decision matrix. The reason for running a separate pilot test for this study, rather than simply duplicating the previously selected attributes according to the aforementioned study of Luce et al. (1998), was to collect new data to account for potential cohort effects and age differences that might influence assessments of importance and loss aversion. I wanted to make sure that the primary study included stimuli with

appropriate attributes, given the goals of my study. For the charity scenario, the pilot test only asked the second question that taps into importance of each attribute in order to create the Selective-information condition by highlighting the most important attributes. The first question was omitted for the Charity scenario, because of the awkwardness of participants how reluctant they would feel to let go of a trait that is attributed to a person they are trying to help.

Although there may be some concerns about potential age differences in the perceived importance and loss aversion for different attributes, several studies have found that the evaluation of importance and loss aversion does not differ between young and older adult groups (e.g., Chen, Ma, Pethtel, 2011; Ma & Chen, 2015), and as I anticipated, this study's pilot test data assisted me in distinguishing attributes that were highly important and the attributes associated with the most lost aversion across age groups. More detailed explanations on the finding will be elaborated in the result section. See Table 2 and 3 for statistics.

Main Study

Participants

On the basis of the power analysis using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007), a total of 120 participants (60 younger and 60 older adults) were recruited in order to detect a medium (f=.3) effect with a power of 0.80 using a 2 (Age: Young, Old adults) x 3 (Instruction Conditions: All-Information, Selective-Information, Control) x 2 (EF: High, Low) x 2 (Information Search Types: Attribute-based, alternative-based) between-subject design ANOVA. The rationale for the number of participants is that Lockenhoff and Mathers (2007) recruited 60 older and younger adults for their very similar decision-making experiment, and their between-subject design ANOVA yielded robust results with their partial eta square ranging

from .03 to .11. In most instances, their analyses yielded an effect size that would be considered in the medium range for partial eta squared (.06).

Young adults (age 18 – 24) were recruited from students enrolled in Introductory Psychology classes and received 1.5 course credit for participating in the research as their compensation. The older participants (age 55 and older) were recruited through Mturk and were compensated monetarily after completion of the experiment (6 dollars). The informed consent form was filled out digitally by each participant prior to the experiment.

See Table 1 for statistics on demographics. All participants were asked for their age, sex, race, and education. Age of the young adults ranged from 18 – 23 (M=18.82) and older adults ranged from 55 to 73 (M=61.61). All participants self-reported being healthy. One older participant who did not meet the cut-off score established by Short Portable Mental Status Questionnaire was excluded from the analysis. All individuals included in the analysis showed no signs of cognitive impairment.

Table 1
Demographics

Demographic variables	Mean (SD or %)	range		Mean (SD or %)	range
Young adults (n=60)			Old adults (n=59)		
Age	18.82 (1.13)	18-23	Age	61.61 (5.3)	55-73
Sex			Sex		
Female	45 (75%)		Female	38 (64.4%)	
Male	15 (25%)		Male	20 (33.9%)	
Education	12 (0)	12	Education	11.49 (2.05)	12-17
Race			Race		
White/ Caucasian	47 (78%)		White/ Caucasian	55 (93.2%)	
Black/African American	5 (8.3%)		Black/African American	2 (3.4%)	
Asian	4 (6.7%)		Asian	2 (3.4%)	
Hispanic	3 (5%)				
Native Hawaiian/ Pacific Islander	1 (1.7%)				

Design and Stimuli

The main experiment included two decision making scenarios that involved choosing a car and choosing the best recipient for a charity donation. As mentioned above, for the car purchasing scenario, I adopted the design of an earlier study conducted by Luce et al (1998), where they conducted a pilot test that asked participants to rate attributes on the dimensions of loss aversion and importance, in order to pare down a list of 13 attributes to four attributes. The two attributes associated with the highest ratings of loss aversion and the two attributes deemed to be most important were selected for the primary study. Then I presented the aforementioned stimuli (two attributes associated with the highest loss aversion and two attributes rated as most important) in the decision matrix. For the Charity scenario, five attributes used in the original experiment in Luce et al.'s (1998) study were presented in the matrix without narrowing down.

Materials

Mouselab

Following Luce and his colleagues' (1997) paradigm, tasks were presented on a computer screen, and participants' information search patterns, response times, and the total number of clicks were recorded. The reason for using Mouselab is because this program allows the experimenter to track the pattern of information search by calculating how many times people viewed all attributes for each alternative while evaluating options (i.e., alternative-based information search type, therefore a proxy measure for deliberate processing) and the number of times people viewed just one attribute across all alternatives (i.e., attribute-based information search type, therefore a proxy measure for heuristics). Within the Mouselab program, decision paradigms were presented in a matrix form, and each piece of information was hidden in a box. Each row contained information pertinent to each alternative (e.g., car A) and each column

contained information about one specific attribute (e.g., survival rate). Boxes opened one at a time when participants clicked on it.

Short Portable Mental Status Questionnaire (SPMSQ)

This measure was used to screen for dementia or cognitive deficiency. This questionnaire includes 10 items and participants must score above 8 to rule out cognitive decline (Pfeiffer, 1975). In order to accommodate the online testing for this study, an 8-item version was used with three modified questions that are revised to avoid violation of MTurk confidentiality rule (Enam, 2020). The data from participants who scored below 8 were excluded from the analysis.

Emotional Baseline

Emotional experience at baseline was assessed to see whether initial emotion state would affect the intensity of felt-ambivalence. The emotional experience at baseline measure was a 19-item emotion checklist (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000) that was adapted from PANAS (Watson, Clark, & Tellegen, 1988). Participants were asked to indicate how much they experienced eight positive and 11 negative emotions on a 7-point Likert scale with responses ranging from not at all to extremely.

Executive Functions

Stroop Test. Stroop test is often administered to assess one's inhibitory control, which refers to individual's ability to inhibit prepotent responses. Because decision-making tasks generally involve weighing multiple pieces of information at once, inhibiting irrelevant information is one of the critical abilities in decision-making. Friedman and Miyake (2017) argue that there is a common EF that involves maintaining a goal and biasing subsequent processing as to maximize the goal. Inherent in the process of prioritizing relevant goals is the process of

dampening internal and external information deemed to be irrelevant. With the Stroop task, the goal is to name the font color and it is necessary to inhibit the reading response to do this.

N-back. N-back is administered to assess one's working memory capacity. As mentioned above, because there are numerous pieces of information one must simultaneously hold in working memory in order to weigh options before choosing one option. Working memory plays an important role in making a decision. Friedman and Miyake (2017) found that there was evidence of an updating executive function that was independent of the common function.

Task Switching. Task switching is used for measuring one's ability to switch tasks. In the newest model developed by Friedman and Miyake (2017), task-switch remained an EF, independent of the Common Function. This particular task presents a letter-number combination (e.g., G4, U1). When the letter-number combination appears at the top of the screen, participants are told to respond to the letter and identify whether the letter is a consonant or vowel. When the letter-number combination appears at the bottom of the screen, participants are asked to respond to the number and identify whether the number is odd or even. The location of the number-letter combination alternates randomly and participants are expected to switch between identifying letter to number, depending on the location.

Ambivalence Measure

Participants were asked to assess their anticipated ambivalence, or conflictedness, on a 5-point Likert scale when they received the decision-making scenario. Once participants finished making a decision, they rated how much ambivalence they felt while they were making the decision.

Types of Cognitive Processing

Information Search Type. A simple measure of the relative amount of deliberation-based processing patterns and heuristic-based processing patterns were calculated by subtracting the number of attribute-based transitions (i.e., sequence of information search that involves the same attribute but a different alternative) from the number of alternative based transition (i.e., information search that involves the same alternative but a different attribute) and dividing the differences by the sum of all transitions. This yielded a value ranging from -1.0 to 1.0, where lower numbers indicating relatively more attribute-based (heuristics-based) processing patterns and higher numbers indicating more alternative-based (deliberation-based) processing patterns.

Covariates

Need for Cognition. The Need for Cognition (NFC) Scale is an assessment instrument that quantitatively measures "the tendency for an individual to engage in and enjoy thinking" (Cacioppo & Petty, 1982, p. 116). This tendency can lead people to engage more in deliberative processes as well as EFs (Bertrams & Dickhäuser, 2012). In order to see the clearer relationship between EFs and information searching style, I decided to include NFC measure as one of the covarying variables.

COVID 19-Related Experiences. Because this experiment was conducted amidst the pandemic, there was a chance that many participants were impacted by heightened stress which could influence the cognitive and decision-making processes. In order to tease out the stress factor, I included two items that were designed to assess potential distress and disruption from COVID-19. The first item asked "How much are you concerned about your physical safety due to the coronavirus (i.e., COVID-19)?", and the second item asked "How much distress, in general, are you currently experiencing as it relates to coronavirus (i.e., COVID-19)?" These

items were presented on a Likert scale ranging from 1 to 7, with 1 indicating “not at all” and 7 indicating “extremely”.

Instructions

There were three instructional conditions: All-information, Selective-information and No-instruction. In the All-information condition, the instruction directed participants’ attention to all attributes available in the matrix, whereas Selective-information condition attempted to direct participants’ attention to a limited set of attributes. Before each decision-making scenario, participants were given the appropriate instructions based on the Instruction condition. In the All-information condition, participants were told, “Please consider all information, as all information provided here is important in making a good decision” whereas in the Selective-information condition, participants were told “Please only consider information that you think is important, rather than focusing on all information, for your efficient decision-making. Note that highlighted attributes are considered to be most important by many others including experts”. No-instruction condition was treated as a control condition that did not provide any additional instructions. Instructions for All-information and Selective-information conditions were adapted and modified from prior studies (Kennedy et al., 2004; Mather & Johnson, 2000). See Figure 2-5 for study procedure and instructions.

Procedure

Participants first signed the informed consent. After signing the consent, participants took Short Portable Mental Status Questionnaire (SPMSQ) to screen out individuals with impaired cognitive functioning, as well as an emotional baseline survey (i.e., the emotional checklist presented in the Materials Section) of which purpose was to assess their baseline emotions at the beginning of the experiment to make sure it did not influence ambivalence level. After the

completion, one of the three conditions were presented. There were three conditions (All-information, Selective-information, No-instruction), and two decision-making scenarios (Car-purchasing, and Charity scenario).

Within each age group, 20 participants were randomly assigned to each instructional condition (All-information, Selective-information, No-instructions). The order of the decision scenarios (Car-purchasing scenario first vs. Charity scenario first) was counterbalanced across participants.

In each decision-making scenario, participants were presented with a table with types of attributes for each alternative (e.g., price) labeled above the matrix. All the specific values designated for each attribute (e.g., good, poor, very good) were hidden from the participants. In order to review each specific piece of information, participants were instructed to move the mouse pointer into the desired cell that contains the information and then click the mouse. The information appeared when the cell was clicked and remained visible until another cell was clicked. There were no time limits and participants were able to open the same cell as many times as they desired. When participants were ready to choose one alternative, they clicked a button that said "Make Decision." A new screen prompted them to select their choice, without allowing them to view attribute values. Two practice trials were provided to familiarize participants before the main experiment.

Before each decision-making scenario, participants read brief statements explaining the importance of the individual attribute in more detail (e.g., "you will receive information about the fuel efficiency. Fuel efficiency reduces pollution and smog, and it is economical in that it reduces gas costs"). See Figure 3-5 for details on each condition instruction.

Immediately after choosing one option for each decision-making scenario, participants answered ambivalence questionnaire to self-report how much conflictedness they felt on a Likert scale ranging 1 to 5. Participants then completed a series of EF test batteries. All tests were conducted online through MTurk. Participants were given two optional breaks in between.

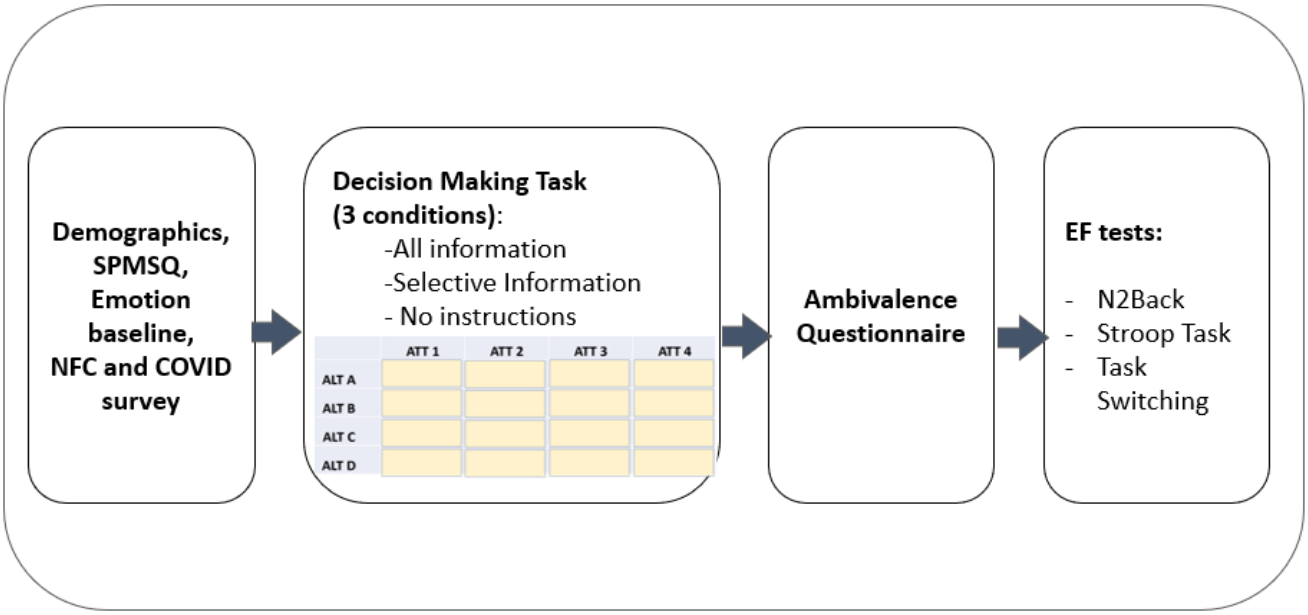

Figure 2: Procedure of the Experiment.

Decision Scenario

After your reliable vehicle broke down, you are trying to buy a car from a dealership. You have learned that there are 5 cars that are within your budget. Because you need a car urgently, you need to purchase one of the 5 cars today. The dealership provided the following information for each car:

Recycling Potential:
Whether the car can be recycled after is important because you are trying to be conscious of the environment.

Occupant Survival Rate:
The occupant survival rate is considered important because you are trying to make sure that the car can guarantee better safety even when you get in an accident.

Trunk Space:
The trunk space is considered important because you often find yourself having to carry various items/ tools/ bags with you.

Breakdown Frequency:
The breakdown frequency is important because you want to avoid a car that often has problems when traveling.

****Please consider all information carefully, as all information provided here is important in making a good decision****

Figure 3: Instructions for All-information Condition

Decision Scenario

After your reliable vehicle broke down, you are trying to buy a car from a dealership. You have learned that there are 5 cars that are within your budget. Because you need a car urgently, you need to purchase one of the 5 cars today. The dealership provided the following information for each car:

Recycling Potential:
Whether the car can be recycled after is important because you are trying to be conscious of the environment.

Occupant Survival Rate:
The occupant survival rate is considered important because you are trying to make sure that the car can guarantee better safety even when you get in an accident.

Trunk Space:
The trunk space is considered important because you often find yourself having to carry various items/ tools/ bags with you.

Breakdown Frequency:
The breakdown frequency is important because you want to avoid a car that often has problems when traveling.

****Only consider information that you think is important, rather than focusing on all information, for your efficient decision-making.****

Note that Occupant survival and Pollution/MPG are the attributes that are considered to be most important by many others including experts. **Important attributes are highlighted in the matrix box.**

Figure 4: Instructions for Selective-information Condition

Decision Scenario

After your reliable vehicle broke down, you are trying to buy a car from a dealership. You have learned that there are 5 cars that are within your budget. Because you need a car urgently, you need to purchase one of the 5 cars today. The dealership provided the following information for each car:

Recycling Potential:
Whether the car can be recycled after is important because you are trying to be conscious of the environment.

Occupant Survival Rate:
The occupant survival rate is considered important because you are trying to make sure that the car can guarantee better safety even when you get in an accident.

Trunk Space:
The trunk space is considered important because you often find yourself having to carry various items/ tools/ bags with you.

Breakdown Frequency:
The breakdown frequency is important because you want to avoid a car that often has problems when traveling.

Figure 5: Instructions for No-instruction Condition

RESULTS

Pilot Study Participants and Procedure

The pilot study was conducted to make sure that the materials chosen for the scenarios were effective in inducing ambivalence. Earlier research (Luce et al., 1997), has shown that ambivalence is heightened when a decision requires a trade-off between two factors: importance of the attribute and the loss aversion associated with the attribute. This pilot study was administered to determine which attributes associated with buying a car or donating to a charity were deemed to be most important and associated with the most loss aversion among young and older adults. 10 young adults and 10 older adults were recruited for this online pilot study.

Pilot Study Results

See Table 2 for statistics on the car purchasing scenario pilot data. In reviewing the pilot study data, both older and younger adults indicated that Occupant Survival Rate and Breakdown Frequency were highly important and most associated with loss aversion. On the other hand, Recycling Potential and Trunk Space were two attributes deemed to be some of the least important and associated with the lowest loss aversion. Based on the findings of the pilot study, I decided to include the aforementioned attributes for the car-purchasing decision scenario.

Table 3 depicts the pilot data statistics for the charity scenario. Both older and younger adults reported Personality and Living Condition of the child to be most important attribute. Unlike the car purchasing scenario, I did not query participants about loss aversion with regard to the charity scenario. I thought that participants would be uncomfortable making loss aversion judgments about attributes of a child.

Loss Aversion

An independent t-test was conducted to assess whether there was a significant difference in the self-reported loss aversion as a function of age. The data yielded a significant age difference ($t(18)=-4.99$, $p<.001$) in that the loss aversion reported by older adults was significantly higher than that of young adults (Older adults: $M=5.21$, $SD=.43$; Young adults: $M=3.98$, $SD=.65$).

Table 2
Pilot Data on Mean Importance (SD) and Loss Aversion for the Car Purchase Scenario

Importance

	Breakdown frequency	Accident avoidance	Maintenan ce cost	Routine maintenan ce	Car appearanc e	Interior roominess	Occupant survival	Accelerati on	Noise & Vibration	Sound system	Pollution caused	Trunk space	Treatment of workers	Recycling potential
Young adults	6.4 (1.26)	5.9 (1.20)	5.7 (1.89)	5.8 (1.69)	4.6 (2.41)	5.1 (1.37)	6.3 (.95)	4.5 (1.72)	4.7 (2.21)	4.4 (1.51)	3.8 (1.55)	3.4 (1.73)	3.2 (1.23)	2.4 (1.43)
Older adults	5.9 (.88)	5.2 (1.03)	5.6 (1.51)	5.8 (.79)	5.3 (1.34)	4.7 (.95)	5.9 (1.00)	5.7 (1.16)	5.1 (.74)	5.3 (1.42)	5.0 (1.41)	4.4 (1.35)	5.6 (1.07)	4.4 (2.12)

Loss Aversion

	Breakdown frequency	Accident avoidance	Maintenan ce cost	Routine maintenan ce	Car appearanc e	Interior roominess	Occupant survival	Accelerati on	Noise & Vibration	Sound system	Pollution caused	Trunk space	Treatment of workers	Recycling potential
Young adults	5.6 (1.71)	5.4 (1.51)	5.1 (1.07)	4.7 (1.83)	4.6 (1.90)	3.7 (1.70)	5.8 (1.55)	3.5 (1.51)	3.2 (1.69)	2.9 (1.79)	2.3 (1.42)	2.7 (1.63)	3.0 (1.63)	2.6 (1.96)
Older adults	6.2 (.63)	5.1 (1.98)	5.3 (.95)	5.4 (.84)	4.9 (1.45)	5.3 (.95)	5.6 (.97)	5.3 (.95)	5.2 (.95)	4.6 (.95)	5.5 (1.08)	4.7 (1.16)	5.4 (.84)	4.3 (2.05)

Table 3
Pilot Data on Mean Importance (SD) for the Charity Scenario

	Importance				
	IQ	Age	Personality	Family Size	Living Condition
Older adults mean (SD)	4.75 (1.72)	3.32 (1.70)	5.00 (1.55)	4.65 (1.83)	4.77 (1.83)
Young adults mean (SD)	4.91 (1.30)	4.36 (1.43)	5.55 (1.21)	5.45 (1.44)	6.36 (1.21)

Main analysis

In the main study, one of my primary goals was to determine if there were age differences in felt ambivalence. I predicted that the relation between age and ambivalence would be mediated via the information search style (i.e., attribute vs alternative-based searching style). Although overall I predicted that young adults would engage in deliberative processing more than older adults, I also predicted that the age differences in information searching style would be moderated by Instruction conditions and EFs. To manipulate Instruction Conditions, I varied the extent to which I encouraged participants to engage in different types of information searching styles.

My first analyses examined whether there were age differences in levels of felt ambivalence in the Car-purchasing scenario as a function of Instruction Condition. This analysis was followed by an examination of felt ambivalence in the Charity scenario. As noted earlier, the level of felt ambivalence was measured by participants' self-report of conflictedness.

Effects of Age and Instruction Condition (All, selective, none) on Ambivalence

Car Purchasing Scenario. I conducted a 2 Age (Young vs. Old) x 3 Instruction Condition (All Information vs. Selective-Information vs. No-Instructions) ANOVA to determine the way in which Age and Instruction conditions impacted felt-ambivalence. NFC and COVID

were treated as covariates. There was no significant interaction between age and instruction condition on the level of ambivalence. However, I found a significant main effect of Age ($F(1,111)=4.58$, $p=.035$ $\eta_p^2= .04$) indicating that older adults experienced more overall ambivalence ($M=3.44$, $SD=1.27$) than young adults ($M=3.0$, $SD=.81$). There was no significant main effect of instruction conditions on the perceived ambivalence ($F=(2, 111)=.62$, $p=.54$, $\eta_p^2= .01$).

Table 4 and Figure 6 present the data as a function of Instruction Condition and Age, which also show that older adults self-reported experiencing more ambivalence than younger adults. Note that ambivalence was evoked the most within the Selective-information condition for both age groups. My findings were surprising because I had initially predicted that younger adults would experience greater felt ambivalence than older adults and that the greater ambivalence would be reported within the All-information condition for both age groups. Further explanations regarding this finding will be discussed in the discussion section. I next examined age differences in ambivalence in the charity scenario. Recall that in the charity scenario participants were asked to select a child that would be the best recipient of a monetary donation to improve her life.

Table 4
Car Purchasing Scenario: Mean Ambivalence as a Function of Instruction Condition and Age

	Age	
Condition	Younger	Older
All information	2.65 (.49)	3.5 (1.19)
Selective information	3.2 (.89)	3.58 (1.39)
No instructions	3.0 (.81)	3.44 (1.27)

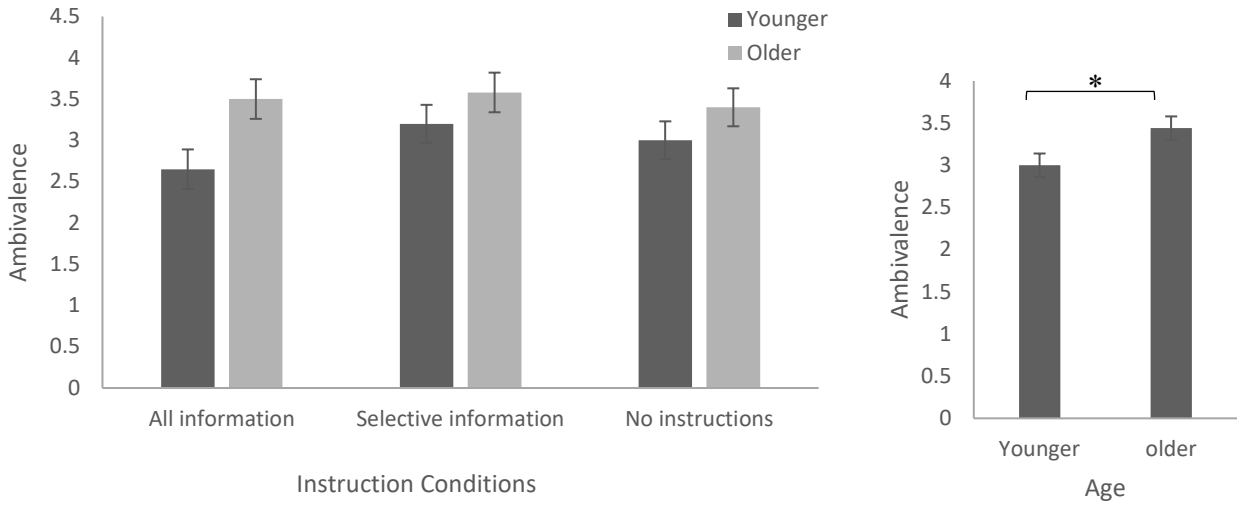

Figure 6: Car Purchasing Scenario: Mean Ambivalence as a Function of Age and Conditions

Charity Scenario. Table 5 and Figure 7 present the data on felt-ambivalence for the charity scenario as a function age and instruction conditions. I conducted a 2 Age (Young vs. Old) x 3 Instruction Condition (All Information vs. Selective-Information vs. No-Instructions) ANOVA to determine the way in which Age and Instruction conditions impacted self-reported levels of felt-ambivalence with regard to the charity scenario. NFC and COVID variables were treated as covariates. The ANOVA yielded a marginally significant interaction of Age x Instruction condition $F(1.111)=2.45$, $p=.06$, $\eta_p^2=.05$) because the young adults experienced the least ambivalence in the No-Instruction condition, whereas the older adults experienced the greatest ambivalence in this condition. Additionally, young adults, but not older adults, experienced the greatest ambivalence in the All-instruction condition. There were no significant main effects of Age or Instruction condition.

Table 5
Charity Scenario: Mean Ambivalence (SD) as a Function of Instruction Condition and Age

	Age	
Condition	Younger	Older
All information	2.9 (.85)	2.75 (.91)
Selective information	2.6 (1.0)	2.68 (1.29)
No instructions	2.5 (.83)	3.05 (1.15)

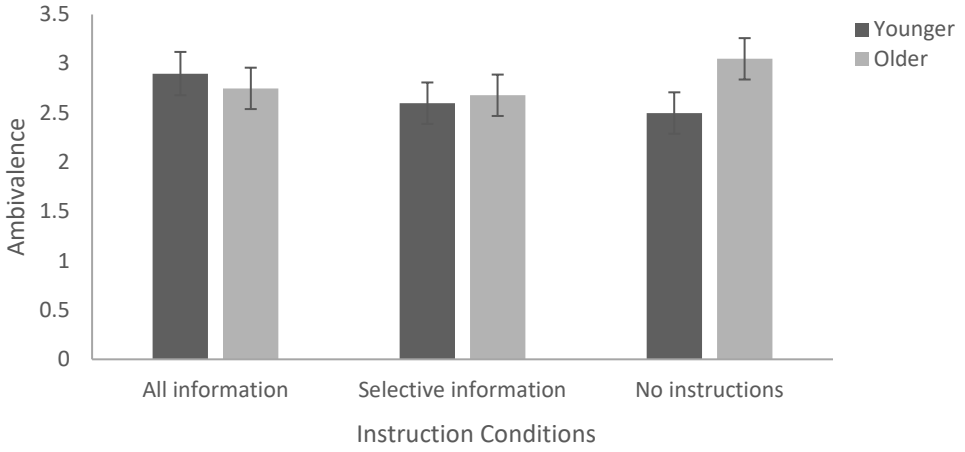

Figure 7: Charity Scenario: Mean Ambivalence as a Function of Age and Conditions

Age Differences in Information Search Style as a Function of Instruction Condition

My next set of analyses focus on age differences in the propensity to engage in an alternative-based deliberative search. The reason why investigating information search style is critical in this study is because there were several previous studies that have indicated that ambivalence is associated with deliberation (Choi, 2019; Hanze, 2001; Jonas et al., 1997; Maio et al., 1996; Rudolph & Popp, 2007). There is also evidence that age is associated with the propensity to deliberate (Mutter & Poliske, 1994; Peters, Dieckmann, & Weller, 2011; Tversky & Kahneman, 1974; Yates & Patalano, 1999). In the following analyses, I examined whether age was associated with alternative-based deliberative search, and the possibility that age differences

in ambivalence is mediated via age differences in deliberation. I first conducted ANOVA analyses to determine if there were age differences in deliberation as a function of instruction conditions in the Car purchasing scenario and the Charity scenario.

Car-Purchasing Scenario. Initially, I predicted that overall young adults would be more likely to engage in an alternative-based information search style than older adults, and that they would exhibit the most alternative-based search style within the All-information condition and the least within the Selective-information condition. I also predicted a similar pattern within older adults, with them engaging in the most alternative-based information search within the All-information condition and least in the Selective-information conditions.

A 2 Age (young vs. old) x 3 Instruction Condition (All-information, Selective-information, No-instructions) ANOVA was conducted to determine if age and instruction conditions affected the likelihood of engaging in alternative-based information search style. NFC and COVID were treated as covariates.

The analysis yielded a main effect of Age ($F(1, 111)= 8.40$, $p=.005$, $\eta_p^2= .07$) indicating that young adults were significantly more likely to engage in an alternative-based information search style relative to older adults (Young adults: $M=.41$, $SD=.39$; older adults: $M=.17$, $SD=.47$). There was also a significant main effect of Instruction Condition as well ($F(2, 111)= 4.13$, $p=.019$, $\eta_p^2=.07$). I followed up with a post hoc Bonferroni test and found that the Selective-information condition yielded significantly less alternative-based searches than the No-information condition ($p=.03$). There was no significant interaction between age and instruction condition on information processing style ($F(2, 111)=2.19$, $p=.12$, $\eta_p^2= .04$).

Table 6 displays the data of the Information search style (Alternative-based vs. attribute-based search) as a function of Instructions Conditions and Age, and Figure 8 graphically depicts

the data. As predicted, young adults were much more likely to use an alternative-based information search style than older adults across all conditions. However, younger adult's level of deliberative processing varied across instruction conditions. Young adults were most likely to engage in a deliberative or alternative-based search in the All-Information instruction condition and least likely to engage in an alternative-based search within the Selective-information condition. Older adults, unlike young adults, were most likely to engage in a deliberative or alternative-based search in the No-instruction condition and least likely to within the Selective-information condition.

Table 6
Car Purchasing Scenario: Mean Usage of Deliberation (SD) as a Function of Instruction Condition and Age

	Age	
Instruction Condition	Younger	Older
All information	0.53 (.26)	0.13 (.47)
Selective information	0.25 (.39)	0.03 (.53)
No instructions	0.45 (.46)	0.33 (.38)

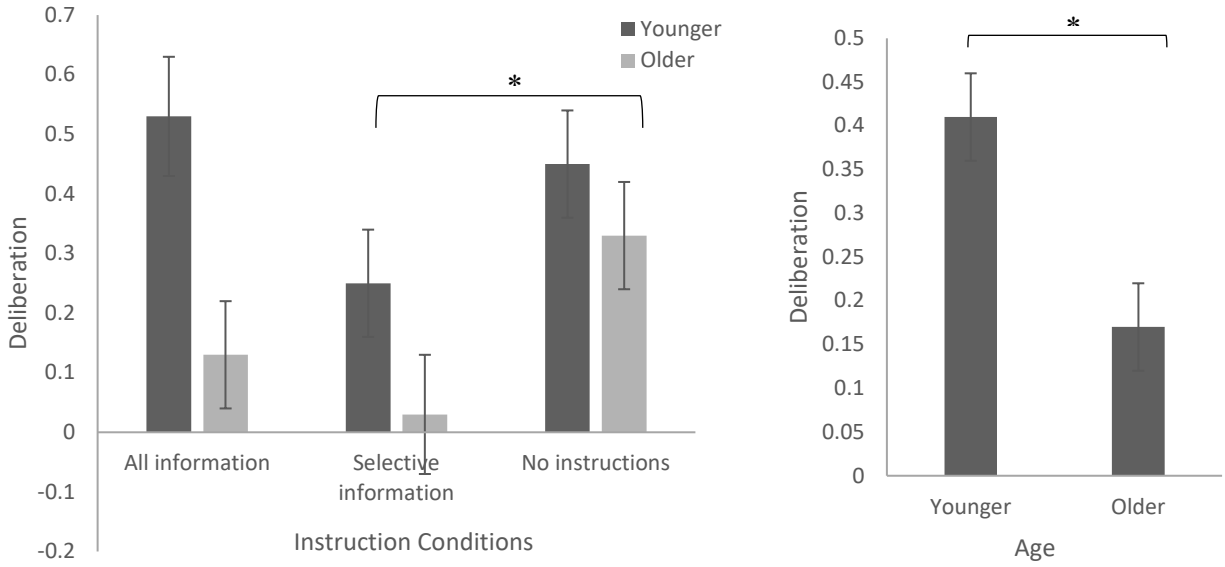

Figure 8: Car Purchasing Scenario: Mean Usage of Deliberation as a Function of Instruction Condition and Age.

Charity Scenario. I again conducted a 2 Age (young vs. old) x 3 Instruction Condition (All-information, Selective-information, No-instruction) ANOVA, with NFC and COVID treated as covariates, on information search style in the Charity scenario to determine if age and instruction conditions affected the likelihood of engaging in deliberative information searching style within the charity scenario.

There was no significant interaction between Age and Instruction Condition ($F(1,111)=.85$, $p=.43$, $\eta_p^2=.015$). However, there was a main effect of Age ($F(1,111)= 9.33$, $p=.003$, $\eta_p^2=.08$), indicating that young adults tended to engage in the alternative-based search style far more than older adults; in fact, older adults engaged in more attribute-based information search in this particular scenario, than in the Car-purchasing scenario. There was no significant main effect of instruction condition ($F(1,111)=.40$, $p=.67$, $\eta_p^2= .007$).

Table 7 and Figure 9 display the information search style data for the Charity scenario as a function of Age and Instruction Condition. Negative values indicate that participants engaged more in an attribute-based informational search (i.e., heuristics) than an alternative-based (i.e., deliberation). Table 7 shows negative values for older adults across instruction conditions. Note that the pattern of data with regard to information search style in the Charity scenario is quite different from the pattern of data in the Car-purchasing scenario.

Table 7
Charity Scenario: Mean deliberation (SD) as a Function of Instruction Condition and Age

	Age	
Instruction Condition	Younger	Older
All information	0.27 (.42)	-0.13 (.49)
Selective information	0.32 (.49)	-0.04 (.57)
No instructions	0.11 (.68)	-0.06 (.56)

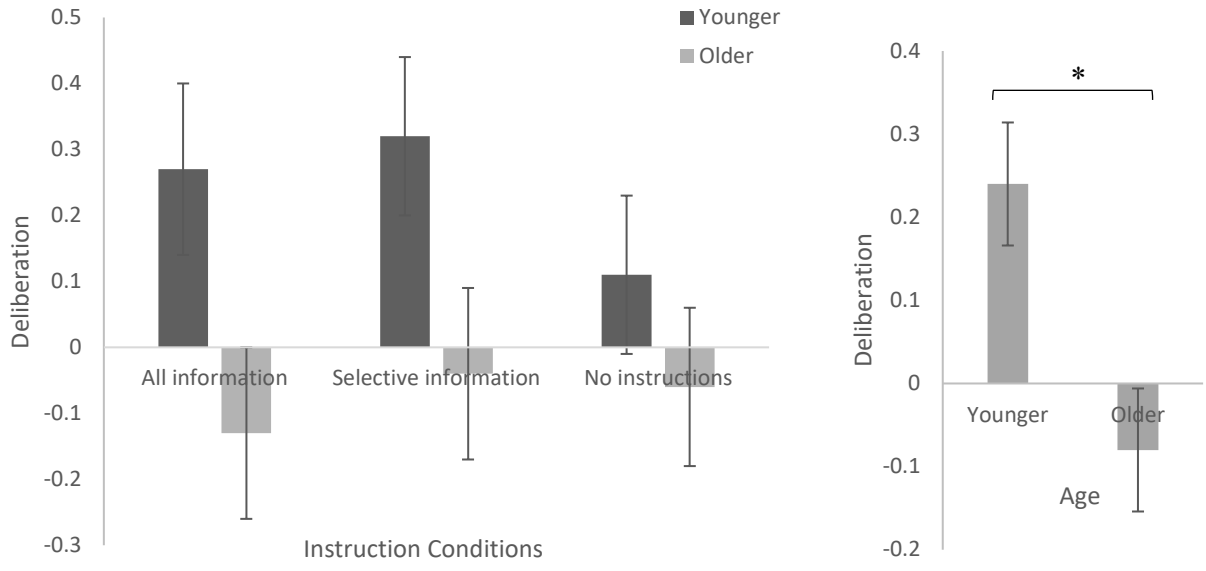

Figure 9: Charity Scenario: Mean Deliberation as a Function of Instruction Condition and Age

Effects of Age, Instruction Conditions and Scenario on Information Search Type

After running a series of ANOVA on two separate scenarios, I noticed the pattern of ambivalence and information searching style varied per scenario. For example, Table 8 shows that participants were likely to consistently engage more in a deliberative search across instruction conditions in the Car-purchasing scenario than in the Charity scenario, especially when they were in the All-Information instruction condition or the No-Instruction condition. I wanted to investigate the possibility that the type of scenario influencing the information search style. Figure 10 graphically illustrates participants' propensity to engage in deliberative search as a function of Age and Instruction conditions. Note that both scenarios were presented to participants and the order they were presented was random, as it was counterbalanced among all participants.

I followed up on the aforementioned observation with a 2 Age (Young vs. Old) x 3 Conditions (All-information vs. Selective-information vs. No instruction) x 2 Scenarios (Car purchasing vs. Charity) mixed ANOVA on Information search type. NFC and COVID scores were treated as covariates.

The analysis yielded a significant interaction between Scenario and Instruction Conditions with $F(2, 111)= 3.93$, $p=.022$, $\eta_p^2=.066$. That is, within the Car-Purchasing scenario, participants engaged in a more alternative-based (i.e., deliberative) information search style in the All-information condition and the No-instruction conditions than in the Selective-information condition. Meanwhile, the Charity scenario yielded a different pattern of data. For one thing, individuals were less likely to engage in a deliberative search in this scenario across all instruction conditions. Also in the Charity scenario, the Selective-information condition yielded the greatest levels of deliberative search. A Bonferroni post hoc test indicated that there were significantly more deliberative information searches in the Car-purchasing scenario, particularly

within the All-information condition (p=.006) and No-instruction condition (p<.001) compared to those counterpart conditions within the Charity scenario. There was no significant difference in deliberation within the Selective-information condition between two scenarios (p=.98). There was also a significant main effect of Age (F(1,111)=13.80, p<.001, η_p^2=.11), because young adults tended to engage more in a deliberative search throughout all conditions relative to older adults (Young adults: M=.33, SE=.05; older adults: M=.04, SE=.05).

Table 8. Mean (SD) Deliberation as a Function of Scenario and Instruction Conditions

	Instruction Conditions		
Scenario	All	Selective	None
Car-purchasing	0.33 (.43)	0.145 (.47)	0.389 (.42)
Charity	0.069 (.49)	0.145 (.56)	0.028 (.65)

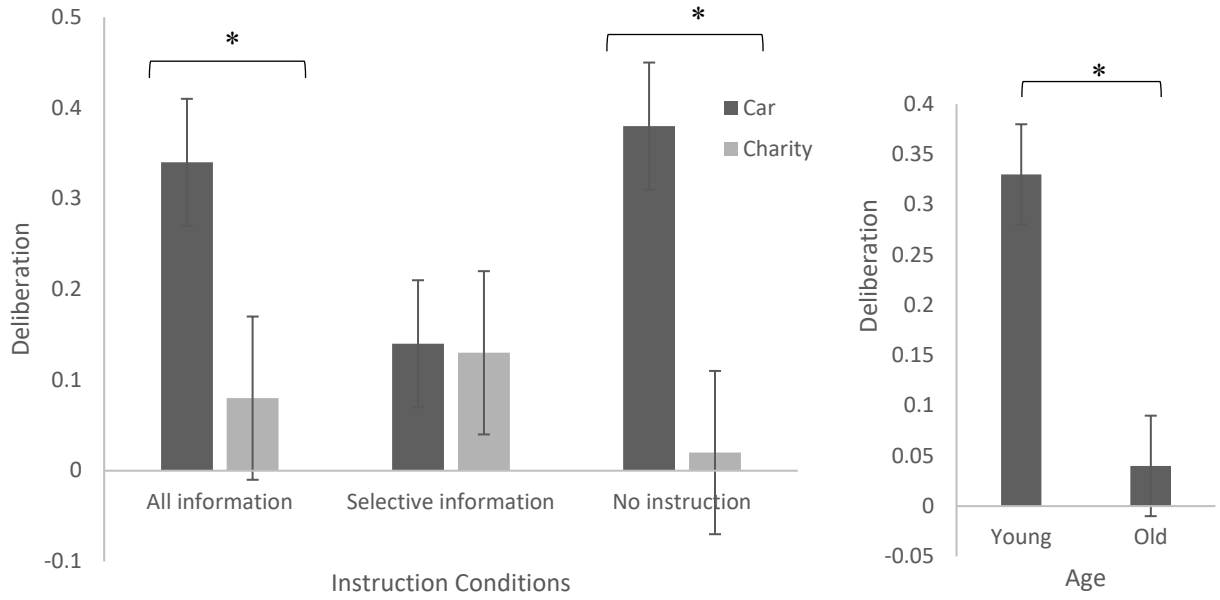

Figure 10: Mean Deliberation as a Function of Conditions x Scenarios.

Effects of Age, Instruction Conditions, and Scenario on Ambivalence

After conducting analyses in which I examined the information search style across the two scenarios, I decided to follow up with an analysis to examine ambivalence across the two scenarios. Table 9 and Figure 11 present the data for self-reported ambivalence as a function of age, instructional conditions, and scenarios. It should be noted that older adults self-reported more ambivalence than younger adults in the Car-purchasing scenario. In the Charity scenario, there was not much difference in levels of ambivalence as a function of age compared to the Car-purchasing scenario.

The above observations were supported by A 2 Age (Young vs. Old) x 3 Conditions (All-information vs. Selective-information vs. No-instruction) x 2 Scenarios (Car-purchasing vs. Charity) mixed ANOVA. NFC and COVID scores were treated as covariates again. The analysis yielded a significant interaction between Scenarios and Age ($F(1,111)=5.61$, $p=.02$, $\eta_p^2=.048$), indicating the magnitude of the age difference in self-reported ambivalence varied as a function of scenarios. More specifically, the magnitude of the age difference in ambivalence was greater in the Car-purchasing scenario (Older adults: $M=3.49$, $SD=1.27$; younger adults: $M=2.95$, $SD=.81$), than within the Charity scenarios (Older adults: $M=2.83$, $SD=1.12$; younger adults: $M=2.67$, $SD=.90$). There was also a main effect of Scenario ($F(1,111)=7.70$, $p=.006$, $\eta_p^2=.065$), indicating a significant higher level of ambivalence was evoked in Car-purchasing scenario ($M=3.22$, $SD=1.09$) than in Charity scenario ($M=2.75$, $SD=1.01$).

Table 9
Mean Ambivalence (SD) as a Function of Age and Scenario

	Age	
Scenario	Young	Old
Car-purchasing	2.95 (.81)	3.49 (1.27)
Charity	2.67 (.90)	2.83 (1.12)

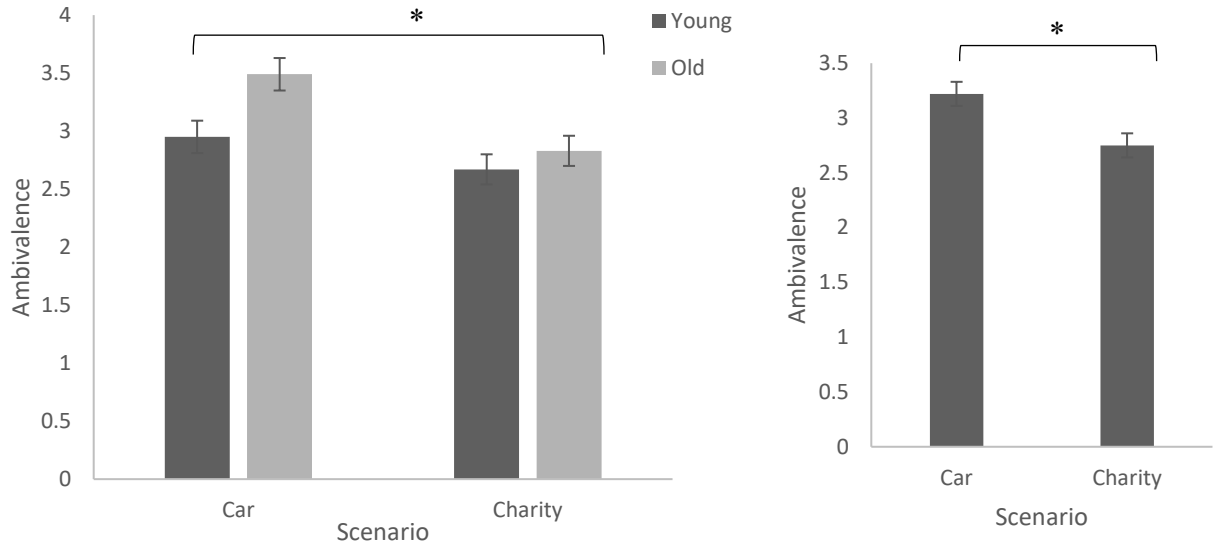

Figure 11: Ambivalence as a Function of Age and Scenario

Path Analysis: Moderation and Mediations

In addition to the prediction that Instruction condition would moderate the degree to which two age groups differ in the propensity of engaging in deliberation, I also made a prediction that EF would moderate the age effect. That is, older adults with more EF capacity would be more likely to engage in deliberative processing than older adults with less EF capacity. I used PROCESS developed by Hayes (2021) to examine moderation effects. Prior to conducting the analyses, I examined the extent to which ambivalence, age, deliberation, and the various components of EF were correlated. There were no significant concerns of multicollinearity. See Table 10 for the statistics.

Table 10 Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12
1 age	-	-0.17	-.200*	-.301**	-0.05	0.161	-.242**	.268**	-.251**	0.056	0.155	.307**
2 EF_total	-0.17	-	.642**	.716**	.497**	.461**	.0.100	-.237**	-0.11	-0.09	-0.04	-0.08
3 Switching cost	-.200*	.642**	-	.456**	0.073	-0.04	-0.1	-0.11	-0.02	.195*	-0.1	0.037
4 Mixing cost	-.301**	.716**	.456**	-	0.086	0.116	-0.02	-0.15	0.017	0.079	-0.08	-0.05
5 Stroop-Time interference	-0.05	.497**	0.073	0.086	-	-0.01	-0.18	-0.1	-.208*	-0.07	0.058	-0.06
6 Nback_ accuracy	0.161	.461**	-0.04	0.116	-0.01	-	0.071	-.185*	-0.04	-0.01	0.026	-0.13
7 Car_ deliberation	-.242**	-.100*	-0.1	-0.02	-0.18	0.071	-	0.141	.332**	0.005	-.226*	-0.06
8 Car_ Ambivalence	.268**	-.237**	-0.11	-0.15	-0.1	-.185*	0.141	-	0.129	.274**	-0.11	.304**
9 Child_ deliberation	-.251**	-0.11	-0.02	0.017	-.208*	-0.04	.332**	0.129	-	0.088	-0.14	-0.01
10 Child ambivalence	0.056	0.085	.195*	0.079	-0.07	-0.01	0.005	.274**	0.088	-	0.102	.377**
11 NFC	0.155	-0.04	-0.1	-0.08	0.058	0.026	-.226*	-0.11	-0.14	0.102	-	0.131
12 COVID	.307**	-0.08	0.037	-0.05	-0.06	-0.13	-0.06	.304**	-0.01	.377**	0.131	-

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed)

EF as a Function of Age

My EF measures were based on the Unity/Diversity framework proposed by Friedman and Miyake (2017) and the original framework developed by Miyake (2000). I selected a measure for each of the traditional components of EF: task-switching, working memory, and inhibition. All three components of EF (i.e., inhibition, updating, task-switching) outlined in the previous Miyake (2000) model were still important in the new model proposed by Friedman and Miyake (2017), but the new model was structured a bit differently with the inhibition factor subsumed under a component called the common EF. The two other components, task switching and updating working memory, remained as independent components. However, Friedman and Miyake (2017) acknowledged that inhibition is an integral part of EF because of its importance

in goal maintenance. In the section below, I have explained how I calculated the scores for the various measures and whether there were age differences on that particular measure of EF. In order to calculate the common EF, I converted all scores to standardized z-scores. Following the conversion to z-scores, I ran a t-test to see whether there were age differences on each measure. See Table 13 for statistics.

Measures of EF

Task-switching Switching Cost. The Task-switching task was included to measure shifting ability. Switching cost score was calculated by taking the difference in performance between switch and repetition trials in mixed-task blocks (Fagot, 1994; Kray & Lindenberger, 2000). Switching cost is often viewed as a specific or transient control mechanism. That is, switching cost indexes more transient control processes related to task switching, such as the re-categorization or updating goals or the associating task cues to appropriate responses (Braver et al., 2003; Logan & Bundesen, 2003). The analysis indicated a significant age difference with $t(117)=2.16$, $p=.03$, suggesting that young adults ($M=.19$, $SD=.12$) yielded better switching cost scores than older adults ($M= -.20$, $SD=1.04$).

Task-switching Mixing Cost. The mixing cost score is also from Task-switching task, and it is thought to reflect a global control mechanism or a sustained control process, that may require an individual to maintain attentional monitoring that is not just limited to tasks specifically (Graver, Reynolds, & Donaldson, 2003; Koch, Prinz, & Allport, 2005). Studies comparing task-switching effects in older adults have shown sizeable increases in mixing cost but only subtle increases in switching cost (Kray & Lindenburger 2000; Meiran et al. 2001). There were significant age differences in performance on this task, $t(117)=3.06$, $p=.003$, with

young adults (*M*= .27, *SD*= .70) showing better performance on exhibiting global attentional control processes than older adults (*M*= -.27, *SD*=1.18).

N2Back. N2Back test was included as another representative measure of EF, particularly for updating of working memory ability. N2Back accuracy was calculated by dividing the number of correct responses over the total trial number. This score was also significantly different between two age groups ($t(117)= -2.07$, $p=.04$). However, it was not in the predicted direction because older adults actually performed better on this task than younger adults. Young adults showed poorer working memory score (*M*= -.19 , *SD*=1.00) than older adults (*M*=.19, *SD*=.98).

Stroop Task Time Inference. The Stroop task was included in this study as a representative measure of inhibition ability. The Stroop Time Interference score was calculated by subtracting the reaction time within the congruent condition from that of the incongruent condition. This score did not yield any significant group differences $t(117)=.01$, $p= .99$.

Common EF. I have also created a composite score of EF. This score was included in the measure to address a new framework of EF from the unity/diversity framework. Unity/Diversity framework purports that the common EF reflects one's ability to actively maintain task goals and goal-related information. This basic ability is necessary for all three components of EF in the traditional model of EF (i.e., inhibition, shifting, and updating) and has also been suggested as a key requirement of response inhibition (Friedman & Miyake, 2017). The common EF score was calculated by adding z-scores of all the subcomponents of EF that comprised the EF test battery. This score was not significantly different between the two groups ($t(117)=1.32$, $p=.19$).

Table 11 shows that the primary age differences were in the Switching and Mixing Cost measures, as well as in the N2Back measure. See Figure 12 for the graphic representation.

Table 11.
Mean EF Measures (Z-Score) for Young and Old Adults

	Age	
EF Measures	Young	Old
Switching Cost	.19 (.12)	-0.20 (1.04)
Mixing Cost	.27 (.70)	-.27 (1.18)
Time Inference	.001 (.87)	-.001 (1.13)
N2 Back	-.19 (1.00)	.19 (.98)
Common EF	.28 (.22)	-.28 (2.81)

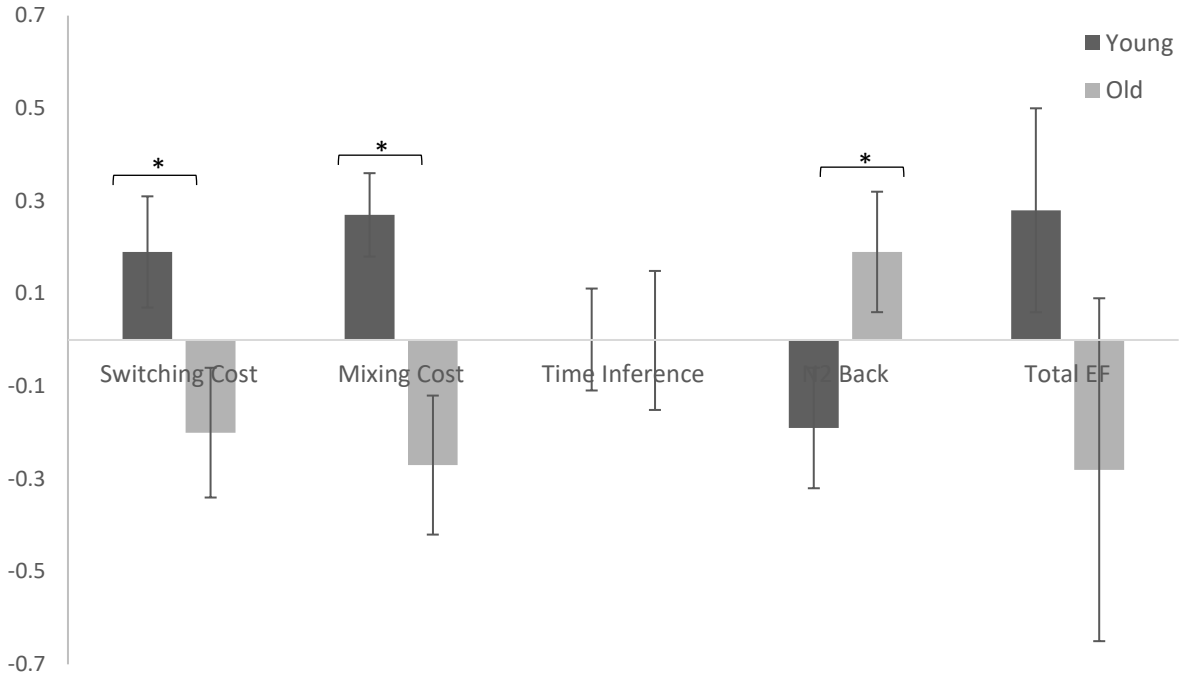

Figure 12: Mean EF for Young and Old Adults

Executive Functions as a moderator between age and information search style

I predicted that EFs would moderate the extent to which age predicted information search style. I used Hayes' PROCESS macro v4.0, model 1 to conduct each of the analysis below. I examined whether the common EF or any of the three components of EFs moderated age

differences in the information search style. In each analysis, the IV was Age, the moderating variable was EF (separately and combined), and the DV was Information Search Style. The same two variables, NFC and COVID stress survey, were covariates in each of the analyses.

Switching Cost

Car-purchasing scenario. My first analysis included Age as an IV, Information Search Style as a DV for the Car-purchasing scenario. Switching Cost was included as a moderator, and the covariates were NFC and COVID survey measure. The model was significant when all of the variables were included in the model $F(5, 113) = 3.30$, $p = .008$, $R^2 = .13$. Although there was a significant negative association between age and deliberation ($\beta = -.005$, $t(114) = -2.75$, $p = .007$), switching cost did not yield significance in its moderating effect ($F(5, 113) = .20$, $p = .65$, $R^2 = .002$).

Charity scenario. I also examined whether switching cost moderated the age effect within the Charity scenario using the same variables used in the Car-purchasing scenario. The model was marginally significant in explaining the variance associated with information search style ($F(5,113) = 2.17$, $p = .06$, $R^2 = .09$). Only age was significantly associated with deliberation ($\beta = -.0073$, $t(114) = -2.88$, $p = .005$). There was no significant moderating effect of switching cost on information search styles ($F(5,113) = .06$, $p = .80$, $R^2 = .005$).

Mixing Cost

Car-purchasing scenario. I followed up on the analysis involving switching cost by conducting an analysis involving mixing cost, to determine if this measure would moderate the extent to which age predicted information search style. Once again, the IV was Age and Information Search Style was the DV, and NFC and COVID were the covariates, but mixing cost was the moderator for this analysis. The model with all variables included was significant

($F(5,113)=2.9$, $p=.02$, $R^2=.11$) when all of the variables were included. However, there was not a significant moderating effect of mixing cost ($F(5,113)=.21$, $p=.65$, $R^2=.002$).

Charity scenario. Within the Charity scenario, the overall model with all the variables included (Age was the IV; Mixing Cost was the moderator; Information Search Style was the DV; NFC and COVID were the covariates) was marginally significant ($F(5,113)=2.22$, $p=.057$, $R^2=.09$). The mixing cost did not moderate the age effect ($F(5,113)=.72$, $p=.40$, $R^2=.006$).

N2Back

Car-purchasing scenario. With all of the variables included in the model (Age was the IV; N2Back task was the moderator; Information Search Style was the DV; NFC and COVID were the covariates), the model was significant ($F(5,113)=3.05$, $p=.01$, $R^2=.12$). Age was negatively associated with deliberation ($\beta= -.005$, $t(114)= -2.68$, $p=.009$), but there was no significant moderating effect of N2Back ($F(5,113)=1.18$, $p=.28$, $R^2=.009$), indicating that there was no evidence that the working memory moderated the strength of the age effect with regard to the information search style.

Charity scenario. I also examined the possibility that the N2Back task moderated the propensity to deliberate as a function of age, with respect to the Charity Scenario. The same variables (Age was the IV; N2back task was the moderator; Information Search Style was the DV; NFC and COVID were the covariates) were included in the model. The model was significant ($F(5,113)=2.38$, $p=.04$, $R^2=.10$). As expected, age was negatively associated with deliberation within the charity scenario ($\beta= -007$, $t(114)=-2.80$, $p=.006$), but the N2Back task did not moderate the Age effect ($F(1,113)=2.01$, $p=.16$, $R^2=.02$).

Time Interference

Car-purchasing scenario. My final analysis of the componential aspects of EFs focused on the time inference score from the Stroop task, to determine whether the time inference score moderated age differences in the information search style. The model included Age as the IV, Stroop Time Interference as the moderator, and Information Search Style as the DV, and NFC and COVID as covariates. The overall model with the aforementioned variables was significant ($F(5,113)=3.39$, $p=.007$, $R^2=.13$). Age was a significant predictor of information search style ($\beta=.009$, $t(114)= -2.53$, $p=.01$), but no significant moderation effect of time inference was found ($F(5, 113)= .40$, $p= .53$, $R^2= .003$). That is, there was no significant interaction between the switching ability and age.

Charity scenario. I conducted the same analysis with the Charity scenario. The data produced a model that was significant when all variables were included ($F(5,113)=3.21$, $p=.01$, $R^2=.12$). Age was negatively associated with deliberation ($\beta=-.007$, $t(114)=-2.91$, $p=.004$), but no significant moderating effect of time inference was found ($F(5,113)=.13$, $p=.72$, $R^2=.001$).

Common EF

Car-purchasing scenario. The model included Age as the IV; Total EF as the moderator; Information Search Style as the DV; NFC and COVID survey measures were covariates. The summary analysis, which included all of the aforementioned variables, indicated that the model was significant ($F(5,113)=3.0$, $p=.014$, $R^2=.12$). As expected, age significantly predicted deliberative information search style ($\beta= -.005$, $t(114)= -2.57$, $p=.012$), but the common EF did not significantly moderate the age effect on deliberation ($F(5,113)=.004$, $p=.95$, $R^2=.000$). That is, the common EF score did not significantly moderate the degree to which age was associated with the propensity to deliberate.

Charity scenario. Within the Charity scenario, when all variables were included in the analysis (Age was the IV; Composite EF was the moderator; Information Search Style was the DV; NFC and COVID were the covariates), the model was significant with $F(5,113)=2.58$, $p=.03$, $R^2=.10$. Age was a significant predictor of deliberation ($\beta= 0.007$, $t(114)=-2.96$, $p=.004$), but no other variables showed significant association. The common EF did not significantly moderate the Age effect within the Charity scenario ($F(5,113)=.004$, $p=.95$, $R^2=.000$).

EFs as moderators

Overall, neither the individual components of EFs nor the common EF moderated the strength of the Age effect with regard to the information search style. This is surprising because I initially predicted that older adults with greater EFs would be more likely to engage in a deliberative search than older adults with less EFs capacity. Aside from EFs, I also predicted that Instruction Conditions would moderate the age effect. Specifically, I predicted that age effects on deliberation would be attenuated in the All-information instruction condition relative to the No-Instruction Condition, which led to conducting the following analysis below.

Instruction Condition moderating the degree to which Age predicts Deliberation

One of the reasons that I manipulated Instruction Condition was to determine if age differences in information search style would be attenuated when older adults were given explicit instructions to examine all of the information (e.g., All-Information Condition). I had assumed that instructions to examine all of the information would facilitate a deliberative search.

Even though the ANOVA analyses that I conducted earlier suggested that there was no significant interaction between Instruction Conditions and Age, I followed up on that analysis with a path analysis to investigate the moderating effect of instruction conditions. Age was the predictor variable and Information search style (deliberation) was the outcome variable, with

Instruction Condition being the moderator. NFC and COVID measures were included as covariates. The PROCESS macro v4.0, model 1 (Hayes, 2017) in SPSS version 28 was used to test the significance of moderation of Instruction condition on the relationship between Age and Information Search style.

Car-Purchasing Scenario

When examined Car-purchasing scenario, all variables accounted for a significant portion of the variance ($F(7, 111)=3.61$, $p=.0015$, $R^2=.19$). Age was negatively associated with the information search style ($\beta= -.01$, $t(111)= -3.05$, $p=.003$) indicating age predicted a decrease in deliberative information search style. Specifically, it was within the All-information condition that age predicted a decrease in deliberative information searching style ($\beta= -.01$, $t(111)= -3.06$, $p=.003$). No other instruction conditions showed significant moderation effect on the relation between age and information searching style.

Charity Scenario

I used the same variables to conduct the moderation analysis using the charity scenario (Age was the IV; Instruction Condition was the moderator, and Information search style was the dependent variable, and NFC and COVID were covariates). Upon conducting the moderation analysis with the Charity scenario, I found that the model was not significant ($F(7,111)=1.82$, $p=.09$, $R^2=.10$). However, as in previous analyses, age was a significant predictor of deliberation within this model ($\beta=-.01$, $t(111)=-2.33$, $p=.02$). No significant moderating effect of Instruction condition was found ($F(2,111)=1.02$, $p=.36$, $R^2=.02$). Thus, there was no strong evidence that Instruction condition or EFs moderated the extent to which age predicted the propensity to engage in alternative-based deliberative information search style.

Information Search style as a mediator between age and ambivalence

The Hayes' Macro Process v4.0 model 4 (Hayes, 2017) was used for the following mediation analyses to consider whether a mediator has a mediational effect when the indirect effect of Age on Ambivalence via Information search style (i.e., indirect effect = path a x path b; a = the effect of age on the mediator of information search style, b = the effect of information search style on the level of ambivalence). The bootstrapping method was used to assess the statistical significance of the mediational effect, and the bias corrected 95% CI around the indirect effect from 5000 bootstrap re-samples.

Car Purchasing Scenario

When Age and Information Search Style were included in the model to determine if information search style mediated the relation between age and ambivalence, the model was significant with $F(3, 115)=4.059$, $p=.009$, $R^2=.10$. In step 1 of the mediation model, the regression of age on ambivalence, ignoring the mediator, was significant ($\beta=.013$, $t(114)=2.80$, $p=.006$). Step 2 showed that the regression of Age on the mediator, Information Search Style, was also significant ($\beta= -.005$, $t(115)= -2.35$, $p =.02$), indicating that older people tend to use less deliberation and relied more on heuristic-based search style. Step 3 of the mediation process showed that the mediator (Information Search Style), controlling for age, was significant ($\beta= .46$, $t(114) =2.1$, $p= .038$), indicating the more deliberation people engaged in, the more ambivalence they experienced, which is consistent with other research findings. Step 4 of the analyses revealed that, controlling for the mediator (deliberation), age was a significant predictor of ambivalence ($\beta= .013$, $t(114)= 2.80$, $p=.006$). However, there was no significant mediating effect of information search type (unstandardized indirect effect = -.002, SE=.002, 95% CI [-.0064, .0003]).

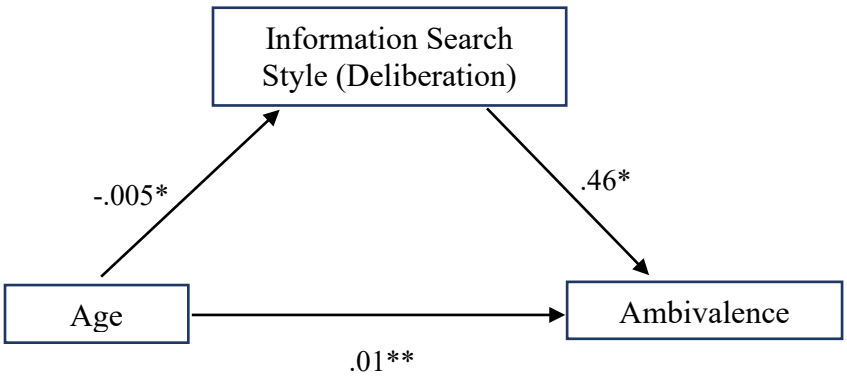

Figure 13: Car Purchasing Scenario: Information Search Type as a Mediator Between Age and Ambivalence. There was no mediating effect of Information Search style found.

Charity Scenario

I also conducted analyses to determine if information search style mediated the relation between age and ambivalence. Age was the predictor variable; Information search style was the mediator, and ambivalence was the outcome variable, with NFC and COVID as covariates. The entire model was significant with $F(3, 115)=3.28$, $p=.024$, $R^2=.08$. In step 1 of the mediation model, the regression of Age on Ambivalence, ignoring the mediator, was not significant ($\beta= -.003$, $t(115)= -.81$, $p=.42$). Step 2 showed that the regression of Age on the mediator, Information Search Style, was significant ($\beta= -.007$, $t(115)= -2.74$, $p =.007$), indicating that older people tend to use less deliberation and relied more on heuristic-based search style. Step 3 of the mediation process showed that the mediator (Information Search Style), controlling for age, was not significant ($\beta= .16$, $t(114) =1.01$, $p= .32$). Step 4 of the analyses revealed that, controlling for the mediator (information search style), age was not a significant predictor of ambivalence ($\beta= .013$, $t(114)= 2.8$, $p=.006$). However, there was no significant mediating effect of deliberative information search type (unstandardized indirect effect = -.001, SE=.001, 95% CI [-.0043, .0011]).

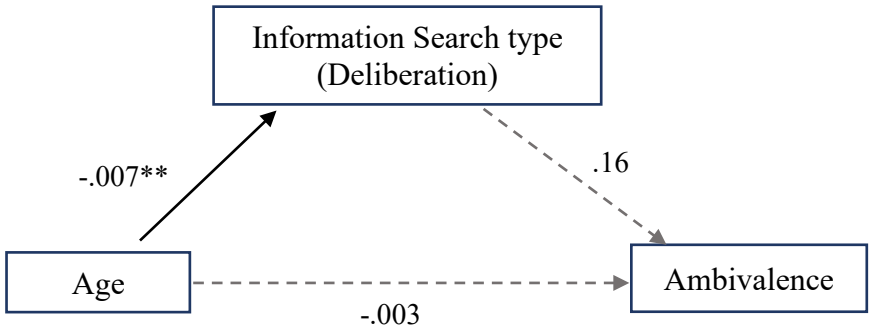

Figure 14. Charity Scenario: Information Search Type as a Mediator Between Age and Ambivalence. There was no mediating effect of Information Search style found.

Working Memory as a mediator in relationship between age and ambivalence

The previous analyses found that the information search style did not mediate the relation between Age and ambivalence. However, there is evidence from extant research which states that the key to resolving ambivalence is integrating all of the information associated with an option (Van Harreveld et al., 2009). It has been also suggested by several studies that working memory is especially essential for integration of information (Bruine de Bruin et al., 2016; Schiebener et al., 2011). Based on these premises, I decided to assess the mediation effect of working memory (N2Back) on the relationship between age and ambivalence using Process Macro model 4. Because the previous analyses with Charity scenario yielded insignificant results, this analysis was conducted only using the Car-purchasing scenario.

All variables were the same as the previous mediation analysis, except for the mediator which was working memory (i.e., N2Back) in this model. The overall model with all variables was significant ($F(3,115)=4.13$, $p=.03$, $R^2=.06$). There was a significant positive association between age and working memory ($\beta=.01$, $t(115)=2.33$, $p=.02$) in that older adults had greater working memory capacity than younger adults based on the N2back score. There was also a significant negative association between working memory and ambivalence ($\beta=-.21$, $t(114)= -$

2.23, p=.03), indicating that individuals with higher working memory capacity experienced less ambivalence than individuals with low working memory capacity. Additionally, there was a significant association between age and ambivalence (β=.01, t(114)=2.56, p=.01), suggesting that older adults self-reported greater ambivalence than younger adults. There was a small mediation effect of working memory with unstandardized indirect effect =-.002, SE=.001, 95% CI [-.0052, -.0001].

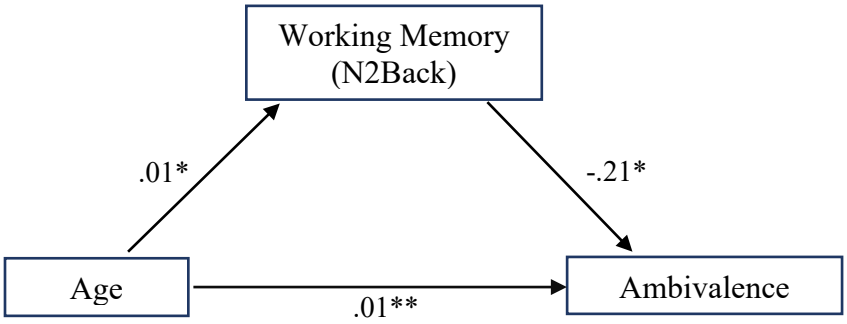

Figure 15: Working Memory Mediating the Relationship Between Age and Ambivalence. A significant mediating effect of N2Back was found (unstandardized indirect effect =-.002, SE=.001, 95% CI [-.0052, -.0001])

Information Search Style and Working Memory as a mediator between Age and Ambivalence

In the previous analysis, I found that working memory did mediate the relation between the age and ambivalence even though the information search style did not. However, I found that information search style still did predict ambivalence even though it did not mediate the relation between age and ambivalence. Considering the close relationship between working memory and information search style (Oberauer, 2009) as well as their associations with ambivalence (Nohlen et al., 2014; Rudolph, 2011; Rudolph & Popp, 2007), it is reasonable to consider the relationship between the deliberation and working memory impacting ambivalence simultaneously. In order to investigate further, I used Hayes' Macro Process v4.0, model 6 (Hayes, 2017) to conduct a dual mediation analysis with two mediators, information search style (deliberation) and working

memory (N2Back score). Age was the IV, ambivalence was the DV, and NFC and COVID were treated as covariates again. Again, only Car-purchasing scenario was used for the analysis.

As shown in Figure 16, age significantly predicted the mediator variable deliberation in that increased age was associated with decreased deliberation (β=-.005, t(115)= -2.37, p=.02). The mediator, deliberation, significantly predicted an increase in ambivalence (β=.52, t(113)=2.46, p=.016). Age also predicted the second mediating variable, working memory, indicating age significantly predicting a small increase in working memory (β=.01, t(114)=2.52, p=.01). The working memory was negatively associated with ambivalence (β= -.24, t(113)= -2.56, p=.01) suggesting that higher working memory capacity predicted a less likelihood of participants self-reporting high levels of ambivalence. The association between two mediators, deliberation and working memory, was not significant (β=.29, t(113)=1.35, p=.18). Finally, the total effect of age on ambivalence was examined, which was significant (β= .01, t(113)=2.36, p=.02). A small mediation effect of working memory (unstandardized indirect effect= -.003, SE=.002, 95% CI [-.0061, -.0004]) was found; however, there was no significant mediation effect of deliberation (unstandardized indirect effect= -.002, SE=.002, 95% CI [-.0067, .0001]). There was no significant serial mediation effect of deliberation and working memory (unstandardized indirect effect=.0003, SE=.0003, 95% CI [-.0001, .0011]). This result shows that working memory independently mediates the relationship between age and ambivalence.

As will be discussed in more detail in the discussion section, it appears that deliberation may have a significant impact on the age effect with respect to ambivalence even though it may not mediate the relationship. Additionally, the data seems to suggest that working memory is the key element that mitigates the level of ambivalence. Both working memory and deliberation are significantly associated with ambivalence, so it appears that ambivalence is influenced by at least

two processes: deliberation that varies among individuals and working memory that assists integrating the information and resolve the ambivalence.

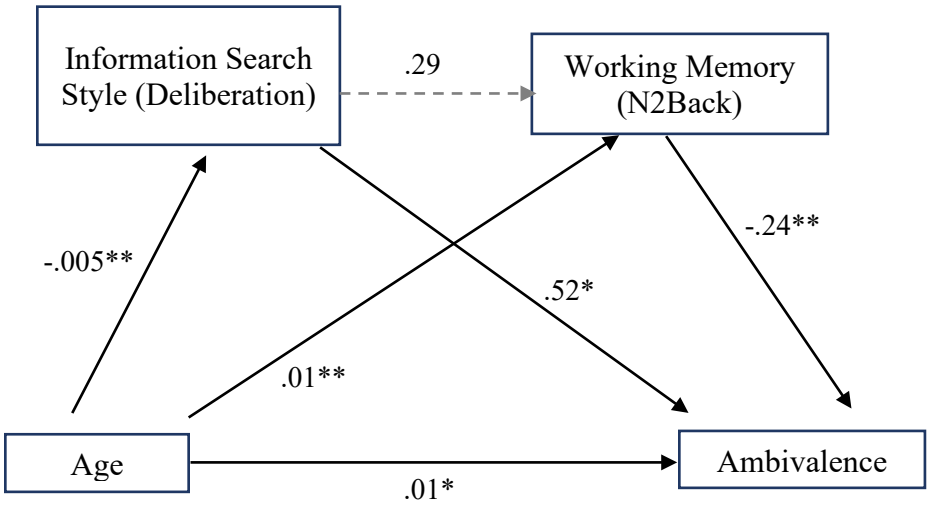

Figure 16. Information Search Style and Working Memory as Serial Mediation on the Relationship Between Age and Ambivalence. N2Back was the only mediation that was significant in the model (unstandardized indirect effect= -.003, SE=.002, 95% CI [-.00617, -.0001]). There was no significant mediation of deliberation or serial mediation.

Alternatively, it is feasible that there can be a reverse order of the serial mediation; that is, rather than age effect on ambivalence being impacted by deliberation first and then mitigated by working memory, it could be the case that working memory capacity would determine whether an individual would engage in deliberative information searching style, and therefore impact the age effect on ambivalence. Figure 17 shows the result of the alternative serial mediation of age effect on ambivalence via working memory and deliberation serial mediation. This model showed that age significantly predicted the mediator working memory in that increased age was associated with an increase in working memory (β=.01, t(115)= 2.28, p=.02). The mediator working memory significantly predicted a decrease in ambivalence (β= -.24, t(113)=-2.56, p=.012). Age also predicted the second mediating variable, deliberation, indicating age

significantly predicting a decrease in deliberation (β= -.005, t(114)= -2.61, p=.01). The deliberation was positively associated with ambivalence (β= .52, t(113)= 2.46, p=.02) suggesting that higher deliberation predicted a higher likelihood of participants self-reporting high levels of ambivalence. The association between two mediators, working memory and deliberation, was not significant (β=.05, t(113)=1.35, p=.18). Finally, the total effect of age on ambivalence was examined, which was significant (β= .016, t(113)=3.37, p=.001). A small mediation effect of working memory (unstandardized indirect effect= -.048, SE=.027, 95% CI [-.1102, -.0047]) was found; however, there was no significant mediation effect of deliberation (unstandardized indirect effect= -.054, SE=.037, 95% CI [-.1416, .0007]). There was no significant serial mediation effect of deliberation and working memory (unstandardized indirect effect=.0057, SE=.0062, 95% CI [-.002, .0217]). This result shows that working memory independently mediates the relationship between age and ambivalence.

This alternative serial mediation analyses yielded a very similar pattern as the previous analysis, suggesting that the order of the mediation does not impact the relationship between age and ambivalence, but rather, the working memory and deliberation influence the age effect on ambivalence independently.

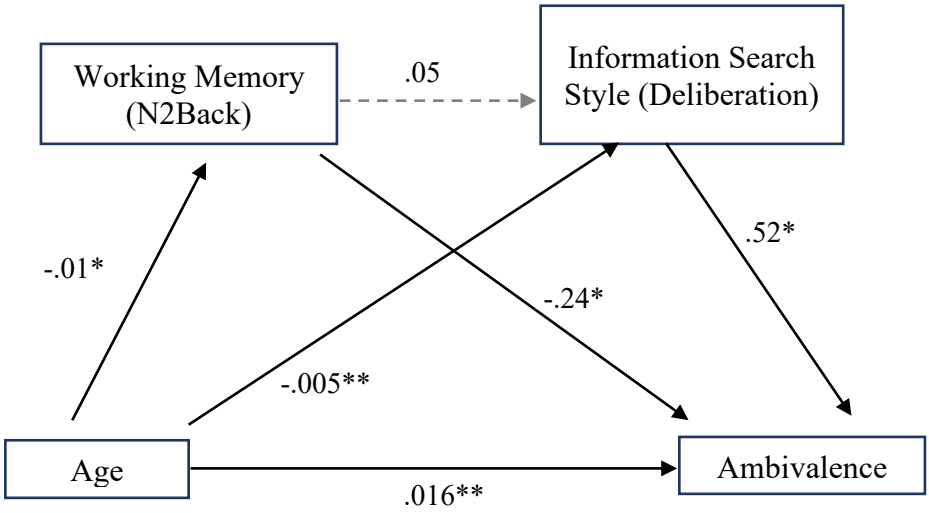

Figure 17. Working Memory and Information Search Style as Serial Mediation on the Relationship Between Age and Ambivalence. Working memory was the only mediation that was significant in the model (unstandardized indirect effect= -.048, SE=.027, 95% CI [-.1102, -.0047]). There was no significant mediation of deliberation or serial mediation.

Baseline Emotions

In addition to my concerns about the relationships among the variables (Age, Information search style, and ambivalence), I was also interested in investigating the baseline emotions to see if mood prior to the experiment would impact the level of ambivalence. To elaborate, because ambivalence is considered a negative emotion, and if participants were to experience negative emotions prior to the experiment, this baseline emotion could influence the degree to which they experience ambivalence. As mentioned above, this study used a PANAS scale (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Watson et al., 1988). Participants indicated their intensity of their current emotions (8 positive and 11 negative) on a Likert scale ranging from 1 to 7. The score for emotions were added to create two separate composite scores of positive emotions and negative emotions.

The mean statistics and graphic representation of the baseline emotions between two age groups are depicted in Table 11 and Figure 12 below. There were significant differences in both

positive and negative baseline emotions between two age groups, young and older adults. That is, young adults experienced significantly less positive emotions ($t(114)= -2.27$, $p=.025$), and more negative emotions ($t(114)= 4.37$, $p<.001$) relative to older adults. This result shows that within our sample population, young adults exhibited more intense negative emotions, perhaps due to the negativity bias where they tend to place more weight to negative information in impression formation and decision making (Rozin & Royzman, 2001), whereas older adults exhibited less intense negative emotions, but rather more intense positive emotions that can allude to their age-related positivity effect (e.g., Carstensen & Mikels, 2005; Mather & Carstensen, 2005) where they attend and process more positive information and emotions.

Considering previous analyses presented the patterns of older adults experiencing heightened ambivalence compared to young adults, it seemed that baseline emotions did not in fact have an impact on the level of ambivalence each age group experienced.

Table 12
Baseline Emotions for Young and Older Adults

	Age	
Condition	Younger	Older
Positive	25.9 (9.06)	29.93 (10.11)
Negative	22 (9.62)	15.1 (7.19)

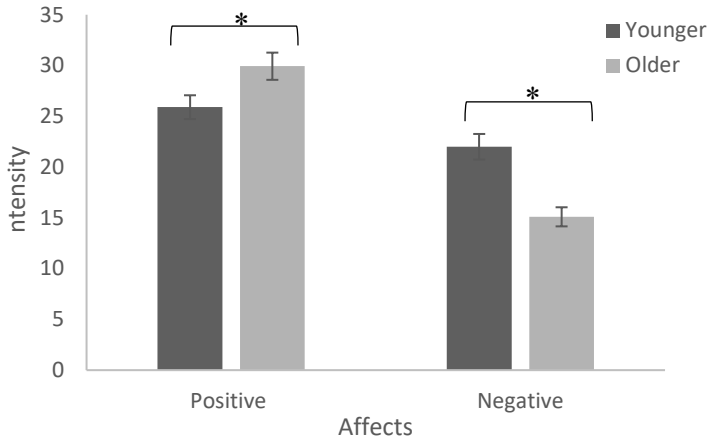

Figure 18: Mean Differences in Baseline Emotions Between Young and Older Adults

DISCUSSION

One of the main hypotheses of this study was that young adults would self-report more ambivalence than older adults. This prediction was based on the past research that implied an association between deliberative thought processes and ambivalence (Choi, 2019), along with a body of literature that indicates that older adults tend to be cognitive misers due to a decrease in cognitive resources (Greenwood, 2000; Hess, 2014; Moscovitch & Winocur, 1995; Salat et al., 2004; West, 1996). Given the premise that ambivalence is dependent on deliberation and young adults are more likely to deliberate than older adults, I hypothesized that young adults would engage in more deliberation than older adults and thereby self-report more pronounced ambivalence compared to older adults. Additionally, I predicted that the age effect in the propensity to use a deliberative information search style would be moderated by two variables: Instruction Condition and EFs. Participants' information search style (i.e., alternative-based deliberative search vs attribute-based heuristic search) was tracked via the Mouselab program for each instruction condition (i.e., All-information, Selective-information, No-instruction). Participants also received an EF assessment battery. With regard to age differences in the propensity to engage in deliberation, the results of this study were consistent with my prediction and a plethora of studies (Greenwood, 2000; Moscovitch & Winocur, 1995; Salat et al., 2004; West, 1996), showing that young adults are more inclined to use deliberative processing than older adults. However, the findings with regard to age and ambivalence were opposite of what I hypothesized.

Age difference in Deliberation and Ambivalence

Although this study found evidence that there were age differences in self-reported ambivalence, the pattern of data was opposite of what was hypothesized. Initially, it was predicted that there would be lower self-reported ambivalence among older adults than younger adults based on the findings of a previous study (Choi, 2019). However, unlike the prediction, this study found that older adults reported higher level of ambivalence during the decision-making task. This difference between the previous study and the current study could be explained by the way the study was designed.

The previous study by Choi (2019) queried participants about commonly debated controversial issues. Although participants were told to make decisions based on the information provided, a result of the questionnaire survey given after the decision-making task indicated that older adults were more likely than younger adults to forgo careful analyses of the information presented. Instead, older adults were more likely than younger adults to rely on their preexisting opinions and less likely to consider the information presented. The controversial topics presented in the earlier study were topics that had been frequently debated via media, and there was a high probability that older adults had preexisting views on these topics prior to the study. Thus, in a sense, deliberation was less likely to be necessary for older adults relative to younger adults. Conversely, in the current study, participants were instructed to review and search information for each alternative and make decisions based on the information they gathered within this experimental paradigm. This suggests that the current task was more difficult compared to the previous study (Choi, 2019) because older adults were presented with novel information and had to engage in some level of information search. Although older adults have had experiences buying cars and donating to charity, they had to familiarize themselves with the specific facts

associated with the attributes of given options available within the specific scenarios used in this study. Moreover, older adults had to engage in some level of deliberation in this study to make decisions. However, as stated earlier, some of the findings were counterintuitive. For example, although older adults did not engage in deliberative search to the same degree as younger adults, they experienced more ambivalence. If ambivalence were related to deliberation, then young adults should experience more ambivalence than older adults.

Van Harreveld and his colleagues (2009) proposed a model that explains a series of stages involved in decision-making, which suggested that the first stage of decision-making might be information gathering. This stage is important, but not as important as the second stage. During the second stage, the decision maker has the opportunity to integrate available information about each option. Integration refers to combining all of the information (i.e., pros and cons) associated with each option into a one unified opinion. For instance, consider a car-purchasing situation in which a decision maker was presented with an option in which safety was rated as average, gas mileage was rated as good, and the car was rated as attractive. Integration would involve the prospective buyer considering all of the attributes associated with that particular alternative—taking into consideration the pros and cons and the importance of each of those attributes. Individuals who successfully integrate the information associated with each option and then decide the one option that they consider the best would experience lower ambivalence after making the decision than an individual who deliberated but had not successfully integrated the information and resolved the ambivalence. That is, if the decision maker gathered information but never integrated the information associated with each option, then the individual would still experience a high level of ambivalence according to the model.

Van Harreveld et al. (2009) suggested that the key to reducing ambivalence could be the integration of the information, regardless of what type of information search style you use.

In the current study, the alternative-based deliberative search was associated with integrating the information associated with a particular option. Specifically, the alternative-based deliberative search was operationalized as individuals clicking on cells within the same row (considering all information about the alternative) rather than clicking on cells in the same column (comparing one specific attributes at a time across alternatives). That is, when participants were clicking on cells within the same row, they were accessing information related to one specific alternative (e.g., Option A). For example, if the attributes concerning safety and breakdown frequency were juxtaposed such that the safety was excellent for an option while the breakdown frequency was also high, then the decision maker would need to assess both negative and positive attributes associated with this specific option in order to form an integrated opinion about this given option. The challenge is that when participants engage in a deliberative information search, there is more information to be considered simultaneously, which can create a situation that becomes more difficult to integrate all information into a unified opinion. On the other hand, a person using a heuristic information search would mainly focus on information in the same column, which indicates that they would focus on one attribute at a time for each alterantive. They might, for example, follow a rule, such as picking the car that is highest in safety. In other words, they would not be considering multiple attributes at the same time in determining the best purchase, but rather, evaluate whether or not the purchase meets the criterion of the rule. This sutdy's serial mediation analysis corroborates Van Harreveld et al's (2009) claim as well, showing that although the deliberative information search style does increase the perceived level of ambivalence, the high working memory capacity (i.e., N2Back

accuracy), which is imperative in integration of information, plays a significant role in resolving the level of ambivalence, operating independently from the information search style (See Figure 17). That is, working memory is an essential factor that may be needed to integrate the information to resolve the ambivalence.

This study also found that older adults were more likely to use heuristic-based seraches by sequentially clicking on cells within a column than younger adults. Making a decision based on a simple rule (e.g., heuristics) is less cognitively taxing thean making a decision based on all of the attributes associated with a product. One theory that supports this idea is selective engagement theory (Hess, 2014), which states that older adults only selectively use deliberative processing when they have to (e.g., if the decision was self-relevant or they had high personal involvement in the decision), because deliberative processing becomes increasingly more cumbersome as a function of age; therefore, older adults' default decision making strategy may be to use heuristics. With regard to the current study, if older adults anticipated that certain decisions would be especially difficult, they may have opted to use heuristics because it was not worth their while to engage their limited cognitive resources to make the decision.

Furthermore, age differences in emotion-regulation could have additionally contributed to age differences in ambivalence. Ambivalence is associated with negative affect which most people want to resolve by dampening that negative affect or eliminating the unpleasant situation that causes the negative affect. There are two approaches: problem-focused strategy and emotion-focused strategy. Within a decision-making paradigm, participants who decide to utilize a problem-focused strategy would examine all of the information. Choosing this option will expose them to more emotional distress because it will temporarily increase ambivalence. However, the advantage of a problem-focused strategy is that it will ultimately resolve the root

cause of the ambivalence after the decision is made. Because problem-focused strategies tend to involve investigating more information, it is often understood as effortful (Luce et al., 1997; Van Harreveld et al., 2009). When participants use an emotion-focused strategy such that they avoid examining every piece of information, they can protect themselves from additional information that requires tradeoffs; hence, it limits the exposure to ambivalence and conserves cognitive resources.

Consequently, young adults with more cognitive capacity than older adults are more likely to use a problem-focused strategy to solve the root of the dilemmas whereas older adults are more likely to use emotion-focused to conserve their limited cognitive resources (De Liver et al., 2008; Van Harreveld et al., 2009). With regard to the current study, older adults might have found it both cognitively draining and emotionally exhausting to choose between two attributes associated with high importance and high loss aversion. One way that could reduce their cognitive load and their emotional exhaustion would be to focus on limited number of attributes deemed more important and ignore other attributes. The current study supports the notion that older participants prefer an attribute-based heuristic information search, perhaps to conserve their cognitive resources and to protect themselves from heightened level of ambivalence that is more likely to stem from a deliberative information search that requires more extensive integration of information.

Another source of increased ambivalence among older adults could be the increase in loss aversion as a function of age. Several studies have evinced increased loss aversion in older adults (Gachter, Johnson, & Herrmann, 2007; Kim, Goldstein, Hasher, & Zacks, 2005), and this study's pilot test also found that self-reported loss aversion of older adults was significantly higher than that of young adults (See Table 3). In this study, participants were forced to make tradeoffs

between two attributes associated with high importance and high loss aversion. Based on the finding that the loss aversion of older adults was higher than young adults, it could be speculated that this may have led the older adults to experience more difficulties in sacrificing a highly valued attribute in favor of another highly valued attribute, and therefore experienced more heightened ambivalence.

Deliberation and Ambivalence as a function of Instruction Condition

The current study varied instructions such that there was a condition designed to encourage deliberative processing, a condition designed to encourage heuristic processing and a control condition in which no instructions were given. Previous research by Lockenhoff and Carstensen (2007) had shown that older participants' information search strategies could be influenced by the instructions provided by the experimenter. In order to manipulate the information search strategies, the instructions for this current study were adapted from Lockenhoff and Carstensen's (2007) study where the researchers presented a matrix with different colored cells with each color indicating different type of information. For instance, Lockenhoff and Carstensen (2007)'s matrix included gray cells that indicated there is positive information hidden behind, whereas dark cells indicated there is negative information hidden behind. They then instructed participants to either "focus on the specific facts and details" or "focus on how you are feeling" in order to manipulate types of information the participants inspected. Following their example of instruction manipulations, I instructed participants to "consider all information carefully" within All-information condition, and to "only consider information that you think is important, rather than focusing on all information" in Selective-information condition. For Selective-information condition, I also presented a matrix with two columns highlighted in yellow that included attributes with high loss aversion and importance,

whereas All-information and No-instruction condition did not have any columns highlighted. Because in the Lockenhoff and Carstensen study (2007), participant's search behavior varied as a function of the instructions, I anticipated that participants would be more likely to engage in a deliberative search in the All-information condition and less in Selective-information condition; however, I did not consistently find that pattern of results across age groups or across scenarios. In fact, two scenarios used in this study yielded very different results with regard to the effects of instruction on information search style. The two age groups also yielded very different results with regard to the effects of instruction on information search style. The explanations for the findings for each scenario will be addressed in turn.

Car Purchasing Scenario

I initially anticipated that the All-information condition would yield the most alternative-based deliberative information search style and Selective-information condition would yield the least alternative-based deliberative information search style. Unlike the hypothesis, there was no significant difference between the All-information condition and Selective-information condition when examining both age groups together. The two age groups produced a different pattern of data, however, with young adults engaging in deliberative information search more in the All-information condition as expected. Surprisingly, however, older adults engaged in the most deliberative processing in the No-information condition.

Thus, when examining just the older adult data, it is clear that the instructions did not produce the intended effect. One explanation for this finding could be that older adults might have interpreted the instruction "use all information provided" as "seek as many pieces of information as possible" and that it did not matter if they searched across rows (i.e., alternative-based deliberative search) or down columns (i.e., attribute-based heuristic search). I investigated

this possibility by examining the average number of clicked cells in each condition. It turned out that the average number of clicks in the All-information condition (M=41.4, SD=31.4) and No-Instruction condition did not differ (M=41.1, SD=19.03). Ironically, older adults seemed to have investigated the most information within the Selective-information condition (M=46.11, SD=32.75). However, an ANOVA analysis indicated that there was not a significant effect of Instruction condition on the number of clicks on the informational cells. Based on this additional analysis, it seemed the alternative explanation that older adults may have paid attention to more pieces of information in exchange of using attribute-based information search may not be a sufficient justification. The other possible explanation for this could be the small sample size of the study that could not discount the individual variability.

In addition, although it was expected that there would be an increase in ambivalence within the All-Information condition because this condition was expected to be associated with deliberative processing, the data showed that there was no significantly higher level of ambivalence in All-Information condition in either age group. Instead, the highest level of ambivalence was reported within the Selective-information condition from both age groups. This was unexpected because Selective-information condition was designed to elicit more attribute-based heuristic information search and therefore was expected to attenuate the level of felt-ambivalence. One potential reason for heightened ambivalence observed in Selective-information condition could be that the attributes that were highlighted as important within the Selective-information condition might have made participants become aware of the importance of highlighted elements more than other conditions that did not highlight any attributes. Considering those highlighted attributes were based on pilot test results that were deemed most important and evoked the most loss aversion, accentuating these two attributes could have

contributed to making the conflict more difficult to resolve and thereby amplified the intensity of felt-ambivalence.

Charity Scenario

Even though the main effect of instruction condition on information search style was not significant in this scenario, the pattern was very different from the Car-purchasing scenario. Within the Charity scenario, participants used the most alternative-based deliberative information searching style in the Selective-information condition, whereas the All-information and the No-instruction conditions showed less deliberative information searching pattern. One explanation for this pattern could be that the Charity scenario was a very different decision-making task compared to the Car-purchasing scenario, because the Charity scenario might have prompted participants to rely on their personal values associated with interpersonal relationships. Because interpersonal relationships are critical for psychological well-being as well as survival, it is possible that most young and older adults have an established idea of the characteristics that they value, as several studies have suggested preexisting views influence how people perceive and or judge (e.g., Leising, Gallrein, & Dufner, 2014; Leising, Ostrovski, & Zimmermann, 2013; Munro et al., 2002). These preexisting values might have resulted in participants choosing a child with attributes consistent with their values in the All-information and No-instruction conditions. For instance, one might just prefer to help a child whose personality is good, or the youngest of all available children based on preconceived values in evaluating people. However, within the Selective-instruction condition, participants were explicitly told that many others, including experts, found the highlighted information to be particularly important. This additional information concerning opinions of the masses and experts may have resulted in participants

being more deliberative in assessing the attributes, especially when the highlighted attributes were inconsistent with their preestablished values.

Interestingly, within the Charity scenario, the Selective-information condition yielded a fairly low level of ambivalence despite this condition yielding a higher deliberative information search than any of the other conditions. This could be due to the fact that the Selective-information condition emphasized the expert's opinion that may have helped participants to feel more validated in their decision of the chosen child.

Deliberation as a function of Scenario

When comparing two scenarios, it is evident that the overall level of deliberation within the Car-purchasing scenario was higher than within the Charity scenario. Perhaps this unexpected finding could be explained again by the fact that the Charity scenario might have prompted participants to pay attention to their own personal values in making decisions on which child to provide financial support. As mentioned above, it is likely that the charity scenario, by its design, emphasizes a judgment of character that plays a critical role in interpersonal relationships. Because interpersonal relationships are important for psychological well-being as well as survival, it is suspected that most young and older adults in this experiment already had an established idea of the characteristics that they value. Many previous studies have pointed out that preexisting views influence how people perceive and or judge others in interpersonal relationships (e.g., Leising, Gallrein, & Dufner, 2014; Leising, Ostrovski, & Zimmermann, 2013; Munro et al., 2002). These preexisting values might have resulted in participants choosing a child with attributes consistent with their values. Because using preexisting values is considered a heuristic-based strategy, it is likely that within this experiment, participants showed more attribute-based (i.e., heuristic-based) information searching style within the charity scenario.

Ambivalence as a function of Scenario

The level of ambivalence reported in the Car-purchasing scenario was also quite different than that of the Charity scenario. That is, overall, both age groups felt more ambivalent within the Car-purchasing scenario than in the Charity scenario. Perhaps this is due to the fact that ambivalence is heightened when the situation evokes anticipatory regret (Anderson, 2003; Simonson, 1992; Tykocinski & Pittman, 1998; Tykocinski, Pittman, & Tuttle, 1995; Van Harreveld, 2009). Within the Car-purchasing scenario, participants were clear on what attributes and alternatives they were losing in order to gain another. This sense of loss was particularly accentuated in the Car-purchasing scenario because some of these included attributes were deemed most loss aversive based on the pilot test result. Meanwhile, the Charity scenario did not evoke a great sense of loss aversion; participants were aware that regardless of which option they chose they were helping someone, which significantly reduces the guilt or regret. It is also important to note that within the Charity scenario, the outcome of the decision does not call one's attention to what was lost (i.e., options that had to be abandoned in order to choose one), but rather, the benefit the chosen child would receive. Because ambivalence is often defined by the perceived loss-aversion (Luce et al., 1997; 1998), when the scenario fails to underscore the loss, but rather the gain, it may be difficult to induce heightened ambivalence that is often described as emotional discomfort.

EF as a moderator

I predicted that EF would moderate the age effect with regard to information search style; however, the data did not yield any of the EF measures having a significant moderating effect. This finding was surprising considering several extant studies have pointed to a positive relationship between EFs and deliberation (Jonas et al., 1997; Maio et al., 1996; Nohlen, van

Harreveld, Rotteveel, et al., 2014). There are also numerous studies that document the age-related decline in deliberative processing (Mutter & Poliske, 1994; Peters, Dieckmann, & Weller, 2011; Tversky & Kahneman, 1974; Yates & Patalano, 1999). One reason why this study might not have found the significant moderating effect of EF could be that that there was an unusual pattern with respect to age and EF. Normally, younger adults outperform older adults on tasks measuring EF. However, in this study there were no age differences in the common EF, although there were age differences in subcomponents of EF.

Age differences in EF

This study found that there was an age difference in EF as expected, but only in selective components of EFs, rather than all EF measures. One surprising finding of this study was that older adults performed better (i.e., higher accuracy score) than younger adults on N2Back task, a task known to assess the working memory capacity. One potential reason for this finding could be that our particular sample for older adults of this study was considered relatively young, with their age ranging from 55 to 73. Several studies pointed out the significant cognitive differences between young-old adults and old-old adults, noting that the decline of EFs becomes far more pronounced as people enter their old-old age (Baudouin, Isingrini, & Vanneste, 2019; McAlister & Schmitter-Edgecombe, 2016).

Another potential contributing factor for this finding could be that the data collection took part in the midst of pandemic, which is impacting everyone with added stress and collective trauma. Particularly, the result of the unusual finding on young adults' poor working memory score could be that this age group may have been influenced more severely by the stress of the pandemic. Generation Z adults (ages 18–23) are at a pivotal moment in their lives, experiencing adulthood at a time when the future looks uncertain than before. According to the National Stress

in America Survey, Gen Z adults are experiencing the highest level of stress compared to all other age groups since pandemic, and it has been increasing steadily as of 2021; meanwhile, older generations (e.g., boomers and older adults) reported markedly lower levels of stress (APA: Stress in America, 2021).

There is evidence that stress impairs working memory and cognitive flexibility, whereas it had nuanced effects on inhibition (Luethi, Meier, & Sandi, 2009; Mizoguchi et al., 2000; Shields, Sazma, & Yonelinas, 2016), and specifically, some studies emphasized adolescence being the critical period that can be more vulnerable to stress, because adolescent human brains might be especially sensitive to the effects of elevated levels of glucocorticoids and, by extension, to stress (Lupien et al., 2009; Chang et al., 2021). Given that the young adult participants of this study were mainly 18-19 years old, they may have been impacted more severely by stress due to pandemic. Moreover, one can speculate further that the young adults' lower working memory performance relative to older adults might be due to the extra stress that is on par with that of trauma. The definition of trauma is broadly known as "generating impotence and vulnerability, capable of causing such severe stress to threaten the integrity of the person's psychophysical balance" (Perrotta, 2019, p. 1). Several studies have examined the impact of trauma on cognitive functions and have found that working memory capacity is reduced when individuals are anxious and/or dealing with trauma (Blanchette, & Caparos, 2016; El-Hage et al., 2006; Op den Kelder et al., 2018), especially resulting in poorer accuracy of the N2back task (Philip et al., 2016). These studies corroborate that the findings of this study's abnormally low accuracy score on N2Back within young adults may be due to the trauma from the pandemic.

Granted, this study included the COVID stress measure and tried to control for the potential stress from the pandemic; however, these questions were rather limited and focused on

direct stress concerning COVID-19, rather than the indirect and consistent stress one may not even attribute to COVID-19, such as stress of social isolation (Clair, Gordon, Kroon, et al., 2021; Hwang et al., 2020; Kim & Jung, 2021). Particularly young adults who are expected to engage in daily social interactions from attending schools, the sudden drastic change of complete isolation over an extended period of time may have made a substantial impact. Several studies note the direct influence of social isolation on memory within animal model (Huang et al., 2011; Hueston et al., 2017; Green & McCormick, 2013; Kamal et al., 2014; Mataga et al., 2001; Mumtaz et al.,2018), indicating the potential detrimental impact of social isolation on people as well.

Lastly, this study's older participants were comprised of exceptionally high performing individuals who were well-educated and technologically savvy enough to navigate the software platform of Mturk. In fact, about 56% of older adults (N=33 out of 59) were college graduates and 22% (N=13 out of 59) had higher education. Because studies show that those with higher education tend to show higher EFs (e.g., Insel et al., 2006), the EF scores included in this study may not be representative of normative older adult population. A plethora of studies indicated that education and intelligence are protective factors with regard to aging and that such factors are associated with cognitive reserves (Angel et al., 2010; Arbuckle, Gold, & Andres, 1986; Lee, Lee, &Yang, 2012; Stern, 2009). Most of the participants in this study exhibited high education level which is more education than the typical older adult. In fact, there was a significant age differences in education, evincing that the sample of older participants in this study had significantly higher education than younger adults. Moreover, some researchers have argued that when younger and older adults are equated on education, the two groups are not necessarily comparable in intelligence or academic ability (Twenge, Campbell & Sherman, 2019). In previous decades, universities were more selective in recruitment of students such that

individuals needed higher high school grades and higher motivation to succeed in college. Thus, the older participants in this study might have scored higher on measures of EFs in their youth than our sample of younger adults. In other words, this study's result might have been influenced by a sample of older adults that is a subgroup of high performing older adults whose working memory performance overlaps with younger adults.

What is particularly interesting in this study is that even though the older adults had greater working memory capacity than young adults as N2back scores show, the older adults still engaged in a heuristic-based search, rather than a deliberation-based search. The N2back result indicates that older adults had the capacity to use a deliberative search strategy if they desired to do so. I additionally examined the possibility of the Need for Cognition (NFC) moderating this effect for older adults; however, I found no effect of the NFC on the propensity to engage in a deliberative versus a heuristic search for both scenarios. Hess (2014) argues in his selective engagement theory that older adults are very selective with regard to engaging cognitive resources because it is more taxing for them than for younger adults. It is also possible that as individuals gain expertise in various domains, they become adept at using heuristics that normally leads to the "correct" answer. It may be the case that older adults are so well-practiced at using heuristics that their default information search strategy is the one that relies on heuristics, more so than their younger counterparts.

FUTURE DIRECTIONS

This study mainly sought to investigate the age difference in ambivalence as a function of EFs and information search style. Although this study did not specifically find significant moderation of EFs and information search style, future research may increase the sample size to investigate whether they replicate the same result as the current study with increase power. Also, it may be more helpful to include old-old adults in the future study to investigate fuller extent of age effect. A careful manipulation of different conditions may be necessary for future studies to structure each condition differently to prevent some potential confounds. Specifically, this study's Selective-instruction condition may have led participants to experience more ambivalence by providing additional information that highlighted attributes were deemed highly loss-aversive and important by experts which may have laid an additional element that compounded the complexity of decision-making process within that particular condition. Additionally, investigating different types of scenarios that have different criteria for ambivalence (e.g., anticipated regret or loss aversion) will further the understanding of decision-making study as well.

Future research should also consider including more diverse population to consider how different cultural background may impact individual's perceived ambivalence. For instance, it is suggested that individuals from individualistic culture tend to be more rational in their decision-making processes while those with collectivist background tend to rely more on heuristics such as conforming to the group norms (LeFabvre & Franke, 2013). One study that investigated the cultural impact on ambivalence found that those individuals who were brought up from a

collectivist culture often engaged in dialectical thinking and reported to have perceived less emotional discomfort when bivalent information regarding options were provided (e.g., presentation of both positive and negative information that induces ambivalence), whereas when only one-sided information was presented (e.g., only positive or only negative information), they reported heightened discomfort (Pang et al., 2016). Meanwhile, those from individualistic culture reported heightened ambivalence when addressed with bivalent information and reported less discomfort when univalent information was presented (Pang et al., 2016). Considering the level of perceived ambivalence can be contingent upon one's values driven by their socioecological background, it may be important for the future studies to recruit diverse participants in order to promote further understanding of decision-making processes in various contexts.

Most importantly, it should be noted that this study was conducted amidst pandemic which has presented prolonged societal abnormality that may have induced more stress on participants, particularly young adults, as corroborated by the survey result by APA (APA: Stress in America, 2021). It is imperative to note that the sample within this study is not a representation of the normative population, and the result of this study may not replicate in the future. Considering the uncertainty of the future in regard to the pandemic status, it may be important to control for the level of stress better with more extensive questionnaires for the future studies.

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APPENDIX A

SPMSQ QUESTIONNAIRE FOR M-TURK

SPMSQ Screener for M Turk

1. What are the month date and year for today? (mm/dd/yyyy): _____
2. What is the day of the week? _____
3. Do you know your phone number? _____
4. Were you born before 1964? _____
5. Who is the current president? _____
6. Who was the president before him? _____
7. Do you know your mother's maiden name? _____
8. Can you count backward from 20s by 3's? Yes/No

APPENDIX B

IRB APPROVAL LETTER

THE UNIVERSITY OF ALABAMA® | *Office of the Vice President for* Research & Economic Development
Office for Research Compliance

July 14, 2021

Jaimie Choi
Department of Psychology
College of Arts & Sciences
The University of Alabama
Box 870348

Re: IRB # 21-04-4553: "The Role of Executive Functions on Ambivalence in Decision-Making"

Dear Jaimie Choi,

The University of Alabama Institutional Review Board has granted approval for your proposed research. Your application has been given exempt approval according to 45 CFR part 46. Approval has been given under exempt review category 2 as outlined below:

(2) Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:

(i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects

The approval for your application will lapse on July 13, 2022. If your research will continue beyond this date, please submit the annual report to the IRB as required by the University policy before the lapse. Please note, any modifications made in research design, methodology, or procedures must be submitted to and approved by the IRB before implementation. Please submit a final report form when the study is complete.

Please use reproductions of the IRB approved informed consent form to obtain consent from your participants.

Sincerely,

[redacted]

Carpantato T. Myles, MSM, CIM, CIP
Director & Research Compliance Officer

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