"Pick Me! Incorporating Self-Relevance and Working Memory in a Cognitive Dissonance Model"

Kathryn L. Lloyd

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Pick Me!: Incorporating Self-Relevance and Working Memory
in a Cognitive Dissonance Model

by

Kathryn L. Lloyd

A thesis submitted in partial fulfillment of the requirements for the degree of
Master of Science in Experimental Psychology
with a concentration in Behavioral Neuroscience
Seton Hall University

August, 2008
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Dedication

Marianne E. Lloyd, Ph.D., my mentor, advisor, and advocate – without your guidance and support, this paper and my thesis would not be where it is today. I dedicate this paper, with all its revisions, to you.

Most importantly, to my mother, Katherine D. Lloyd, you are my friend and my confidant. So many times you offered a smoother path through graduate school. In the end, you have always supported me and my decision the entire way. I love you, and I dedicate everything I have learned to you and your unwavering support.
Acknowledgment

To all the special people in my life who have aided me along my path to become a stronger and independent individual and have started me on my journey as a professional.

To my committee members, Janine Buckner, Ph.D. and Susan Teague Ph.D., you both offered assistance, suggestions, and encouragement. Marianje E. Lloyd, Ph.D., you always believed in me and the goals I wanted to achieve. I cannot thank you all enough for always being there to help. To the department of psychology faculty members at Seton Hall, my fellow graduate students, and my roommates, thank you for providing so many academic and life lessons.

To all my family, especially my mother Katherine D. Lloyd, – whether you offered your homes for weekends “away from it all,” phone calls of support, or even nourishment both body and soul, thank you for always having faith in me, encouraging me, and for being there when I needed you the most.

Thank you all for each of your special contributions as I progressed through graduate school in the pursuit of my Masters. It has been an invaluable and memorable experience.
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Abstract

The current study expands previous literature (Lieberman, Oschner, Gilbert, & Schacter, 2001; Stone & Cooper, 2001) by investigating the relation among working memory, self-relevance and cognitive dissonance. The phenomenon of dissonance reduction was investigated by rating 15 pictures to measure individual attitude change. According to Festinger (1957), individuals can reduce dissonance by either changing their attitudes or justifying their actions. Results indicate that maximizing self-relevance and minimizing working memory demands leads to the greatest degree of attitude change. The results support the Baddeley and Hitch (1994) working memory model and the Self-Standards Model of cognitive dissonance (Stone & Cooper, 2001).
Introduction

Linda was a self-proclaimed feminist. She believed that women were equal to men and, in turn, should receive the same equality when it came to contracts, properties, workplace rights, politics, and even discrimination. Often, Linda’s friends would find her at the local mall proclaiming these rights of equality. So naturally, when it came to the 2008 Presidential Primary involving Democratic candidates Hillary Clinton and Barack Obama, Linda wanted to vote for Clinton, the female candidate, over the male candidate. However on the day of her state’s primary, Linda arrived at her local election office, went into the voting booth, and paused. Instead of voting for Clinton as she had expected, Linda found herself marking the circle to elect Obama. Afterwards, Linda nonchalantly left the office, thinking little about her decision until she arrived home. Once there, Linda began to feel uncomfortable and felt that her decision was slightly irrational. Linda, the feminist, the person who believed that woman were equal to men, just voted for a man over a woman. “Why did I do that?” was all Linda could think about as she shook her head, placing it in her hands. As she thought about her situation and how uncomfortable she felt about her decision, Linda started to say to herself, “Maybe Clinton isn’t the best candidate for the presidency. I mean, she’s a woman; I whole-heartedly believe that women can do as many things as men. Yet, I feel that Obama’s platform has more substance and that it actually might help the country… yeah, that’s it! I voted for Obama because his platform is better for the country than Clinton’s.”
The psychological discomfort Linda felt about going against her feminist views by voting for a man over a woman is a common state called cognitive dissonance. Linda's discomfort arose when there was a "mismatch" between her actions and attitudes. Festinger (1957) first rationalized the notion of cognitive dissonance when he observed it in everyday situations and the need an individual experienced to resolve the mismatch and discrepancy feeling. As humans, we try to maintain a consistency in our lives so as not to create any unneeded stress; we try to be consistent as much as possible. Part of this consistency is the maintenance of both our actions and attitudes; when they match, one can continue through life focusing on other events beyond the consistent balance between actions and attitudes. (See Figure 1 below.)

**Figure 1: Consistent Human Behavior (No Cognitive Dissonance)**

*Normal Activity/No Cognitive Dissonance*  

```
Actions

Consistent

Attitudes

Everything is good!  
I am okay!  
I feel rational!
```
However, in the case of cognitive dissonance where an inconsistency occurs between one's actions and attitudes, stress may ensue causing the psychological discomfort that is characteristic of this state. (See Figure 2 below.)

**Figure 2: Inconsistent Human Behavior Causing Cognitive Dissonance**

![Diagram showing the relationship between actions, attitudes, inconsistency, and experience.](image)

*Festinger's Original Dissonance Theory and Its Background*

In Festinger's (1957) original theory, cognitive dissonance may arise in interpersonal or intrapersonal situations. In Linda's case, she experienced an intrapersonal situation where the discrepancy between her attitudes and actions created cognitive dissonance. Her personal beliefs did not match her personal actions. Linda
believed in one concept (feminism and woman were equal to men), but her actions (voting for Obama over Clinton) contradicted her beliefs.

Interpersonal situations can arouse cognitive dissonance also, a dissonance arousing situation called hypocrisy theory (Stone, Cooper, Wiegand, & Aronson, 1997). In hypocrisy theory, an individual may experience dissonance if they have a personal connection with a group or another individual who is directly displaying the dissonance actions. An example would be an interaction between Kristin and her best girl friend. The girls had been friends for years, which also means that they knew each others’ attitudes regarding particular situations (i.e., the friends did not get along with another girl in their town and chose not to associate with her). Yet, one day the best friend did something that contradicted the behavior Kristin would have expected from her friend (i.e., the best friend started hanging out with the girl that both friends had confessed to each other they did not like). Here, cognitive dissonance was aroused within Kristin as an observer because she was intimately connected to the individual (her best friend) exhibiting the dissonance behavior. Thus, Kristin would experience an interpersonal dissonance-arousing situation (and consequently vicariously experience the state of cognitive dissonance) because an external situation created the same psychological discomfort within her that she might experience from an intrapersonal dissonance-arousing situation. Because Kristin had the personal connection to her friend, she experienced vicarious dissonance. Conversely, if the personal connection, or close friendship, did not exist between Kristin and her best girl friend, Kristin would have been less likely to experience dissonance because she may not have acknowledged the inconsistency in her friend’s behavior (Dickerson, Thibodeau, Aronson, & Miller, 1992).
Once an individual has experienced cognitive dissonance, regardless whether the trigger was an inter- or intrapersonal situation, one may try to actively resolve the situation. Festinger (1957, 1967) stated that the dissonance reduction process is an active process that can be completed consciously or unconsciously. When it is a conscious process, an individual might perform actions or justify their thoughts to relieve their dissonance feelings. However, dissonance reduction can also be an unconscious process where individuals will change their responses or thoughts to remedy the situation without knowingly doing so. Thus, an individual will try to resolve the uncomfortable situation as quickly, in the most effective manner, and with as little change or harm to the individual’s identity as possible. An individual can either try to justify her actions as being a one-time occurrence or adjust her attitudes saying to herself, “Maybe this is how I truly feel.” Either way in the dissonance reduction process, individuals will try to directly resolve the situation in one of three potential ways: (1) by changing their behaviors or actions; (2) by changing their ideas or beliefs; or (3) by changing both their behaviors and beliefs. So, one or both of the contributing variables (actions or attitudes) has to change. (See Figure 3 below.) According to Stone (Festschrift for Elliot Aronson, APS Convention, May 25, 2008), individuals are more likely to change their actions over changing their attitudes to reduce dissonance.
Figure 3: Dissonance Reduction Process

The amount or magnitude of cognitive dissonance experienced by an individual differs depending upon that individual’s susceptibility to behavioral inconsistencies and the type of inconsistency that aroused the dissonance state (Stone, J., Festschrift for Elliot Aronson, APS Convention, May, 25, 2008). To estimate the amount of dissonance experienced (D), it can be expressed as a ratio between an individual’s consistent (C) and inconsistent (I) actions and attitudes. In this ratio (see Figure 4 below), the greater the inconsistency between ones’ actions and one’s attitudes given one’s overall consistent and inconsistent tendencies, the greater the amount of dissonance the individual will experience. Thus, if an individual has inconsistent behaviors, she may be more likely to
experience dissonance than another individual who generally displays consistent behaviors.

**Figure 4: Dissonance Experience Ratio**

\[
D = \frac{1}{1 + C}
\]

Alas, according to Festinger (1957, 1967), dissonance cannot be reduced in all cases. This is due to the additional consequences or issues that may be aroused during the reduction process which may have more detrimental effects to the individual experiencing dissonance than the original dissonance experience itself. For instance, a soldier was trained to kill members of a certain group and thus believed it was his obligation to kill them. However after several kills and feelings of personal distress regarding his actions, the soldier changed his views to save the out-group instead of killing them as ordered. Here, if the soldier tried to either justify his actions or change his attitudes it could create too much additional discomfort beyond the original dissonance experience. The soldier would have to deny everything he was taught and once believed regarding the out-group, or he would have to come to terms with killing those people. The soldier may choose to consciously ignore his dissonance feelings because trying to reduce the dissonance would cause too much additional pain. In a case like this, Festinger (1957, 1967) suggested that it would be easier for the individual to live with the original dissonance discomfort, making no effort to reduce it because of the
additional consequences and feelings of uneasiness that may occur if that individual should try to reduce it.

In the example above, dissonance was not reduced because the soldier purposely and consciously decided to ignore the state of cognitive dissonance. On the other hand, dissonance reduction can also be an unconscious occurrence. For instance, at the grocery store, a mother was trying to decide between two brands of cleaning products. At the moment, she had no preference for one brand over the other. So when choosing, the mother bought the brand that had the most aesthetically pleasing label. She continued to buy this brand whenever she went grocery shopping, until one day that product was no longer available. Instead of her preferred brand, the mother had to decide between a new brand and the previously unchosen brand. Again, the mother thought she had no preference for either brand, and so bought the newer brand. The mother was unconsciously reducing dissonance because she had previously rejected the one brand as being inferior or less desirable. So when given the opportunity to buy the previously rejected brand or a new one, unknowingly the mother rejected the old brand again and chose the new brand. The mother unconsciously maintained her belief that the old brand was the less preferred brand by buying the new brand instead.

To date, numerous studies have been conducted supporting the existence of cognitive dissonance as a phenomenon (e.g., Aronson & Carlsmith, 1963; Bem, 1965; Bem, 1967; Brehm, 1956; Cooper & Fazio, 1984; Egan, Santos, & Bloom, 2007; Festinger & Carlsmith, 1959; Greenwald & Ronis, 1978; Harmon-Jones, Brehm, Greenberg, Simon, & Nelson, 1996; Jahoda, 1997; Lieberman, Ochsner, Gilbert, & Schacter, 2001; Scher & Cooper, 1989) (for a review, see Stone & Cooper, 2003).
However, the phenomenon of cognitive dissonance has yet to be fully explained. In the fifty years since its inception, individual aspects of dissonance (i.e., the arousal of dissonance, the state of dissonance itself, and the reduction processes) have been investigated, but there is little understanding of the phenomenon as a whole except that it is a naturally occurring human state.

The ability of the individual to reduce the psychological discomfort associated with cognitive dissonance, also known as dissonance reduction, has been researched as much as the theory of cognitive dissonance itself. Both the arousal of dissonance and the reduction of dissonance are personal states, drawing upon each person’s individual characteristics such as self-concepts, self-expectancies, attention, memories from previous experiences, and self-relevance. It is for these reasons that many theories, beyond the original cognitive dissonance theory provided by Festinger (1957), have been created and reviewed over the years.

Since cognitive dissonance was first proposed, some of the original nuances of Festinger’s (1957) theory have changed, losing many of the qualities of the phenomenon itself. For instance, Festinger originally gave examples of individuals experiencing dissonance because they could not draw a connection between two items (e.g., the belief that humans would not travel to the moon but yet a machine was built with the capabilities to achieve such an outcome) (as cited in Greenwald & Ronis, 1978). Festinger claimed that multiple stimuli from personal and external sources could arouse dissonance, whereas more recent theories propose that only personally controlled stimuli are able to arouse dissonance (e.g., Greenwald & Ronis, 1978). For instance, Aronson and Carlsmith (1963) suggested that dissonance arousal and reduction are very personal
states and the psychological discomfort generated by an internal discrepancy should result in greater dissonance discomfort than the discomfort generated by an external stimulus (e.g., Linda would experience more dissonance regarding her anti-feminism actions than the knowledge about the moon example described earlier).

*Alternative Cognitive Dissonance Theories*

Although many theories regarding cognitive dissonance arousal and reduction exist, no single theory has been able to address all the evidence provided from fifty years of research. For instance, little is known regarding why the phenomenon of cognitive dissonance generates the psychological discomfort it does, nor is there a universal strategy for resolving or reducing the discomfort that arises. Instead, individualistic approaches (e.g., Stone & Cooper, 2001) appear to be the most effective means for reducing cognitive dissonance. Each theory presented since Festinger's (1957) provides a small portion of information unique to the cognitive dissonance phenomenon, but they do not incorporate information from other theories and outside sources.

In the Self-Consistency Theory, cognitive dissonance is generated when there is an inconsistency between one’s actions and the individual’s self-concept or self-expectancies (Aronson, 1968; Thibodeau & Aronson, 1992). According to the theory, individuals use their self-concepts about a situation to create self-expectancies about how a situation should progress. When an individual has strong self-concepts, one is more likely to experience dissonance through the mismatched actions and attitudes because it threatens the expectancies the individual already formed regarding the situation. In other words, one would feel that her identity is threatened in some manner by her behaviors when there is a mismatch. Thus, dissonance is reduced by maintaining one’s attitudes
and considering one's discrepant actions to be an accidental occurrence. The main concern of individuals then, is to reduce dissonance as quickly as possible, in whatever manner possible, even if it means changing one's individual self-concepts to achieve such an outcome or explain a behavior.

In the "New Look" dissonance theory proposed by Cooper and Fazio (1984), the mismatch of cognitive dissonance involves the individual feeling personally responsible for the discrepant situation and its consequences. One may feel that she is responsible for the discrepancy between her actions and attitudes, in turn also responsible for any and all negative consequences associated with the discrepancy. Therefore, an individual in this theory will reduce dissonance by: (1) changing one's actions or one's attitudes so as to minimize any further negative consequences associated with the event; (2) reduce the feeling that one is personally responsible for what has occurred; (3) and reestablish the consistency between one's actions and attitudes so any similar further events will not reoccur.

Unlike the other two theories (Aronson, 1968; Cooper & Fazio, 1984; Thibodeau & Aronson, 1992), the Self-Affirmation Theory (Steele, 1988) proposed that dissonance results only when an individual's actions contradicts one's morality. When an individual has an extremely firm moral belief regarding a topic (e.g., Christians believe that marriages should be monogamous), that belief is held higher than any other self-expectancy or attitude (e.g., not speeding, not drinking while driving, etc...). According to the Self-Affirmation Theory, when this moral is threatened by a competing action (e.g., an emotional interaction or connection with someone other than one's spouse), the said individual is likely to experience cognitive dissonance. It should be noted that one's
dissonance can be aroused by not only the direct mismatch between thought and actions (physically acting it out) but also by the mere temptations that may or may not lead towards physical enactment. Thus, dissonance reduction in this theory is sought by actively maintaining the individual’s morals and actively being aware of a mismatch (or potential mismatch) between attitudes and action so as to never invest in these again.

*The Self-Standards Model (SSM) of Cognitive Dissonance*

Incorporating many of the theories that have been presented thus far and adjusting for some of their shortcomings, Stone and Cooper (2001) proposed a newer model of cognitive dissonance, the Self-Standards Model (SSM), to explain some of the underlying issues associated with the phenomenon. Unlike Self-Affirmation (Steele, 1988) or Self-Consistency theories (Aronson, 1968; Thibodeau & Aronson, 1992), the SSM does not emphasize the importance on one particular moral over others nor does it emphasize the self-concepts or self-expectancies of the individual. Instead, the SSM focuses upon the multi-faceted individual with emphasis on individual differences in traits (i.e., attention and memory). All humans have multiple self-expectancies and multiple beliefs. While some are deemed more important than others, the SSM states that any one of these expectancies can increase in importance during dissonance arousal.

The primary goal of the Self-Standards Model (SSM) was to unify the previous theories mentioned into an encompassing model that would better explain the occurrence of cognitive dissonance. Whereas previous models often tackled one angle of dissonance reduction, Stone and Cooper (2001) attempted to incorporate individual attention and personal preference from the Self-Consistency (Aronson, 1968; Thibodeau & Aronson, 1992), the Self-Affirmation (Steele, 1988), and “New Look” theories (Cooper & Fazio,
into their cognitive dissonance model. Many factors can accumulate to cause the state of cognitive dissonance, but it is the role of the individual that leads to both dissonance arousal and reduction (Stone and Cooper, 2001). The SSM incorporates how individuals behave, interpret, and evaluate one’s behaviors. This model creates a standard by which an individual can measure one’s actions, where the behavior then establishes the involvement of the self and the individual’s attitudes in the dissonance arousal process. Once these mitigating factors have been identified, the SSM suggests that accounting for certain personal aspects will cause the individual to justify one’s mismatched actions and attitudes while simultaneously using the individual’s self concepts as a way to reduce cognitive dissonance. Thus, the primary argument of the SSM is that the role of the self in the dissonance processes of arousal, state and reduction is dependent upon the individual self-attributes and standards that are first available when a discrepant behavior occurs.

In the SSM, Stone and Cooper (2001) theorize that self-relevant information, or personally important information, in addition to the incorporation of an individual’s attention are fundamental for both the arousal and reduction of cognitive dissonance. For instance, unless Linda was truly bothered by her anti-feminist actions, or other similarly arousing situations, which would create the self-relevance needed to arouse cognitive dissonance, it would be unlikely Linda would change either her attitudes or her actions to resolve the psychological discomfort she experienced. Thus, the SSM incorporates individually specific characteristics into the arousal, state, and reduction of cognitive dissonance.
Two types of standards are associated with the SSM: personal standards and normative standards (Stone & Cooper, 2001). Although both are available when a dissonant behavior occurs, how an individual initially acts during dissonance reduction proves to be the most significant factor in the final reduction outcome. With personal standards, the dissonant behavior is measured against the individual’s personal beliefs and attitudes. To reduce dissonance along this path, the individual uses one’s self-expectancies and beliefs to reduce the psychological discomfort of cognitive dissonance (e.g., Linda’s beliefs are held higher than her actions, thus she always will deem her beliefs as being more important than her actions, thereby trying to justify her actions instead of changing her beliefs). Thus for dissonance reduction, self-expectancies are important because they become more important than an individual’s actions. In Linda’s case, she is upholding her self-expectancy that her feminist views are more important than her actions by justifying to herself that her choice for presidency was based on politics and which candidate was better for the country than the possibility she may believe something different.

Contrarily, normative standards depend upon comparing the individual actions against those that are expected by the community or culture. In this process, dissonance is reduced by lowering the individual’s self-expectations when the community or cultural beliefs and standards are viewed as more important to maintain than exerting oneself as an individual within that community (Cooper & Fazio, 1984; Stone & Cooper, 2001). When Linda was voting, she held her personal feminist point of view while simultaneously being held to the voting standard, “Vote for the candidate that you feel will fulfill the job and its duties best.” Although she has firm beliefs regarding feminism,
at the moment she was voting, she might have been more concerned with fulfilling her voting responsibilities by voting for the best candidate than maintaining her personal beliefs and voting for her preferred candidate. In a case such as this, Linda deemed normative standards more important, therefore she reduced her dissonance discomfort by thinking, "I did my duty as a voter; that is more important than my personal beliefs." Linda would rather change her thoughts or beliefs than not comply to the normative standard.

The SSM also addresses the involvement of attention and motivation associated with cognitive dissonance (Elliot & Devine, 1994; Stone & Cooper, 2001). Unless an individual is motivated to make a change or gives the situation enough attention to notice the discrepancy between her actions and attitudes, the individual will continue to unconsciously experience cognitive dissonance unless one takes the initiative to resolve the matter. Returning to the example, Linda did not notice her discrepant voting actions until she went home and began thinking about which candidate she marked on her ballot. Linda was unconsciously experiencing dissonance until she thought about her actions, causing her to be consciously aware of the dissonance discomfort. Once she experienced this discomfort, Linda was uncomfortable with her contradicting actions and attitudes, and was thereby motivated to reduce dissonance by justifying her vote as being for the better political candidate than for candidate that fit her feminist views. Linda might not have been aware of her dissonance state until she paid attention to how she voted and how that contradicted her beliefs. Consequently, she also became motivated to reduce dissonance so her beliefs would be preserved and so her actions would be considered accidental.
Previous cognitive dissonance theories have focused on particular aspects of dissonance without much attention to the overall arousal, state, and reduction process itself. For instance, the Self-Consistency Theory (Aronson, 1968; Thibodeau & Aronson, 1992) maintains that an individual's attitudes must be upheld at all costs, a process which will aid in later dissonance reduction. Conversely, Self-Affirmation Theory (Steele, 1988) proposed that when an individual's morality is threatened, dissonance must be reduced at all costs. Similarly, the “New Look” Theory states that dissonance reduction must be accomplished at any cost regardless of its threat to an individual’s idea or morals. Unfortunately, these theories fail to take into account that not every individual experiences cognitive dissonance in the same manner. Consequently, the SSM focuses upon individual differences within cognitive dissonance, specifically what motivational and attentional levels are necessary for dissonance to be aroused, the state felt and reduced. Although many theories have been presented, it is this more inclusive, individualistic model that can more fully explain how individuals experience dissonance differently. (Refer to Table 1 for differences among the theories presented.)
Table 1: Characteristics of Previous Dissonance Theories

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<tbody>
<tr>
<td>Focus/Emphasis</td>
<td>Maintain attitude over actions</td>
<td>Minimize anyway possible</td>
<td>Individual morality is threatened</td>
<td>Individual differences in attention and motivation</td>
</tr>
<tr>
<td>Where in Dissonance Process</td>
<td>Reduction</td>
<td>State/Reduction</td>
<td>Arousal</td>
<td>Arousal, State, Reduction</td>
</tr>
</tbody>
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The Involvement of Working Memory on Cognitive Dissonance

The Self-Standards Model (SSM) focuses on the role of attention in the cognitive dissonance process. In Cognitive psychology, attention frequently is associated with working memory, though most forms of memory also can be affected by attention as well. However, processes within working memory appear to be greatly affected by an attentional component. Previous literature by Daneman and Carpenter (1980) proposed that working memory capacities are more indicative of an individual's cognitive abilities than simple short-term memory assessments. When enough attention is given to each task or incoming stimuli, a person is more effectively able to recognize or recall information at a later point. However, in cases where not enough attention is given because one is distracted, later recall or recognition can be hindered. In two working memory models (Baddeley and Hitch, 1994; Unsworth & Engle, 2007), attention is proposed to be important for the integration of information from the environment. Here,
attention is used as a focusing component to differentiate between multiple incoming stimuli to determine what actually will be encoded into memory. Thus, working memory also appears to be involved in the cognitive dissonance process because of the intertwining attentional component necessary for both memory and dissonance tasks.

Working memory is often defined as a mental blackboard that is employed for the short term storage of previously processed information while simultaneously serving as a place for the processing and manipulation of new material (Cohen, Perlstein, Braver, Nystrom, Noll, Jonides, et al., 1997; Smith & Jonides, 1997). Early memory research by Brooks (1968) showed that when verbal and spatial information are encoded, recall can be interrupted when other similar information was encoded at the same time. This disruption, also known as interference, is associated with using the same processes for the same type of task (e.g., encoding two distinct verbal stimuli at the same time). However, when two separate processes were used to encode information, this disruption did not occur (e.g., encode verbal and encode spatial) (Brooks, 1968). This early work lead directly to our current understanding of working memory while providing evidence that there was more involved in human cognitive processes than just the direct encoding and retrieval of information. Currently there are two major models of working memory (Baddeley & Hitch, 1994; Unsworth & Engle, 2007); each makes predictions that relate to the issues of attention described in Stone and Cooper’s (2001) SSM of cognitive dissonance.

*Baddeley and Hitch’s Revised Working Memory Model*

Baddeley and Hitch (1994) proposed a model of working memory that consisted of a three-component structure where a central executive processor regulated the activity
of its two subsidiary processes, the articulatory or phonological loop and the visuospatial sketchpad. The phonological loop is associated with the processing of short-term verbal memory tasks. In Linda’s case, she is able to remember the question asking her which candidate she preferred as the Democratic presidential candidate. The visuospatial sketchpad performs a similar function with visual and spatial stimuli. On Linda’s drive to the election office, she received visuospatial information regarding her surroundings and the route she was taking to the office. Overseeing these verbal, visual, and spatial processes is a selective processor known as the central executive processor. Its purpose is to regulate the attention given to stimuli so it can be processed by these two subsystems. The central executive processor determines which material will be processed into memory by discriminating between the verbal, visual, and spatial information that are simultaneously competing for an individual’s attention and memory space. The central executive processor delegates the processing of information between the visuospatial sketchpad and the phonological loop.

This three-component model is supported by studies using a dual-task coordination method of working memory (e.g., Arnell, 2006; Cocchini, Logie, Sala, MacPherson, & Baddeley, 2002; Oberauer & Kliegl, 2004; Zeithamova & Maddox, 2006). In the dual-task method, an individual is presented with information to be processed using both their visuospatial sketchpad and the phonological loop. When both subsystems are used to process separate tasks, there is no interference in the encoding or retrieving of information; however, as the tasks begin to use the same processes simultaneously (e.g., visuospatial sketchpad to process two sets of visual stimuli), interference becomes evident, usually hindering the cognitive process being performed.
This idea supports the findings by Brooks (1968) that suggest that when the same pathway is used, there is a marked decrease in cognitive ability, suggesting interference. However when separate processes are used, no interference is present during processing. When both subsidiary processes in Baddeley and Hitch's (1994) model of working memory are used to process separate tasks, there is no interference. However, as soon as a single type of processing is used (e.g., the phonological loop) for more than one task, interference exists (Baddeley, 2003; Baddeley & Hitch, 1994; Brooks, 1968).

Processing of Auditory Information in a Baddeley and Hitch (1994) Model

In this model, however, Baddeley and Hitch (1994) do not directly address how auditory information is processed. They state that the visuospatial sketchpad processes visual and spatial information while the phonological loop processes verbal information. Subsequently, Imbo and Vandierendonck (2007) and Andersson and Lyxell (2007) address this concern in the Baddeley and Hitch (1994) model by proposing that the three-components process more types of information than previously thought. Imbo and Vandierendonck (2007) postulated that the phonological loop may process more than verbal information alone. The researchers found that when participants had to count to solve a mathematical equation, the phonological loop was needed, at least passively. Conversely, Andersson and Lyxell (2007) also found that children with known mathematical difficulties scored lower on counting span tasks than their control counterparts. The counting span task has been shown to assess working memory processes. Thus, recent research has proposed that the Baddeley and Hitch (1994) three-component working memory processes may be accessed during the use of specific, counting-related, processing tasks. Nonetheless, it cannot be concluded that counting
abilities access auditory working memory processes in addition the working memory processes specified by Baddeley and Hitch (1994).

Unsworth and Engle's Working Memory Model

A second working memory model is that proposed by Unsworth and Engle (2007), where the combination between primary and secondary memory affects the encoding and retrieval process of information. In this model, primary memory is defined as the attentional component necessary to discriminate between information to be processed. Secondary memory is defined as the retrieval element involved with long-term memory, usually involving a cue-dependent search process. Primary memory allows for the ongoing processing of information through the continuous allotment of attention. However, primary memory still has its limitations. As stated by Unsworth and Engle (2007), primary memory has a limited capacity where up to four distinct items can be processed simultaneously. When an attempt to process more than four items is made, primary memory becomes dependent upon the cue-based recall processes of secondary memory. When this happens, newer items are processed whereas older items are sent to secondary memory for processing. In addition to capacity limits within primary memory, attention is essential for the processing of information. When not enough attention (i.e., when multiple tasks are being performed simultaneously) is given to the processing of information in primary memory, the information will be split between primary and secondary memory.

Secondary memory allows for the processing and storage of information that could not be initially processed by primary memory. Also, Unsworth and Engle (2007) proposed that secondary memory allows for the retrieval of information based upon cues.
The presence of a cue-dependent retrieval memory process within this model is of particular importance since the cues allow for a memory search for specific items that are associated with those cues in both short-term and long-term storage. The capacity of secondary memory is vast; thus, without a cue to limit what is to be retrieved, the searching process would be hindered by too much information. However, as with any cue-based encoding and retrieval processes, the recalling of information is only as effective as the connection match between encoding cues and retrieval cues. When the cues are similar, the retrieval of information is fairly effortless. However, in cases where the cues for encoding and retrieval do not relate, retrieval can be hindered. For example, a female student named Susan meets a guy named Tom at the bar. They talk throughout the night exchanging only first names and not last. When Susan is trying to recall information regarding Tom, she associates the information being retrieved with the bar at which they met. In this case, the bar serves as a cue to retrieve the information about Tom from Susan's secondary memory. However, if Susan happens to subsequently see Tom at the grocery store, she may recognize him but have a hard time recalling where they originally met because the encoding cue (meeting him at the bar) does not relate to the retrieval cue (meeting him at the grocery store).

Both the Baddeley and Hitch (1994) and Unsworth and Engle (2007) models of working memory involve a governing or primary processor used to delegate an individual's selective attention toward pertinent information waiting to be processed (i.e., Baddeley and Hitch's central processor and Unsworth and Engle's primary memory). Although the subsidiary components in each model differ (i.e., Baddeley and Hitch's phonological loop and visuospatial sketchpad versus Unsworth and Engle's secondary
memory), they both work towards the successful retrieval of information from memory. Baddeley and Hitch (1994) found that retrieval is based upon the type of stimulus encountered (visuospatial vs. verbal) whereas Unsworth and Engle's retrieval process is only governed by the secondary memory process (cue matching). Unfortunately, encoding methods are not addressed in the Unsworth and Engle model (2007); in this working memory system the specifics of "how" this process happens is not discussed. The secondary memory serves as a form of long-term memory and aids in the retrieval process, but no specific component is mentioned as to which information is encoded. Baddeley and Hitch's model, on the other hand, uses the same visuospatial sketchpad and phonological loop in both the encoding and retrieval process (Baddeley & Hitch, 1994).

By incorporating both models of working memory (Baddeley & Hitch, 1994; Unsworth & Engle, 2007) within the framework of cognitive dissonance addresses some of the attentional and simultaneous-processing issues that were raised by the previously mentioned cognitive dissonance theories (Aronson, 1968; Cooper & Fazio, 1984; Steele, 1988; Stone & Cooper, 2001) Both working memory models have a governing component that directs an individual's attention to certain information while ignoring other information. For instance when Linda was voting, she received information regarding the feel of her clothes, the fact that her shoe was leaving a blister on her foot, the feel of the pencil in her hand, what other individuals in the room were talking about, and that the air conditioning made the room very cold. Yet, Linda's attention was directed towards the election question and filling out the necessary paperwork to make her vote count. Unless there was a governing process (e.g., central processor or primary memory) to direct Linda's attention towards her voting ballot and not to the other stimuli,
she may not have noticed it. Thus in the SSM of cognitive dissonance, an individual’s attention has to be drawn to the discrepancy in order for one to become aware of the mismatch.

As more information is presented, an individual has to give more attentional resources to each set of material; thus an individual gradually increases her cognitive workload when processing multiple sets of information (Baddeley & Hitch, 1994). The functioning of the individual therefore can be impaired when not enough attention is given to any particular task, instead dispersing it between multiple tasks. Such dispersals, it is argued, creates the discrepancy between actions and attitudes – in effect, dissonance (Festinger, 1957; Aronson, 1968; Stone & Cooper, 2001).

Previous Memory and Cognitive Dissonance Research

Another form of memory besides working memory was suggested to require attentional capacities to retrieve and encode information. Lieberman, Oschner, Gilbert, and Schacter (2001) evaluated the involvement of explicit memory and working memory in a cognitive dissonance model, focusing on participant attitude change scores for pictorial stimuli. Previous research had shown that amnesiacs have impairments and deficits with their explicit memory capacities (Chun, 2005; Curran & Schacter, 1997), but little research had investigated the relation among amnesia, explicit memory, and working memory in terms of cognitive dissonance or personal attitude change. To this end, Lieberman et al. (2001) compared the cognitive dissonance process of amnesiac patients and normal participants. Initially, the researchers tried to determine the involvement of explicit memory in an attitude change rating task performed by participants. Amnesiacs and normal participants rated picture postcards in two different
tasks in such a way to arouse dissonance and later reduce it. Results indicated no
difference in memory functions between the amnesiacs and normal participants.
Implications from this initial study suggested that explicit memory may not be necessary
for the state and reduction of cognitive dissonance.

Based on the finding that amnesiacs were not impaired in the attitude change task
when an explicit memory task was employed, Lieberman et al. (2001) shifted their
investigations to analyze the effect of working memory in a dissonance reduction process
as working memory differs from implicit and explicit memories in terms of how
information is processed. Implicit and explicit memories require the extraction of
information from an individual’s long term memory capacity (Balota & Marsh, 2004).
When an individual tries to retrieve information purposefully (i.e., in recall conditions),
one is using explicit memory, whereas implicit memory retrieval is more of a “bottom-
up” process that is automatic and therefore less effortful. Conversely, working memory
involves the processing of information in a temporary storage blackboard to be later
stored into long term memory. The processing can be either effortful or effortless
depending on the importance of the amount of information presented. Based on this
understanding, Lieberman et al. (2001) investigated if the situations that arouse cognitive
dissonance, and reduce it, require working memory processing.

Participants in Lieberman et al. (2001) were randomly assigned to either a
cognitive-load or a no cognitive-load condition (no-load) and then asked to rate pictures
in two sessions so the rating scores could be compared against each other. The working
memory processing task employed was auditory in nature, where participants listened to
a pre-recorded tape consisting of various tone frequencies. In the cognitive-load
condition, participants were asked to count the number of lowest tone that were presented while simultaneously making preference ratings to postcards. In the no-load condition, the same pre-recorded tape was presented in the background, but participants were told that it did not relate to their current task. Results indicated that there was no difference between postcard ratings across conditions. However during an identification task in the study, participants in the cognitive-load condition were not able to identify the paired postcards as accurately as those in no-load condition. Although there was no difference in cognitive dissonance ratings between conditions, participants who received the extra cognitive load (cognitive-load condition) showed an impaired ability to recall the behavior they had performed previously as compared to their counterparts (no-load condition); the cognitive-load participants identified fewer postcards suggesting the ability to identify pictures may be separate from cognitive dissonance processes also.

Based on these results, Lieberman et al. (2001) claimed that explicit memory and working memory may not relate to the cognitive dissonance process. However when participants were engaged in a working memory processing task, their ability to perform tasks and pay attention to their behavior was impaired by additional cognitive work load.

_Criticisms of Lieberman et al. (2001)_

In Lieberman et al. (2001), the task used in the study is a measure of attitude change between the two ratings sessions for the visual test stimuli (the postcards). Because the phenomenon of cognitive dissonance is marked by a discrepancy between an individual’s actions and attitudes, this discrepancy can either be resolved by the individual changing either one’s actions (i.e., the changing of the picture ratings between rating sessions) or one’s attitudes (i.e., maintaining their preference for some pictures
over others). Upon reviewing the article, the following concern arose: the methodology ruled out the involvement of both explicit and working memory in the phenomenon of cognitive dissonance without taking into account that the stimuli used may have affected the results they found.

Lieberman et al. (2001) used an auditory working memory processing task with a visual test stimulus. According to revisions of Baddeley and Hitch’s (1994) working memory model, because two separate memory processes were used, there would have been no interference in how the information was processed. The visuospatial sketchpad specifically would process visual and spatial information (e.g., Linda would be able to gauge the space between her car and the car ahead of her on the way to the election office). The phonological loop, on the other hand, would process verbal information (e.g., Linda read her directions to the election office and was able to process and encode the information). When both the visuospatial sketchpad and the phonological loop were used simultaneously, there would have been no interference in the encoding process since two separate processes were employed (e.g., gauging distances and trying to get somewhere for the first time). However when one of the processes was used to encode multiple pieces of information (e.g., visuospatial sketch pad trying to register the distance between Linda’s car and the one in front of him and imaging herself changing lanes on a curve, simultaneously), some interference could have occurred since both pieces of information could not be encoded at the same time but rather in subsequent processes or in partial, segmented, but never fully processed segments.

The differences between how information is processed within working memory could explain the results from Lieberman et al. (2001). Again, there was no difference
between cognitive dissonance or attitude change ratings in participants assigned to the
cognitive-load and no-load conditions. Assuming Baddeley and Hitch’s (1994) model of
working memory is correct, separate processes were used in the cognitive-load condition,
thus participants were able to process both sets of information without interference.
However, Brooks (1968) demonstrated that when the same type of information is to be
processed, information processing becomes harder because there is interference between
the material. The information cannot be processed in a single bulk set of information, but
rather in subsequent smaller sets of information.

Present Study

In light of this potential problem, and the subsequent conclusions, of Lieberman et
al. (2001), the current study incorporated multiple working memory processing tasks in a
cognitive dissonance rating task to measure if personal or self-relevant information can
affect the overall dissonance process. Stone and Cooper’s SSM (2001) proposed that
self-relevant information can affect the degree an individual experiences cognitive
dissonance, an aspect not addressed in Lieberman et al. (2001). If the individual were
personally affected by the dissonance process, she would experience cognitive
dissonance to a greater degree than an individual who was not personally affected by the
dissonance process, and thus the difference would show in their rating behaviors toward
the visual stimuli. Lieberman et al. (2001) selected stimuli and tasks for their study based
upon differences in explicit and working memory when cognitive dissonance was
experienced. The researchers, however, never address the issue of motivating
participants to draw a connection between the individual and the test stimuli, or they
failed to mention it in their research. Thus, participants may not have been as motivated
to reduce dissonance as other participants who have a personal connection with or self-relevance for the test stimuli.

Although some research has incorporated the involvement of memory into the process of cognitive dissonance (Lieberman et al., 2001) and others have incorporated self-relevance and attention into its models (Stone & Cooper, 2001), more research is needed to evaluate the role of each process in the SSM of cognitive dissonance. Therefore, the purpose of the current study was to expand the previous research started by Lieberman et al. (2001) by specifically investigating the relation among working memory and cognitive dissonance. Also, the present study sought to investigate the role of self-relevant information in the dissonance process.

In the present study, a visual working memory processing task was used as well an auditory memory processing task.

**Hypothesis 1:** It was predicted that results from Lieberman et al. (2001) would be replicated; however it also was hypothesized that specific forms of working memory would produce different results in the arousal of cognitive dissonance as exhibited by an attitude change.

- When a visual working memory processing task is used in conjunction with visual test stimuli, it was expected that there would be a smaller amount of attitude change or dissonance reduction between the rating sessions since competing information would be simultaneously presented.
A difference in results should be exhibited only if working memory is necessary in the cognitive dissonance process.

**Hypothesis 2:** By employing multiple processes within working memory, the current study was expected to support one of the two working memory models described earlier.

Although there was a “control” working memory condition (where participants were presented with the auditory working memory processing task and told it did not relate to their task, in a manner similar to Lieberman et al. [2001]) and an auditory working memory processing task, particular focus was placed upon the results from the visual working memory condition to determine if interference from competing visual stimuli would affect dissonance reduction.

- There would be interference between the visual working memory processing task and the visual test stimuli as evidenced by only a small attitude change between rating phases for this condition. This would suggest that attention of a specific processing type is important for demonstrating attitude change.
- Contrarily, if there were large differences across the visual and auditory working memory conditions, it would indicate that not only are the test stimuli and working memory processing tasks different from one another, but that there is a differentiation between visual and auditory tasks in working memory.
• If there was evidence for interference between visual working memory processing task and visual test stimuli (visual task-visual test) but not between auditory working memory and visual test stimuli (auditory task-visual test), then the results would supplement the revised Baddeley and Hitch (1994) working memory model.

• If there was no difference in dissonance ratings with auditory task-visual test but there was for the visuospatial task-visual test, results would indicate that separate memory processes were used in the processing of working memory material.

• In contrast, if there was no interference between visual task-visual test or auditory task-visual test, then the results would provide support for Unsworth and Engie’s (2007) working memory model, since both type of stimuli are able to be effectively processed by primary memory.

In primary memory, there is no distinction between types of stimuli (i.e., auditory versus visual), but rather processing can be limited by the amount of material that is to be processed (i.e., limit of four items). It is suggested that since there are less than four items to be processed (i.e., the rating task, the self-relevance manipulation when present, and the working memory processing task), that there would be differences between either the auditory, visual, control, or self-relevance conditions.

A second goal of the present study was to evaluate the role of self-relevant information in the cognitive dissonance process. According to the SSM (Stone & Cooper, 2001), unless attention is given to a particular stimuli or object, observers will
fail to see relevance for or draw a connection to the information. In this experiment, two self-relevance conditions were used: high and low. In the high self-relevance condition, participants were told that the pictures may relate to their personalities in addition to their personal preference. However, in the low self-relevance condition, participants were told that the pictures solely related to their preference for one picture over the other.

**Hypothesis 3:** Personality is more individual and self-relevant that reference alone, and in turn, should affect attitude change ratings.

- Participants in the high self-relevance condition were expected to pay more attention to their ratings than participants in the low self-relevance condition.
- Participants in the low self-relevance condition would pay attention to how to rate the pictures, but they would not give as much effort or attention to the process because it would not relate to an personal aspect that was highly important or self-relevant.

The role of self-relevance here was used as an attentional factor. It was theorized that as an individual pays more attention to a dissonance process, one was more likely to exhibit greater dissonance discomfort, and in turn, become more motivated to reduce dissonance (Stone & Cooper, 2001). Consequently, these two variables (self-relevance and attention) would interact with working memory in how information was processed. As an individual pays more attention to a particular set of information, one would not only draw a personal connection to the material (the material becoming increasingly self-relevant), but also would designate the material that would be processed actively by
working memory. In turn, participants would be more motivated to reduce cognitive dissonance since they felt personally connected to the information presented.
Method

Participants

One hundred twenty six undergraduate students (59 males, 67 females) from a private Catholic university in the Northeastern United States served as participants for this study. Students received course credit for their participation. Each participant was tested individually. Four participants’ data were not included in analysis due to their failure to comply with study instructions.

Materials

Stimuli: A series of fifteen neutral Impressionist pictures were chosen because of their ambiguous nature (see Figures 8-10 in the appendix). These specific fifteen pictures were chosen because they were perceived as being lesser known Claude Monet paintings by the experimenter (i.e., a student would be less likely to see these fifteen pictures on television or in a text book) (i.e., “Waterlilies” or “Japanese Water Bridge”). The pictures were postcard copies of Monet originals. Postcards were obtained from the Cleveland Museum of Art gift shop. Participants were not told the artist’s name and were not asked to identify the artist until the end of the experiment.

Working Memory Processing Tasks: Each of the working memory conditions was designed based on the idea that these tasks employ the same working memory processes (Baddeley and Hitch, 1994). It was suggested that each of these three tasks involve the processing of visual and auditory stimuli separately within the same working memory
processing capacity. Three working memory processing tasks (further known as memory processing [MP] tasks or conditions) were employed: visual, auditory, and control.

An auditory tape consisting of varying tone frequencies were used for the auditory and control MP conditions. This task and procedure was similar to the auditory MP task used by Lieberman, Oschner, Gilbert, and Schacter (2001). The tones (three total) were played on a piano, and recorded to tape in a ninety second series for presentation in the test setting. Only one recording was used for all participants in the control and auditory MP conditions.

In the auditory MP condition, participants were instructed to count the number of low tones that were presented in the taped series. Counting was to be completed mentally (i.e., count the tones in your head) and verbally or out load for verification the participants were completing the task. Participants’ scores were recorded as the proportion of correct responses out of the total possible correct.

The control MP condition was presented with the same tone recording that was used in the auditory condition. Participants were instructed that the auditory presentation had no relevance to the task they were completing, and it was meant to serve as background noise. Since no responses or scores were given, all participants in this condition received a “0” for analysis.

The visual MP condition consisted of a task taken from Brooks (1968) where participants were instructed to visualize a block letter (i.e., “F”) and starting with the lower-left corner and proceeding rightward (counterclockwise), trace along the edges of the letter indicating whether the corner they approached was an internal or external corner. In this task, participants were instructed to make verbal responses of “outside” to
indicate an external corner and "inside" to indicate an internal corner. For example, starting in the lower-left corner of an "F", the responses given should have been "outside," "outside," "inside," "outside," and so on. Block letters were specifically chosen for this task because it was similar to the stimuli used by Brooks (1968) and there are more corners to identify as compared to regular, handwritten letters. Participants' scores were recorded as the proportion of correct responses out of total possible correct.

Self-relevance Suggestion: Two self-relevance conditions were addressed in this experiment. Prior to the first rating session, participants were randomly assigned to one of two conditions: high self-relevance or low self-relevance. Participants were instructed to base their picture ratings upon their relevance condition.

In the high self-relevance condition, participants were informed that the pictures may relate to their personality in addition to their preference for the pictures. Consequently, a high self-relevance condition rating was a combined rating between personal preferences for the pictures in addition to which pictures a participant believed related to their personalities the most. So when rating, the personality rating was more important than the preference rating. In the low self-relevance condition, participants were told to rate their pictures solely upon their preference for some pictures over others. No further details or valence descriptions were given.

The goal was to manipulate the participants to become more self-relevant to or create a personal connection with the pictures in the high self-relevance (personality and preference) condition as compared to the low self-relevance (preference alone) condition. In actuality, personality was never measured in the high self-relevance condition or at any other time in this experiment. This context solely served as a guide for participants to
create a personal connection to the pictures presented. Participants did not complete any active task in the self-relevance condition; rather, they were presented with the suggested manipulation that how they rated the pictures pertained to some other aspect besides preference. At the end of the experiment, all participants were told that the pictures did not relate to this measure (personality) and of the condition’s actual connection to self-relevance arousal.

**Distractor Task:** Sudoku puzzles were used as intermediary distractor tasks between the three phases of this study. A total of five puzzles (one for practice and instruction, four for task completion) were taken from an online source (www.wedsudoku.com, 2007; see Figure 11 in the appendix). There were two distractor sessions in this experiment, each consisting of two puzzles, where participants were asked to complete the puzzles to the best of their ability for five minutes in each session (total of ten minutes). Before starting the first distractor task, each participant was instructed how to complete the puzzle. All participants received the same instructions regardless of their level of prior knowledge. This particular task was chosen since it contained a different type of visual stimulus input from the rating pictures and the visual MP condition.

**Choice Pairs:** A total of six sets of Monet pictures, each set consisting of four pictures (24 pictures total), were used during the choice phase of the study. Five of the sets contained novel pictures while one set contained four pictures taken from the original fifteen based upon previous participant ratings. This set was known as the “critical set” and was always presented fourth during the choice phase.
Design

The current experiment was a 3 (working memory: visual, auditory, control) x 2 (self-relevance: high or low) between-subjects design. In the initial rating phase, participants were assigned to one self-relevance and one MP condition. Participants were presented with the self-relevance suggestion and instructed to complete the MP task while simultaneously rating the fifteen pictures. During the re-rating phase, participants were assigned only to the same MP condition as they completed in the initial rating phase.

Procedure

A visual timeline of the different phases and conditions of this experiment is presented in Figure 5. Participants were shown into a room used specifically for experiments. The room contained only the furniture and supplies necessary to complete the experiment and was free from other possible identifiers or distractors. Upon arrival, participants read a description of the experiment before signing an informed consent form. Participants were assigned randomly to both the self-relevance and MP conditions.
Figure 5: Study Timeline

Initial Rating Phase
- Working Memory
- Self-Relevance

Distractor Task

Choice Phase

Distractor Task

Re-rating Phase
- Working Memory

Identification Phase

Rate these pictures from most to least liked.

Which of these would you rather display in your home?

Please rate these pictures again based on how you feel right now.

Please select the pictures that you remember as options to display in your home?

Initial Rating Phase: After assignment to and explanation of the MP and relevance conditions, fifteen 3x5 note cards with corresponding single numbers written on each card (i.e., 1 through 15) were placed on the table to begin the initial rating phase. After explaining the task to be completed, participants received the same stack of fifteen pictures arranged in the same order. In the initial rating phase of the study, participants were instructed to rate all pictures based upon their self-relevance condition (i.e., low: “rate these pictures based upon your preference”; high: “how you rate the pictures tells me something about your personality and your preference”). To rate the pictures, participants were instructed to place the pictures upon the number that corresponded with
their rating. Participants were told that "15" was to indicate their "most liked" picture, "1" was to indicate their "least liked" picture, and "8" was the "middle/neutral" number. During the initial rating phase, one of the three MP conditions (visual, auditory, or control) was completed simultaneously to the rating process and the self-relevance condition evaluation. Also, participants were informed that they had the opportunity to make comparisons between the pictures before rating them and that they could change their ratings at any point during the initial rating phase. The only stipulation during the initial rating phase was that every number was to receive a picture – no duplicate ratings were allowed.

After the initial ratings, a five minute distractor task was given. The researcher presented the participants with the practice/instruction sudoku puzzle and explained the basics of the game. Participants were instructed to complete the puzzles to the best of their abilities. Two uncompleted sudoku puzzles then were given to each participant.

Choice Phase: The choice phase of the experiment contained the six sets of Monet pictures with each set containing two pair choices as previously described in the design section. The critical set in each choice phase was comprised of two pairs of pictures with each pair containing two pictures that participants had previously rated as relatively liked and relatively disliked. Neither of the pairs contained pictures rated in the extremes, allowing for later rating change opportunities. Pair one in the critical set consisted of pictures rated 10 and 4 during the initial rating phase while pair two contained the pictures rated 12 and 6. The pictures were paired in the above manner to correspond with the procedure used by Lieberman et al. (2001). Each participant received critical set pairs that was based upon their ratings from the initial rating phase.
Participants were instructed to choose between pairs of pictures presented in each set based upon the following assumption: If the participant could leave the study that day with full size reproductions of a pair of pictures to display in their living arrangements (i.e., dorm room, bedroom, living room) or a general preference of owning a pair of pictures in some way, which pair would they choose? Participants made a forced choice in this step; they had to choose at least one pair out of the two possible pairs in each set. In all sets, participants were not given the option of mixing any pairs (i.e., 12 and 10, 12 and 4, 10 and 6, or 6 and 4). Also, participants were told to be aware that their choices indicated they wanted both pictures in that pair. To complete this task, participants only had to point to which pair of pictures they wanted or preferred (later to be known as the "chosen pair") over the other pair (the "unchosen pair"). This phase was used to arouse dissonance within the participant. After completion of the choice phase, the five novel sets were not presented in any other part of the study while the critical set pictures were reincorporated with the original fifteen pictures.

Another distractor task was employed between the choice phase and re-rating phase of the experiment. This second distractor task was the same task as the first distractor described above. Again, the task was administered for a five minute period. This task involved the completion of two more sudoku puzzle different from those used in the first distractor task.

Re-rating Phase: After the completion of the second distractor task, participants completed a second rating of the original fifteen pictures. Self-relevance should have been manipulated already in the initial rating phase to generate attention and a personal connection to the pictures being rating. Similar to the initial rating phase, the re-rating
phase employed another MP task (visual, auditory, or control) during the second rating segment. The participants were given the same MP task that they completed during the initial rating phase of the study.

Again, pictures were presented in the same order for every participant. Participants were instructed to make a “right now” or a “gut response” rating where they were to rate the pictures based upon how they felt about them at that particular moment in time, in that phase of the study, without reference to how they rated the pictures previously. The same rating scale described above was used (“15” indicating the “most liked” picture with “1” indicating the “least liked” picture) with the numbered note cards again placed upon the table for rating purposes. The re-rating phase sought to find how the participants’ attitudes would change towards the pictures depending on the pair chosen during the choice phase.

Again, participants received the opportunity to make comparisons between the pictures before and during the re-rating phase. Participants also were told that this particular session was not meant to be a memory task and that they should not try to replicate how they rated the pictures in the initial rating phase of the experiment. This is important because the dependent variable involved how the picture ratings changed across the experiment. (If participants asked if they were supposed to produce the same or similar ratings between sessions, the researcher’s response was “no.”)

Identification Phase: After the re-rating phase, participants were asked to identify the four pictures from the choice phase of the experiment that were part of the critical set. Participants were initially asked to identify all four pictures that they remembered or recognized as being part of that set. Secondly, participants were asked to identify their
chosen pair and then to identify their unchosen pair. Lastly, participants were asked if they could identify the artist of the pictures. After the conclusion of the identification phase, participants received a debriefing statement for their completion in addition to any further explanation the researcher could provide.
Results

Coding

Cognitive dissonance reduction (as operationally defined as attitude change rating or score) was measured by evaluating the difference in ratings between the first and second presentations of the four pictures in the critical set. The initial rating phase served as a baseline to measure the change in attitude regarding the pictures. The choice phase was the intermediary step where the participants made a forced choice between pairs of pictures based upon their preference for ownership or displaying purposes. Then, the re-rated scores (from the re-rating phase) were compared against those recorded in the initial rating phase. If participants reduced cognitive dissonance, the average rating for the pair of pictures the participants chose in the choice phase ideally would have increased in rating during the re-rating phase while the unchosen pair would have decreased in rating (or stayed the same). For example, if a participant chose pair two (pictures 12 and 6, mean of 9), the pairs' rating average should have increased to a mean of 9.5 or above. In the unchosen set (pair one consisting of pictures 10 and 4, mean of 7), the pairs' rating average should have decreased to a 6.5 or less. However, any change in rating between these pairs of pictures was also considered. If a participant chose the pair one (10 and 4), then any decrease in the unchosen pair two (12 and 6) would have been measured; even if the chosen pair did not change in rating, it would also indicate a reduction in cognitive dissonance, and vice versa. Data was analyzed taking the change in pair averages to account for the overall rating difference in chosen and unchosen pairs instead of
individual picture rating differences. Lieberman, Oschner, Gilbert, and Schacter (2001) did not provide detailed criteria for data analysis, so the current analyses tried to replicate the criterion provided as accurately as possible by accounting for all possibilities of attitude change (as observed by rating changes) in the presented pictures.

The scores from the memory processing (MP) tasks were analyzed as follows: Regardless of condition (visual or auditory), the participant’s proportion of correct responses (the participant’s number of correct answers divided by the total possible correct answers) were recorded and entered for analysis. For analysis purposes, correct responses were defined as the responses that corresponded with the answers the experimenter expected for each task. The control condition received no score (recorded as “0”) since the participants did not actively perform a task.

Attitude change was measured as the change in each picture pairs’ average score between the re-rating phase and the initial rating phase. In the initial rating phase, pair one (4 and 10) had a mean rating of 7 while pair two (6 and 12) had a mean rating of 9. After the re-rating phase, the average for each pair was taken (i.e., if 6 increased to 8 and 12 increased to 13, mean for second rating session was 10.5). This average takes into account the potential overall change (whether an increase or decrease in rating) for each pair.

Attitude change was then calculated for participants by taking into account the initial difference between presented pairs in addition to which pair a participant chose. Since there was a difference in initial rating averages (pair one mean = 7, pair two mean = 9, difference of 2), this difference was accounted for when comparing attitude change scores. Regardless of which pair of pictures a participant chose during the choice phase,
the chosen pair was always subtracted from the unchosen pair. For example, pair one (initially 4 and 10) was chosen, the value of two was added to the difference between the pairs’ averages; if pair two (initially 6 and 12) was chosen, the value of two was subtracted from the difference between pairs’ averages. This subtraction or addition of the value two adjusted the mean attitude change to account for the original mean rating difference between the pairs during the initial rating phase. For example, participant A chose pair two (consisting of 6 and 12). As compared to pair one (4 and 10), pair two had an initial two point bias for which the coding accounted. During the re-rating phase, participant A re-rated the pictures as follows:

<table>
<thead>
<tr>
<th>Initial Rating</th>
<th>Increase/Decrease in Rating</th>
<th>Re-Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Decrease</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>Decrease</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>Increase</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>Increase</td>
<td>13</td>
</tr>
</tbody>
</table>

Average re-rating score for pair one (4 and 10) was 4.5 \(\frac{3 + 6 = 9}{2}\). Similarly, the average re-rating score for pair two (6 and 12) was 11.5 \(\frac{10 + 13 = 23}{2}\). To measure
re-rating phase attitude change, the unchosen pair (pair one, 4 and 10) was subtracted from the chosen pair (pair two, 6 and 12), providing an initial attitude change of 7 (11.5 – 4.5). However, to measure actual attitude change, the value two was subtracted from the re-rating phase initial attitude change score to account for the fact that pair two, the chosen pair, had an initial two point rating bias during the initial rating phase. Thus, the actual attitude change observed in this study for participant A was 5 (7 – 2).

Likewise, participant B chose pair one (consisting of 4 and 10). This pair was initially rated two points less than pair two (6 and 12) during the initial rating phase, for which the coding needed to account. During the re-rating phase, participant B re-rated the pictures as follows:

<table>
<thead>
<tr>
<th>Initial Rating</th>
<th>Increase/Decrease in Rating</th>
<th>Re-Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Increase</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>Increase</td>
<td>14</td>
</tr>
<tr>
<td>6</td>
<td>Decrease</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>Increase</td>
<td>13</td>
</tr>
</tbody>
</table>
Average re-rating score for pair one (4 and 10) was 10 \((6 + 14 = 20 / 2)\). Similarly, the average re-rating score for pair two (6 and 12) was 7 \((1 + 13 = 14 / 2)\). To measure re-rating phase attitude change, the unchosen pair (pair two, 6 and 12) was subtracted from the chosen pair (pair one, 4 and 10), providing an initial attitude change of 3 \((10 - 7)\). However, to measure actual attitude change, the value two was added to the re-rating phase initial attitude change score to account for the fact that pair one, the chosen pair, had an initial two point rating difference from the unchosen pair two during the initial rating phase. Thus, the actual attitude change observed for participant B was 5 \((3 + 2)\).

Positive rating scores indicated participants increased the rating difference between the pairs, creating further separation between the choice pairs’ ratings. A negative rating score indicated a decrease in rating, lessening the rating gap between the two pairs. The attitude change model focused upon the reduction of cognitive dissonance through the difference between attitude change scores. Dissonance arousal should have occurred in the re-rating phase where participants were presented with the same pictures that they had to choose between in the choice phase. Also, the re-rating phase, as well as the attitude change score, focused on the reduction of dissonance through the adjusted ratings between the pictures that were chosen and unchosen.

*Attitude Change by Individual Conditions*

Data were split by working memory and self-relevance conditions to compute the individual mean differences for each condition against zero using a single sample \(t\)-test. These results indicate in what conditions attitude change means were different from zero, suggesting dissonance reduction was employed. Results are reported using the mean attitude change as the dependent variable. Participants in the low relevance-control
memory ($t [20] = 0.963, p = 0.35, d = 0.21$, observed power ($\delta$) < 0.17) and high relevance-visual memory ($t [20] = 0.974, p = 0.34, d = 0.22$, $\delta$ < 0.17) did not show significant differences in ratings during the re-rating phase. Participants in the high relevance-control memory ($t [20] = 4.112, p < 0.01, d = 0.90$, $\delta = 0.98$) and both high and low relevance-auditory memory conditions (respectively, $t [20] = 2.855, p = 0.01, d = 0.82$, $\delta = 0.82$ and $t [20] = 2.729, p = 0.013, d = 0.78$, $\delta = 0.78$) had attitude change rating scores significantly different from zero, indicating that these participants were able to reduce dissonance when the condition-specific factors were used. Participants in the low relevance-visual memory condition had marginally significant results ($t [20] = 2.069, p = 0.052, d = 0.45$, $\delta = 0.54$), suggesting that they also were able to reduce dissonance to some degree and likely would show a significant effect if study power were increased. These results indicate that participants in the four aforementioned conditions experienced cognitive dissonance and were effectively able to reduce it to some degree since their rating scores differed between the re-rating and initial rating phases.

*Working Memory and Self-Relevance Effects in Dissonance Reduction*

A 3 (working memory) x 2 (self-relevance) between-subjects analysis of variance (ANOVA) was conducted using the mean attitude change in picture rating as the dependent variable. This result was computed to analyze attitude change across conditions. No main effects were significant for either working memory processing ($F [2,5] = 0.741, p = 0.48, d = 0.01$, $\delta = 0.17$) or self-relevance ($F [1,5] = 0.118, p = 0.73, d < 0.01$, $\delta = 0.06$) conditions. No interactions between conditions was obtained ($F [2,5] = 1.435, p = 0.24, d = 0.02$, $\delta = 0.30$). Figure 6 (below) shows the average change in rating scores between conditions. This indicates that the working memory processing
conditions and self-relevance manipulations, either individually or combined, were not sufficient enough to reduce dissonance in the participants.

**Figure 6: Rating Change as a Function of Working Memory Condition and Relevance**

![Bar Chart: Rating Change as a Function of Working Memory Condition and Relevance](image)

Note. Mean attitude change score (± standard error) for high and low self-relevance groups in auditory, visual, and control conditions. * indicates condition mean significantly different from zero, $p < 0.05$.

*Working Memory, Self-Relevance, and Choice Pair Effects in Dissonance Reduction*

A 3 (working memory) x 2 (self-relevance) x 2 (choice pair) between-subjects ANOVA was conducted using the mean attitude change in picture rating as the dependent variable. A main effect was observed for choice pair ($F [1,11] = 4.341, p = 0.04, d = 0.04, \delta = 0.54$) but no main effects were reported for either working memory ($F [2,11] = 0.904, p = 0.41, d = 0.02, \delta = 0.20$) or self-relevance ($F [1,11] = 0.84, p = 0.77, d < 0.01, \delta = 0.06$). A trend, but non-significant, two-way interaction between memory condition...
and self-relevance ($F[2,11] = 2.047, p = 0.13, d = 0.04, \delta = 0.41$) and a trend for a three-way interaction between memory condition, self-relevance, and choice pair ($F[2,11] = 1.996, p = 0.14, d = 0.03, \delta = 0.405$) were observed. No further interactions were significant (memory condition * choice pair: $F[2,11] = 0.36, p = 0.97, d < 0.01, \delta = 0.06$; self-relevance * choice pair: $F[1,11] = 0.002, p = 0.97, d < 0.01, \delta = 0.05$). Choice pair appears to have an effect upon the amount of dissonance reduction displayed by participants. Figure 7 (below) shows the average change in rating between conditions as a function of choice pair.

**Figure 7: Rating Change as a Function of Condition and Choice Pair**

![Rating Change as a Function of Condition and Choice Pair](image)

Again, working memory and self-relevance individually do not appear to have an effect upon dissonance reduction. The marginal interaction observed between self-relevance and working memory could potentially suggest that combined these two factors may have
an effect on participant’s dissonance state when individual choice pair is taken into account. The main effect observed for choice pair indicated that how a participant re-rated their pictures in the re-rating phase was affected by which pair of pictures that participant said they preferred or wanted in the choice phase of the experiment. Depending on which pair of pictures a participant chose, mean attitude change ratings differed. Participants who choose pair one (pictures 4 and 10) exhibited greater attitude change scores than participants who choose pair two (pictures 6 and 12) during the choice phase. Thus, choice pair was critical for attitude change since by taking into account which pair a participant chose in the critical set adjusted for the amount of attitude change exhibited in the re-rating phase.

*Picture Identification and Recognition*

Participants were asked to identify the four pictures that they remembered (or recognized) as being part of their personal choice set. The percentage of times they were accurately able to identify the pictures were calculated. Overall recognition for all four pictures presented was above chance (55.16\%), corresponding with the recognition results for non-cognitive load participants in Lieberman et al. (2001). However, Lieberman et al. also found that recognition differed based upon cognitive-load versus non-cognitive-load participants (35\% vs. 67\%). (See Table 4 below.)

When split by MP condition, all recognition percentages were above chance levels, but there were no recognition differences between conditions. When asked to identify pictures specifically by which pair participants’ had chosen versus their unchosen pair, recognition results varied. Participants were only able to accurately identify the pictures in the chosen pair in 43.85\% of the cases. Conversely, in only
35.32% of the cases were participants able to identify the unchosen pair pictures. Similar results are reported between MP conditions, again with no significant differences between conditions. When considering self-relevance condition, overall recognition of the pictures was similar to other reported recognition rates, with participants only in the low self-relevance condition showing a difference in recognition between chosen and unchosen pairs. (See Table 4 for percentage recognition and identification of pictures by MP x relevance condition below.)

Consequently, recognition percentages were then subjected to a t-test to compare the scores against 50% change. Overall identification of the critical sets was above chance, but identification decreased when participants were asked to identify specific pairs in that set. However, participants more accurately identified the pictures they remembered or recognized as choosing or wanting as compared to the pictures that were rejected or remained unchosen ($t[125] = 2.549, p = 0.01, d = 0.34, \delta = 0.99$) during the choice phase.
Table 4: Recognition and Identification (ID) Results by Self-Relevance and Memory Processing Condition

<table>
<thead>
<tr>
<th></th>
<th>Auditory</th>
<th>Visual</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Overall Recognition</td>
<td>55.16%</td>
<td>61.90%</td>
<td>50.00%</td>
</tr>
<tr>
<td>ID of Chosen Pair</td>
<td>43.85%</td>
<td>47.62%</td>
<td>42.86%</td>
</tr>
<tr>
<td>ID of Unchosen Pair</td>
<td>35.32%</td>
<td>40.48%</td>
<td>33.33%</td>
</tr>
<tr>
<td>ID of Artist</td>
<td>34.13%</td>
<td>47.62%</td>
<td>42.86%</td>
</tr>
</tbody>
</table>

Note. ** Conditions where attitude change was observed. * Chosen vs. Unchosen Pair $t$-test, $p < 0.05$. $\lambda$ Reported Percentage significantly different from chance (50%), $p < 0.05$. 
Relation among Memory Processing Scores and Attitude Change

Correlational analyses reported no significant overall relation between participants’ attitude change scores and their performance on auditory or visual MP tasks (r = -0.012). When split by memory and self-relevance conditions, participants in high self-relevance conditions, regardless of auditory or visual MP conditions, displayed stronger, negative relations to attitude change scores than participants in low self-relevance conditions. However, reported correlations for each condition indicated no significant relation between these two variables in any condition. See Table 5 (below) for correlational values by condition. These results indicate no significant relation among participant’s score on the MP tasks and the amount of attitude change a participant displayed.

Table 5: Correlational Values by Condition

<table>
<thead>
<tr>
<th></th>
<th>Overall Correlation</th>
<th>Low-Visual</th>
<th>High-Visual</th>
<th>Low-Auditory</th>
<th>High-Auditory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude Change x MP Score</td>
<td>-0.012</td>
<td>0.072</td>
<td>-0.164</td>
<td>-0.060</td>
<td>-0.154</td>
</tr>
</tbody>
</table>

Gender Differences

Data were further split by gender to examine whether gender differences existed in the observed results. No notable gender differences were observed that were different
from previously stated results in either single sample mean tests or ANOVA analyses except in the following cases:

- **Attitude Change in Individual Conditions as a Function of Gender**
  - Low Relevance-Visual Memory Processing – males: $t(12) = 1.876, p = 0.085, d = 0.555, \delta = 0.52$; females: $t(7) = 1.015, p = 0.344, d = 0.360, \delta = 0.17$; male attitude change scores accounted for the marginal results reported in this condition
  - Low Relevance-Auditory Memory Processing – males: $t(7) = 0.858, p = 0.419, d = 0.303, \delta < 0.17$; females: $t(12) = 3.257, p = 0.007, d = 0.903, \delta = 0.90$; female attitude change scores accounted for the reported significant results in this condition
  - High-Relevance-Visual Auditory Memory Processing – males: $t(8) = 3.617, p = 0.007$; females: $t(11) = 1.433, p = 0.180$; male attitude change scores accounted for the reported significant results in this condition
  - Main Effect for Choice Pair in Memory Process x Self-Relevance x Choice Pair ANOVA – males: $t(11) = 4.399, p = 0.041, \delta = 0.54$; females: $t(11) = 1.253, p = 0.268, \delta = 0.20$; male attitude change scores accounted for the reported significant main effect in choice pair

Gender differences were evident in the observed significant results, where one gender could account for the observed results in the above analyses.
Discussion

Overall, the results suggest that when solely looking at the amount of attitude change a participant exhibited, working memory and self-relevance do not appear to have a systematic effect on the amount of cognitive dissonance experienced. However, most individual conditions showed attitude change scores different from zero, specifically in high relevance-auditory memory processes (MP), low-relevance-auditory MP, high relevance-control MP, and marginal significance in low relevance-visual MP conditions. Yet, when the initial rating of the pictures was taken into account with attitude change scores, choice pair had an effect upon which participants were more likely to experience the state of cognitive dissonance and tried to reduce it. Trends between MP conditions and self-relevance manipulations also suggested a change in attitude rating scores where some of the study’s variability could be accounted for by the picture pair a participant chose during the choice phase. Additionally, recognition of the four pictures in the critical choice phase set was above chance, with participants more likely to remember the pair they chose over the pair they did not choose.

In the analyses, MP condition alone (auditory, visual, or control) did not appear to have a significant effect upon participant attitude change scores. However, upon viewing Figure 6 (above), it appears that participants assigned to the visual MP condition displayed decreased attitude change scores as compared to participants in either the auditory MP or control MP conditions with the exception of participants in the low
relevance-control MP condition. Because there was no significant difference due to MP, no definitive differences between MP conditions can be drawn at the present time.

Stone and Cooper (2001) proposed that as a situation or an item became more self-relevant or personally important to a participant, that it would affect the participant's dissonance reduction. The current study employed a self-relevance suggestion during the initial rating phase working on the Stone and Cooper (2001) self-relevance theory. Similar to MP, analyses indicated that self-relevance alone did not have an effect upon the attitude change scores exhibited in this study. No significant differences were reported between participants in the high and low self-relevance conditions. Thus, the self-relevance theory (Stone and Cooper, 2001) was unable to be supported. Participants in high relevance-control MP condition, however, displayed greater attitude change scores, but not significantly, than participants in the low relevance-control MP condition. Although no conclusive statements can be made (no main effect or significant was observed in this comparison), it can be suggested that when participants solely focus their attention upon personal importance and the dissonance rating task, self-relevance may have an effect upon the amount of attitude change that would occur.

Correlational analyses were computed between participants' MP scores for the auditory and visual MP tasks and their attitude changes scores. Overall and in individual conditions, no significant relations were observed. Negative relations were noticed for overall comparison between MP scores and attitude change with this result also being observed in individual self-relevance-MP conditions. Additionally, participants in the high self-relevance condition displayed a stronger, negative relation to attitude change.
than participants in the low self-relevance. Because none of the observed relations were significant, definitive conclusions cannot be made in regards to these results.

Recognition and identification of critical set pictures was above chance in all conditions, with the exception of participants in the high relevance-visual MP condition. Lieberman, Oschner, Gilbert, and Schacter (2001) suggested that participants who performed a cognitive load (an auditory MP task) were less likely to recognize critical set pictures (35%) as compared to participants in the no-load cognition (67%). Current results did not observe any difference between control conditions and either auditory or visual MP conditions. Rather, the recognition rates were quite similar (see Table 4). Thus, the current recognition results differ from previous literature. This difference suggests that participants' explicit memory of the critical set pictures during the final task may not be crucial in predicting participants' attitude change.

When the data were split by gender, it was observed that some of the effects found were present in one gender over the other. For instance, the main effect for choice pair was present in male participants' attitude change scores, but not in female participants' attitude change scores. Similarly, the marginally significant difference from zero found in the low relevance-control memory was also found only in male participants and not in female participants. Contrarily, the significant difference from zero found in the low relevance-auditory memory condition was dependent upon female participants' attitude change scores more than male participants'. However, there were no other gender differences in any of the other reported scores. No definitive conclusions can be drawn from this data that would suggest male or female predominance in the state of cognitive dissonance. Rather, it can be suggested that some of the results observed were
due to greater attitude change scores in one gender over the other in select dissonance reduction conditions. Lieberman et al. (2001) did not report any gender differences in their study. Additionally, Stone and Cooper (2001) addressed individual differences in the state of cognitive dissonance, specifically differences that involve self-relevance and self-esteem. The topic of gender possibly affecting the state of cognitive dissonance, in particular the dissonance reduction process, was not discussed by Stone and Cooper (2001). Thus, no predictions or suggestions have been made as to whether gender differences affect or influence attitude change. Subsequently, future dissonance research should incorporate analyses into gender differences, in addition to individual differences.

Attitude change scores were measured by comparing the ratings between the initial rating and re-rating phases. Participants' ratings were measured in such a manner to be comparative to the results observed by Lieberman et al. (2001). Overall, participants in the current study and those in previous literature were able to reduce dissonance as observed through attitude change scores.

It was predicted that depending on the working memory processing condition, there would be a difference in participant attitude change ratings. Previous research by Lieberman et al. (2001) claimed that there were no rating differences between the control and auditory MP conditions. These results were replicated in the current study with a few exceptions. Current analyses indicated that participants in the high relevance-control memory, low relevance-visual memory, high relevance-auditory memory, and low-relevance-auditory memory conditions were able to reduce dissonance. With the exception of low relevance-control memory, the current study supports Lieberman et al.'s (2001) claim that there were little to no difference in rating scores between the auditory
and control MP conditions. It may be that the low relevance-control memory condition did not replicate the previous literature results (Lieberman et al., 2001) because participants did not have enough motivation to reduce dissonance or were not personally connected to the type of visual rating stimuli.

It cannot be determined, however, if participants amended their ratings because they explicitly remembered how they previously rated the pictures, or if they amended their rating unconsciously to reduce any dissonance discomfort they may have been experiencing. The current study investigated the dissonance reduction process through attitude change scores after participants made a choice that should have aroused a dissonance state. The study was not intended to measure the state of cognitive dissonance itself.

Expanding upon Lieberman et al.’s (2001) working memory analyses, it was observed that the visual MP condition had relatively lower dissonance rating differences than participants in other MP conditions, indicating that participants were experiencing interference between the rating and visualizing tasks. Although the low relevance-visual condition had an overall attitude change marginally significantly different from zero, it was observed that the means for both visual conditions (regardless of high or low relevance) were slightly lower, but not significantly, than the means observed in other significant auditory and control MP conditions. The marginally significant results observed in the low relevance-visual memory condition could be due to not enough interference between rating and visualizing tasks. Participants in the high relevance-visual memory condition appeared to be experiencing a fair amount of interference between the self-relevance manipulation and the competing visuospatial tasks. However,
the same could not be said for the low relevance-visual memory condition since participants were not assigned the self-relevance manipulation, thus not creating enough additional distractions beyond the two competing visuospatial tasks.

Previously, Lieberman et al. (2001) concluded that another form of memory besides both explicit memory and working memory may be involved in the state of cognitive dissonance. Current results also concluded that explicit memory (as observed through identification and recognition results) may not be critical in the dissonance reduction process. Additionally, the current study suggests that varying types of memory processes may have an effect upon dissonance reduction but was unable to make a definitive conclusion because there was only a trend for such a relation.

The results observed in the high self-relevance conditions were unexpected since the participants should have been processing the incoming visual and auditory stimuli differently (e.g., Baddeley and Hitch, 1994), thus they should have been able to direct their attention to both types of stimuli, allowing for interference to be minimized. However, when participants completed a visual MP task in conjunction with the rating of the pictures, they should have exhibited less dissonance since the information was being processed by the same processing function, the visuospatial sketchpad. In turn, participants should have divided their attention between the two types of visual stimuli, thus not giving enough attention to any particular one stimulus to achieve a strong enough dissonance reaction. The participants may have experienced the state of cognitive dissonance, but it either resulted in little dissonance reduction as observed by lower attitude change scores or the attitude change scores did not measure participants' attitude changes because change was minimal.
The results observed in the low self-relevance conditions were surprising. It was hypothesized that all visual rating-visual MP conditions, both high and low relevance, would experience interference. Yet, participants in the low relevance-visual MP condition had attitude changes scores marginally different from zero, suggesting that they were able to divide their attention between tasks and not experience interference. These results, then, support the unitary processing mechanisms associated with Unsworth and Engle's primary and secondary memory model (2007).

The Self-Standards Model (SSM) (Stone & Cooper, 2001) suggested that as a situation or item becomes more self-relevant, thus affecting how much attentional resources are given to the situation or item, it would affect dissonance reduction. As more attention was given to a task, the more likely an individual should have employed their working memory spans to manipulate and store the present stimuli. Thus, according to the SSM, some form of working memory may be involved in the dissonance reduction process, challenging the proposal by Lieberman et al. (2001) that such a relation does not exist.

These seemingly contradictory results between the two working memory processing systems (Baddeley & Hitch, 1994; Unsworth & Engle, 2007) provide support for the Self-Standards Model (SSM) (Stone & Cooper, 2001). The SSM proposed that as information became more relevant or more important to an individual, one would experience the state of cognitive dissonance to varying degrees. In the low self-relevance condition where participants rated pictures solely upon personal preference, all MP conditions displaced attitude change scores significantly different from, or marginally different from, baseline zero. Participants in this condition may have drawn a connection
to the pictures because they were rating the pictures based solely upon preference, not allowing for a strong personal connection to be established between the participants and the rating stimuli. Contrarily in the high self-relevance condition where participants had the added relevance of personality in addition to their rating based on personal preference, there were MP differences. Participants had a connection to the pictures because of their general preferences for some pictures over others but also having the additional personal connection knowing that the pictures might have related to their personality. Thus, support could also be given to the SSM, where current results state that dissonance reduction, as observed through attitude change scores, differed from zero depending on the type of MP employed and the type of self-relevance, either high or low, between the participants and the rating stimuli.

In the identification phase of the experiment, participants were asked to identify the four pictures used in the critical set of the choice phase. Because MP tasks were completed simultaneously rating picture exposure, Lieberman et al. (2001) found that participants identified the pictures at chance levels (25%-35%) in amnesiacs and participants completing an auditory MP task. In the current study, participants were able to accurately recognize approximately all four pictures in the critical set slightly above chance in all MP conditions. Thus, the current identification results do not replicate previous identification findings by Lieberman et al. (2001). Mean overall recognition scores between conditions did not vary. Additionally, identification of the chosen pictures was greater, but not significantly different, than the identification of unchosen pictures. This suggests with further investigations, participants may become more likely
to identify pictures that they preferred or wanted (through which pair was chosen in the choice phase) over pictures to which they did not like.

*Recent Developments in Cognitive Dissonance Research*

In the fifty years of cognitive dissonance research, the same basic paradigm has been used to investigate its effect. Generally, participants are presented with stimuli where they are asked to either rank, rate, or choose between stimuli. This paradigm has been defined as the free-choice paradigm (Chen, unpublished) that is used to examine either a shift in choice preferences or a shift in participants’ ratings or rankings. However, it has recently been postulated that this commonly used paradigm does not accurately measure the state of cognitive dissonance or its reduction (Chen, unpublished; Tierney, 2008). This debate surfaced after Egan, Santos, and Bloom (2007) observed that children and monkeys experienced the state of cognitive dissonance, suggesting that the phenomenon may not be as complex as previously thought.

Chen (unpublished) posits that the dissonance paradigm used in many dissonance studies including Egan et al. (2007) does not measure cognitive dissonance but rather the rationalization an individual experiences when choices need to be made. Choice alone may not cause cognitive dissonance, but rather the need to additionally justify or rationalize the situation can cause a state of cognitive dissonance. In experiments where participants are presented with choices, the participant may have an initial preference or bias for one item, thus leading to their selection of it. When the unselected item is presented with another, newer alternative, the participant has to rationalize why they did not choose the unselected item in the first place instead of trying to justify why they
chose the newly presented item (e.g., the scenario of the mother choosing between cleaning product brands).

Additionally, Chen (unpublished) stated that when participants are rating or ranking stimuli, they are indicating their initial preference or bias for some items over others. The items do not start out with a neutral preference. Thus, when a participant makes an intermediary choice, they are justifying or rationalizing their bias preference. Consequently, when a resulting shift occurs between a previous rating or ranking and a new one (rating or ranking), Chen suggests that it is not the reduction of cognitive dissonance but the affirmation of the participant's bias and preference choice.

Ultimately, Chen (unpublished) proposed that the claims made in cognitive dissonance research over the past fifty years are not conclusive, but should rather be taken as suggestions since the underlying methodology and dissonance paradigms used are flawed. Because there is no absolutely neutral preference during dissonance research but rather an initial bias that every participant experiences, the criteria used to determine whether the state of cognitive dissonance and its reduction is observed should be changed to account for this bias.

In relation to the current study, the procedure used by Lieberman et al. (2001) and this researcher was the free-choice paradigm that examined a shift in rating changes. Participants rated a series of pictures, made a choice between pairs of pictures based upon their ratings, and subsequently were asked to re-rate the stimuli. This methodology allowed for the investigation of dissonance reduction as observed through a shift in participants' attitudes between the two rating sessions. These methods and other similar dissonance-measuring methods focus upon the notion that cognitive dissonance is a
purely psychological phenomenon. One cannot actively measure this state, but instead try to measure its reduction through the physical manifestation of attitude change. Granted a participant's initial preference or bias is not always taken into account when measuring a shift in ratings, the shift still provides a physical way of measuring attitudes and their changes associated with cognitive dissonance. Consequently in the current study, the researcher tried to account for this initial bias between the pictures in the choice set by adding or subtracting the value two (the initial bias difference between choice pairs) from the re-rating phase attitude change scores, thus providing the actual amount of attitude change for the study. By accounting for this initial bias or preference of each participant as utilized in the current study, then the free-choice paradigm may still serve as an adequate physical manifestation of dissonance reduction as exhibited by an attitude change.

Aronson and Cooper (Festschrift for Elliot Aronson, APS Convention, May 25, 2008) discussed Chen’s (unpublished) concerns regarding ways of measuring the state of cognitive dissonance and in turn, provided their own opinions regarding Chen’s concerns. The bias preference as postulated by Aronson and Cooper only accounts for a small amount of variability in the dissonance reduction process whereas the free-choice paradigm has been shown to account for multiple attitude changes and change variability. In Chen (unpublished), individual preference or rating bias was measured mathematically for only one direction of attitude change (an increase of the chosen items and a decrease of unchosen items), thus accounting for only a small portion of change variability. Whereas in the free-choice paradigm, a rating measure that is commonly used to measure participant attitude changes, accounts for more change variability beyond the initial
participant bias or preference -- it can account for attitude change in multiple directions (i.e., either an increase or decrease in chosen items in addition to increases or decreases in unchosen items; total of four potential attitude change directions).

Consequently, Aronson and Cooper (Festschrift for Elliot Aronson, APS Convention, May 25, 2008) posit that fifty years of research has continuously provided evidence for the free-choice paradigm as an satisfactory measure to assess the state of cognitive dissonance, specifically the dissonance reduction process as indicated through participant attitude change scores. Accordingly, Aronson and Cooper postulate that the concern: Chen (unpublished) discussed in the article relates more to the Egan et al. (2007) and the modified free-choice paradigm used to measure cognitive dissonance in monkeys and children. In that experiment, Egan and colleagues modified the free-choice paradigm in monkeys by withholding one stimulus (an M & M) to create the “unchosen” item while presenting another M & M to signify the chosen item. Because the monkey was not directly able to choose which M & M it wanted and did not want, the methodology in Egan et al. (2007) has lead to the proposal that the state of cognitive dissonance may not be as complex as previously thought since it was shown to occur in monkeys. Additionally, Egan et al. (2007) used the free-choice paradigm (unmodified) to measure cognitive dissonance in children. Similarly, children displayed attitude change tendencies consistent with the dissonance reduction process, also suggesting that cognitive dissonance occurs early in life and is not unique to adolescents and adults, populations commonly utilized in dissonance research. Thus, this new research and posits by Egan, Santos, and Bloom (2007) may have lead to the dissonance discussion...
aroused by the Chen (unpublished) article which was later addressed by Aronson and Cooper (Festschrift for Elliot Aronson, APS Convention, May 25, 2008).

**Future Directions**

A potential limitation in this study was that the pictures chosen for this study were not engaging enough. The pictures chosen were similar to those used in Lieberman, Oeschner, Gilbert, and Schacter (2001) and should have engaged a majority of the participants' attention and motivation. The pictures in both studies consisted of postcard art from the same artist, Claude Monet. Nonetheless, some participants may have been more familiar with pictures by Claude Monet than other participants. If another, more age-appropriate rating stimuli were used (i.e., pictures of music artists, posters bought frequently by college students), participants may engage more with the pictures, allowing for better relevance manipulation, preference rating, and motivation to reduce dissonance.

One more way to engage the participants further would be to offer a more appealing choice phase option. Currently, participants were asked which pair of pictures they would prefer to own or display in their living accommodations. If a more appealing option were presented (i.e., which artist would you like to see more in concert or listen to on the radio), it might create more dissonance between the choice pair set in addition to the further engagement of the participants. This further engagement could affect the dissonance reduction process and the amount of attitude change a participant might display.

A second concern may be raised in terms of the manipulation of relevance. It was hypothesized that manipulating self-relevance would have an effect upon how participants would engage and incorporate the presented pictures into their life.
However, the self-relevance manipulation currently used may not have been as effective as it was intended to be. The current manipulation involved the suggestion that the pictures may relate to a participants' personality. Although this seemed sufficient, unless the participants initially engage with the rating stimuli presented, they may not generate a deeper personal connection with the pictures when the manipulation was presented. Again, the use of a more self-relevant suggestion (i.e., reading ability, school or graduation performance, or which picture participant wanted to take home) may allow for a better dissonance experience and reduction.

Furthermore, the stimuli for this study were never normed for neutrality or appeal. The researcher chose the fifteen postcards based on the notion that the selected postcards were less likely to be presented in a non-art related book (i.e., textbook, fiction, nonfiction, etc...) and in turn would have been less familiar to the participants. Although the pictures were similar to those used by Lieberman et al. (2001), it cannot be conclusively stated that they were the exact same pictures or had the same effect as anticipated upon participants because they were not normed.

Moreover, participants were asked to complete a working memory processing task only during the rating phases of the study. Individual working memory capacities were never assessed prior to the completion of the study. The results of the present experiment only assessed memory processing under the conditions presented in the study. Thus, no comparison can be determined on the effectiveness of self-relevance, cognitive dissonance, or the rating task on working memory processing itself.

Similar to Lieberman et al. (2001), the present study used a counting task to measure auditory working memory. Participants were asked to count the number of
times they heard or thought they heard a low tone presented in a pre-recorded auditory sequence. Initially this task was used as an auditory working memory processing task to occupy the phonological loop while the visual test stimuli would occupy the visuo-spatial sketchpad. It was also used to replicate the methods of Lieberman et al. (2001). Nevertheless, the task used may not have fully accessed working memory, consequently making it an inadequate task to occupy working memory processes. In the future, a proven auditory working memory processing task, such as the counting span task suggested by Conway, Kane, Bunting, Hambrick, Wilhelm, & Engle (2005), would be more appropriate and allow for comparisons against verbal and visuo-spatial working memory processes (Baddeley & Hitch, 1994).

To replicate Lieberman, Oschner, Gilbert, and Schacter (2001), the current study’s method was similar to those in previous literature. This included the pairing of pictures for the critical set in the choice phase as described by Lieberman et al. in pairs of 4 & 10 and 6 & 12. As observed in present results, when participants choose pair one (4 & 10), participants displayed a greater attitude change rating score than participants who chose pair two (6 & 12). It is proposed that the greater attitude change was due to a larger possibility for change or rating movement for pair one than there was for pair two (i.e., if picture 4 increased to 15, observed attitude change would be 11; consequently, if picture 6 increased to 15, observed attitude change would be only 9; the same effect would be observed between pictures 10 and 12). In the future, different pairings (i.e., 4 & 12, 6 & 10) would allow for comparison between choice pair taking into account possibility for amount of rating change and without needing to account for an initial rating difference or bias between pairs. Additionally, it is proposed that both the pair
chosen and rating scores would differ as a function of how the pictures would be paired. Participants may be more inclined to choose two moderately rated pictures (i.e., 6 & 10) as compared to two pictures that are relatively more liked and relatively more disliked (i.e., 4 & 12). Therefore, future investigations should examine the effect of how pictures are paired for the choice phase and the amount of attitude change observed for participants.

In conclusion, the results from Lieberman et al. (2001) were partially replicated, and the present study was able to expand upon the previous literature. Analyses from Lieberman et al. (2001) focused specifically on individual condition differences between attitude change scores. The current study tried to analyze the data using the overall attitude change scores in each condition to measure the overall mean attitude change from zero, similar to that of Lieberman et al. (2001). However, the results here are unable to determine if the combination between working memory and self-relevance affected attitude change ratings. Also, it was unable to be determined if any additional motivating factors or different coding techniques were used by Lieberman et al. (2001) that were not reported, and in turn, were not employed in the current study’s analyses. Thus, the current analyses are based upon the researcher’s understanding of the test results reported by Lieberman et al. (2001). The current study also expanded upon research by Lieberman et al. (2001) by determining that a personal self-relevance suggestion and differing working memory tasks employed affected the amount of attitude change a participant displayed.
Conclusions

The findings for the current study were not consistent with the stated hypotheses that attention, personal relevance, and type of memory processing task would have an effect upon the reduction of cognitive dissonance. Although participants appeared to be actively reducing dissonance by changing their picture ratings, the observed change in attitude ratings did not appear to be affected by either working memory or self-relevance individually. However, though not significant, trends in the predicted directions were observed; therefore with further investigation, the interaction between these two factors, specifically in the high self-relevance condition, may indeed be found to affect participants' dissonance ratings. It was also observed that depending on which pair a participant chose in the critical set, attitude change ratings were affected. Potentially with more power (via larger sample sizes), the marginal interaction between working memory and self-relevance may reflect the expected outcome.

Although limited results were observed in this study, it was still proposed that working memory and personally relevant information are important for the experience and reduction of cognitive dissonance, based upon the literature by Lieberman et al. (2001) and Stone and Cooper (2001). Additionally, the observed results currently support both competing working memory models (Baddeley & Hitch, 1994; Unsworth & Engle, 2007).

Cognitive dissonance is still in need of further investigation. It is uncertain why some individuals are more susceptible to experience its psychological discomfort and in turn be more likely to reduce it, but regardless, most individuals have experienced it at some point in their lives. Because of this uncertainty even after fifty years since its
introduction in psychological literature, it is important to know why cognitive dissonance occurs and what makes certain individuals more susceptible than others.
References


Appendix A

Figure 8: Rating Stimulus
Figure 9: Rating Stimulus
Figure 10: Rating Stimulus
Figure 11: Sudoku Distractor Task