TRAINING AN IMPLICIT REASONING STRATEGY: ENGAGING SPECIFIC REASONING PROCESSES TO ENHANCE KNOWLEDGE ACQUISITION

by

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B.A., Central Missouri State University, 2001
M.S., Kansas State University, 2006

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Psychology
College of Arts and Sciences

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2008

Abstract

A training protocol was developed to teach an implicit reasoning strategy to encourage the consideration of alternatives, specifically in behavioral trap decision environments. Engaging the strategy would thereby decrease the effect of focusing on traps, resulting in more rational behavior. In two studies, training was delivered in an instructor-less environment using paper-pencil and multimedia examples. The main training components consisted of analogical problem solving and counterfactual thinking. The potential moderators between training and performance outcomes consisted of an information processing disposition Need for Cognitive Closure, an individualized approach to decisions, Decision-Making Style, and a capacity to process information Working Memory Capacity. Arousal and mood were also measured before, during, and after the training as both have been linked with learning.

In Study 1, participants engaged in analogical problem solving, additive counterfactual thinking, subtractive counterfactual thinking, or none of these (i.e., control group). Results revealed that the training was minimally effective, although some comparisons revealed a large shift from pre- to post-training in commitment score away from trap options. Likewise, the Need for Cognitive Closure was the best predictor of decision behavior revealing that a predisposition for amount of information processed during decision making is indicative of behavioral outcomes in this decision environment.

Based on results from Study 1, the training was reformatted in Study 2 to obtain the maximum potential benefit. Analogical problem solving was coupled with each form of counterfactual thinking so participants engaged in both critical thinking processes. When training was effective, the two forms were differentially effective as related to behavioral trap problem type. Forward-looking training assisted problem types that force explicit cost

recognition and immediate decision outcomes. Past-looking training assisted problem types that force little cost recognition and delayed decision outcomes.

Results of this project could be used to enhance the acquisition of critical thinking as well as improve educational practices. Both information processing disposition and decision approach style predicted learning whereas capacity to process information and training manipulations did not. Future projects will examine how long the training effects last and if critical thinking training can be successfully applied to other decision environments.

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Acknowledgements

I would like to thank, first and foremost, my advisor, Dr. Shanteau for his guidance through this arduous, yet fulfilling and enlightening journey. I would also like to thank the members of my dissertation committee: Dr. Fullagar, Dr. Harris, and Dr. Zbylut for their insights and respectful criticism of this project. I must also thank the members of the K-State Decision Research Group for their helpful comments and suggestions. I most sincerely thank my family and, especially, my wife Nicole, for their support, their faith in me, and immeasurable patience. Without all of the above-mentioned persons, this would, most assuredly, not have been the informative and serenely unique experience that it was. I am forever grateful.

CHAPTER 1 – Background and Training Protocol

Background

In contemporary society, including education, industry, and military, the need for expedited skill acquisition is becoming more popular as advances in technology have begun to shape educational and training settings. Although the NASA motto, "faster, better, cheaper" didn't necessarily encapsulate the understanding that personnel working within such a context may not be able to work at an adapted organizational pace, the maxim is still enticing to many organizations. Fortunately, more recent research has focused on the application of psychological principles to educational settings; these findings could be expanded to professional work settings as well (Sternberg, 2008; Butler, Karpicke, & Roediger, 2007). Thus, with the advent of new technology into education, has come more psychological research and a further integration of psychological learning principles, increasing the functionality of the classroom environment

More and more of the educational and training environments are shifting to non-traditional formats (ie, distance education and/or instructor-less environments). Thus, more of the responsibility of learning is placed on the solitary student, with minimal instructor guidance. This setting is true in colleges and universities throughout the United States and especially for our military forces (where personnel are distributed throughout the entire world). Although this is an attractive setting, especially for non-traditional students, the potential lack of classroom interaction with classmates and an instructor could be detrimental to course performance and knowledge acquisition. This project explored a training protocol developed to quickly train critical thinking in an instructor-less environment. Although the training was intended

specifically for the behavioral trap decision environment, the critical thinking exercises could apply to a variety of decision environments.

As part of a recent exercise requested by U.S. Army Training and Doctrine Command (TRADOC), professionals from academia, industry, and the military services devoted time and effort to a 3-day Army Science Learning Workshop to identify strategies and technologies that would assist the Army in advancing knowledge and skill acquisition opportunities (Quinkert, Morrison, Fletcher, Moses, & Roberts, 2007). Approximately 100 participants were broken into four discussion-topic groups; the two of relevance for this project were, "Learning Model" and "Develop Leaders". The Learning Model group focused on best practices and lessons that could facilitate the development of an Army learning model, while the Develop Leaders group focused on potential approaches for quickening the acquisition of adaptive leader skills.

As noted at the workshop, one of the primary questions of any instructor is, "What elements can impede or facilitate the learning process?" The present research addresses both parts of this question. The current training was delivered in an instructor-less environment which may impede learning; however, a training protocol was created to facilitate acquisition of the training material. The Learning Model members of the workshop determined that a component in need of further validation is the educational function of face-to-face instruction (as opposed to distance learning). Thus, there is a question of whether distance learning (without the aid of an instructor) impedes learning performance, diminishes the effect of training, or can serve as a functional alternative for face-to-face instruction. This current project provides descriptive evidence for the utilization of a distance learning approach; the material was delivered without the assistance of a human instructor. There are arguments against utilizing a learning environment with minimal to no human guidance, because it is wholly ineffective. Moreover,

some argue environments that require students (especially novices) to discover problem solutions and construct mental representations on their own, are inadequate for learning purposes (Kirschner, Sweller, & Clark, 2006). This project involved selected reasoning exercises that the student could utilize in any educational setting in order to enhance the learning experience and do so on an individual basis.

Adaptability was a characteristic that the Develop Leaders group noted as essential for producing functional leaders. Quinkert et al defined adaptability as such, "the ability to change strategy or behavior effectively during actual (or anticipated) altered situations." They further noted that training on adaptability should be tailored to leaders at all occupations and levels within the military. However, as admitted by workshop members, adaptability requirements are not fully known for different levels and positions. The current protocol was designed to train an adaptive strategy quickly and also to be maintained in order to be utilized in future (and novel) settings. The need to better understand how training and education in a military setting is evident for the contemporary (and future) Army force was more recently noted by Dyer, Centric, and Wampler (2007). Dyer et al, emphasized that geographic disparity, changes in battlefield environments, and enhancement in technological training capabilities are forcing the Army to consider more decentralized training programs within the larger Army institution.

The strategy could be applied by persons situated in various occupations, at different levels of leadership, and in various professional settings. Likewise, the need to train quickly and effectively and in less guided learning environments are inherent in this approach.

An interesting cognitive question presents itself if more responsibility is placed on individual employees for learning and doing so at an accelerated rate to maintain pace with organizational standards. It is commonly known that persons learn at different rates, may or may

not learn the same things from the same material, nor acquire the same level of performance from the same instructional materials and format. Likewise, many training materials are composed with the idea that conscious processing must take place (or be the primary stage) in order for learning to occur. However, it is widely contended that we are limited in terms of conscious cognitive capacity, but rather unlimited when considering the unconscious. Thus, is it possible that the unconscious is an untapped resource that could assist, employees, soldiers, and students acquire a desired level of performance and do so with minimal guidance? Likewise, it is commonly assumed that persons will be able to achieve a level of learning, regardless of certain individual predispositions and this places the majority of responsibility of ensuring that learning is occurring on the instructor. What if individual differences are taken into account? Would this not inform and improve training and instruction, especially for distance education and instructor-less learning environments? These questions were explored across two studies.

Training Protocol

Humans possess an innate tendency to search for evidence that provides support of self-generated hypotheses. However, an initial generation may not be optimal or yield the wrong hypothesis. Unfortunately, it is difficult to stop a search process for supportive information once it has begun. Likewise, Dougherty, Gettys, and Thomas (1997) illustrated that the number of possible scenarios generated and the likelihood of those scenarios actually occurring can affect one's ultimate decision about causality. The current training was created to foster an examination of multiple alternatives before making a final decision. Further, this training was offered to facilitate decision making in a decision environment where a natural first response is to consider only one option. This initial response, however, is often perceived as correct and,

thus, information search ceases (the behavioral trap decision environment is discussed in more detail in Chapter 4).

Two reasoning processes persons naturally engage in, although not always explicitly aware of it, are analogical problem solving and counterfactual thinking. As noted by Gick and Holyoak (1980), participants were unlikely to use analogies unless given a hint to do so. The fact that hints had to be given implies that the link between the two scenarios was either not established or still too weak to utilize. This project used a film-based case, Gick and Holyoak only used paper pencil (See Zbylut & Ward, 2004a, Zbylut et al, 2007, and Hill et al, 2008 for further discussion on the use of film-based cases). This further implies that the instruction itself failed to illustrate the necessity to employ a comparative strategy or that learning was not actually occurring. Learning implies that an individual knows that certain information is relevant and when to use it (without extra assistance from an instructor, for instance). Further, the learner would also know how to recognize and disregard information that is irrelevant. In this project, the effect of using a more memorable analogical case to facilitate the utilization of relevant information and disregard of irrelevant information was examined. Relevant and irrelevant information fluctuated with problem type such that past costs either were or were not relevant to the current decision.

Counterfactual thinking was also proposed to enhance learning this reasoning strategy. For instance, additive counterfactual thinking was considered to be particularly functional because it engages individuals in a more innovative or creative processing; persons have to restructure an outcome by generating novel elements not part of the original situation. Alternatively, subtractive counterfactual thinking has been shown to improve analytical reasoning, specifically analogical problem solving. The utilization of both forms of

counterfactual thinking allowed a test of which form may be better suited for improving behavioral trap decision making.

As a result of having engaged in this training approach, students should have: (1) effectively acquired the material, (2) applied the learned strategy to novel situations, and (3) maintained the strategy over time. This approach could be applied at multiple levels of leadership and experience. Thus, this project attempts to address the gaps in training that surfaced during the Army Science Workshop. Specifically, it incorporates information-processing disposition, an intelligence correlate, decision-making style, and training components, the integration of which can effectively train a form of adaptability (multiple hypothesis generation). This project provided evidence that could be used to enhance learning environments such as distance education or those with minimal instructor guidance in a variety of professional settings.

CHAPTER 2 – Behavioral Traps

There are several forms of social or behavioral traps: collective, deterioration, ignorance, investment, and time-delay (Plous, 1993). For a more thorough examination of traps, see Cross and Guyer (1980) and Platt (1973) for a review of 'social traps'. Although each of these are slightly different, they all share certain characteristics. For instance, all involve an investment of some resource (effort, money, personal commitment, time). All traps also share the potential for an action-consequence disconnect; immediate action does not always lead to immediate consequence. Most relevant for this project, all involve a failure or a motivated ignoring to consider and initiate alternative courses of action.

For this project a new classification was used to categorize behavioral trap problems; the two categories were Immediate and Cumulative (Refer to Table 2.1 below). Immediate was defined as a situation where past costs are explicit and expressed in full amount; an example is the Ski Trip problem (See Appendix A). Cumulative problems were defined as those where past costs are not explicit; if present they are stated only in small units or in such a way that makes individual costs appear inconsequential, even though ignoring them renders a long-term outcome that could be detrimental. An example of a cumulative problem is the Planet problem (also in Appendix A). In the Immediate problems, persons are often drawn in or trapped by the explicit costs and use these as the only piece of relevant information for the decision and are, thus, trapped by paying attention to past costs. In Cumulative problems, persons often select the option that leads to a continuation of the small costs and are, thus, trapped by ignoring past costs.

Table 2.1 Classification of Behavioral Trap Problems Used in Current Project

	Behavioral Trap Type	
Problem	Immediate	Cumulative
CEO	X	
Old Stadium*	X	
Pizza	X	
Planet		X
Scholarship*		X
Ski Trip	X	
Steam Press*	X	
Strategy		X

*These problems were used only in Study 2.

Stimulation in any modality that forces individuals to attend to the information, that appears to be salient, is a fundamental property of being human. For instance, when we hear a loud noise, we automatically turn towards the origination of the noise in order to place the source in our foveal viewpoint; the fovea contains a larger ratio of cones to rods and cones have higher acuity, making more accurate processing of visual information possible. Even though the event that created the noise may have long since passed by the time we turn to perceive and process the event, not paying attention to the information could be harmful; hence, this perceptual-motor action is an involuntary process.

The same holds true for the decision making modality. It is natural to pay attention to information of past events, especially if the information appears salient and relevant for making a current decision. It is quite hard to ignore past investments, especially if a current decision is highly important to the decision maker. This does not mean we will necessarily make bad

decisions because we pay attention to past investments; we just need to utilize the information more effectively (Tan & Yates, 1995). Further, in such traps as time-delay and ignorance, the opposite occurs, such that past investments are more easily ignored. This topic was discussed above in terms of Immediate and Cumulative problem types.

This makes, especially good sense if a decision maker is considering his/her goals. Sunk cost decision making situations are said to be unique (Arkes & Blumer, 1985), because the decision maker should not be paying attention to past investments. The normative contention is that the past investments cannot be retrieved and, thus, should be ignored. Further, these past investments will not affect future costs nor benefits and have no informational value for making the current decision. Thus, the decision maker should look only forward.

However, consider the ignorance trap where ignoring the cumulative effect of past investments is actually sub-optimal (i.e., ignoring the effects of alcoholism on one's health). In this case, not paying attention to past investments may lead to continued poor decision making. Thus, the decision maker should look to the past.

In either situation, by focusing on one option, the decision maker becomes trapped into a narrow decision path. In contrast, by considering alternatives, the decision maker may find a more optimal route to guide present and future choices. I am not arguing that change is always good or abandoning the status quo is always the best decision. Rather, by not considering alternative options, there is a potential to make less than beneficial choices and even detrimental. By shifting focus from one option to multiple, using an implicit strategy, the effect of trap options was postulated to diminish.

Hypothesis generation and Behavioral Traps

Hypothesis generation is relevant for decision making involving behavioral traps through two forms: analogical problem solving and counterfactual thinking. Hypothesis generation is usually studied by setting a participant in front of a computer and asking them to view (sometimes hundreds of) stimulus sets. And, somehow, this interaction with a deluge of stimuli, devoid of natural context, is supposed to allow the study of hypothesis generation. Whereas in reality, persons are likely to interact with just a few stimulus examples on a given topic and operate with only a given number of self-generated hypotheses. Likewise, during this interval, persons are utilizing specific reasoning processes, analogical problem solving and counterfactual thinking to form a conclusive picture about related events.

Consider a doctor trying to make a diagnosis, especially based on a difficult presentation or combination of symptoms. S/he will likely draw upon instances from memory in order to establish an analogy with the current case. Let's suppose the doctor makes an incorrect diagnosis (or even a correct one, for that matter), but the treatment ends up fatal. The doctor will likely engage in counterfactual thinking to revisit the steps taken in the attempted treatment of the patient. This production of counterfactuals, although post-hoc, is a form of hypothesis generation.

Stanovich (2004) noted that being able to represent what we are thinking *about* our thinking of world is one of the most adaptive skills human beings possess. Thus, the ability to simulate and imagine alternate futures or alternative outcomes for past events are what make humans so human. Tversky and Kahneman (1982) forwarded the 'simulation heuristic' as the process for estimating outcomes and potential alternative outcomes. Unfortunately, as with most of their postulations on heuristics, this one was assumed to be error-prone. My argument is that

processes like analogical problem solving and counterfactual thinking can be functional and adaptive for decision makers if they engage these processes which will grant a multi-option perspective in a given decision environment (in this project, behavioral trap decision environments).

Analytic versus Intuitive Thought

Part of the conundrum concerning human behavior lies in what Stanovich (2004) called a 'brain at war with itself'. He noted that our intuitive system performs operations without conscious approval. This can lead to conflict, specifically when our slower, analytic system has arrived at a 'solution' that differs from the unconscious response. It is easier to seek confirming evidence than to engage in a process that could lead to more mental effort. For instance, if the solution derived is in conflict with the expected output, this could require further devotion of resources (ie, attention, processing capacity, etc) in order to deliver a solution that satisfies the goal. An example of this is apparent when we react with a stereotypical response. This reaction may have been functional in earlier episodes of our species, however, provides a non-functional reaction in contemporary societal interactions.

Given an evolved interaction with decision environments over several thousands of years (at least for our closest ancestry and much longer if we go further back), multiple systems, although potentially conflicting, would provide different perspectives on the same situation. Thus, engaging both would, at the very least, provide multiple information perspectives.

The behavioral trap situations participants are typically asked to respond to instigate a strong response from our intuitive decision making system, such that we are compelled to focus on the option with the larger investment amount (See Arkes & Blumer, 1985). As discussed earlier in Chapter 2, there is an innate response regarding trap options and consciously

recognizing that our intuitive system is providing a predetermined response is not part of the meta-cognitive decision process of most persons. In *Blink*, Gladwell (2005) provides several vivid examples of excellent intuitive responses, even though persons cannot necessarily verbalize how it is they arrived at their intuitions. For instance, his first example entails art critics asked to judge a piece recently acquired by a museum for a formidable sum of money. All critics intuitively had a bad 'feeling' about the piece, though they could not verbalize what was wrong. The piece turned out to be a fake. Gladwell also cautions that the intuitive system, albeit extremely quick to provide a response, can be fallible. For instance, the unfortunate story of Amadou Diallo who was murdered by off-duty police officers who made bad decisions based on initial reactions to a situation that should have turned out uneventful.

The argument that the intuitive system provides human beings with excellent reactionary responses to many situations, but it may unnecessarily drive us to make irrational decisions is only partially correct. In this project, by having participants explicitly engage in the reasoning exercises and consider the tasks analytically, the intuitive system would be allowed to acquire the underlying reasoning strategy of multiple hypothesis generation.

Unconscious vs. Conscious Thought

The debate between conscious and unconscious thought is often overshadowed by the distinction between intuitive versus analytic thought. Recently, Bargh and Morsella (2007) noted that how unconscious thought is defined is paramount for all research involving this dichotomy. They contrast the commonly held definition of the unconscious being the simple processing of stimuli of which we are not cognizant to "influences or effects of stimulus processing" of which we are not aware. The latter grants an enormous shift in intellectual power to the unconscious mind.

The importance of the unconscious for this project is that the purpose of engaging in the reasoning exercises was to teach an implicit reasoning strategy. Thus, although participants may not have been aware that they were learning the strategy, they could still employ it for future problems. Thus, when participants were asked what they thought the experiment was about, it was not surprising that they did not indicate the purpose as being to learn an implicit reasoning strategy.

CHAPTER 3 –Learning and Relevant Factors

Explicit vs. Implicit Learning

Explicit learning is commonly cited to take place during consciousness or that there is an awareness necessary that guides behavior during the learning phase. Implicit learning, however is commonly argued to take place outside of conscious awareness (Seger, 1994b). Another finding that supports the explicit/implicit distinction is that illustrated by Reber, Gitelman, Parrish, and Mesulam (2003). In their study, participants were given either explicit or implicit instructions for viewing a pattern of dots. As they postulated, different areas of the brain lit up for the different groups, indicating, at least, an anatomical correlate for those processes.

Some early work (See Reber, 1967) involved the learning or artificial grammar rules without explicit instruction. Thus, it is possible to utilize and learn from complex material without being fully aware that learning is occurring. Further, the ability to learn implicitly seems to far surpass the aptitude to process complex information consciously (Halford, Baker, McCredden, & Bain, 2005). The importance of the processing capacity of the unconscious was re-iterated by Dijksterhuis, Bos, Nordgren, and van Baaren (2006), whom illustrated that complex decisions are often better solved by assistance from unconscious thought although their specific results were recently challenged (Acker, 2008). Likewise, the unconscious, just as the conscious, has been illustrated to be goal-driven (Eitman, Hassin, & Schul, 2008). However, most studies of this nature, as those noted above, do not extend a benefit to participants beyond the experimental sessions. This current project involved a training protocol to teach an implicit reasoning strategy, which, if learned, could be applied to future settings, beyond the experiment. This was immediately tested by having participants complete novel problems.

Reber and Allen (2000) tested whether implicit learning and intelligence were related. They found that persons scoring high on typical intelligence tests did not out perform persons with average scores on these same tests (though, many intelligence tests measure explicit knowledge, not implicit). This study included a measure that has been correlated with intelligence, working memory capacity, in order to further test this notion. Though I am certainly not contending that intelligence is dependent or a derivative or working memory capacity, I am arguing that working memory capacity is a component of intelligence.

However, might there be information processing dispositions and/or innate capacities that accompany implicit learning ability? This project included several individual differences measures to examine if dispositional or motivational traits and states might also influence this form of learning. These are discussed further in Chapter 4.

Several learning theories have been developed during the evolvement of cognitive psychology and associated fields. Likewise, there have been several definitions of learning. Langley and Simon (1981) defined learning as, "A process that modifies a system so as to improve, more or less irreversibly, its subsequent performance of the same task or of tasks drawn from the same population." This was echoed by Kirschner, Sweller, and Clark (2006), "Learning…is defined as a change in long-term memory."

However, in many instances results involving learning are based on explicit reactions or involve either motor or perceptual learning. In this project I was particularly interested in abstract implicit learning. This form of implicit learning is believed not to be bound to the surface features of stimuli (See Seger, 1998). Seger (1994b) forwarded the idea that implicit learning occurs in two stages. During the first, an unconscious knowledge structure is triggered and manifests itself as an intuitive feeling. And secondly, the learner, by realizing an absence of

what causes this feeling, a lacking of explicit stimulus knowledge, assigns the value to the stimulus. Unfortunately, these postulations still rely on simple examples, such as the extension of grammatical rules or the mere exposure effect (See Bornstein, 1992).

In this project, I propose to examine complex abstract implicit learning, such that the learning must be applied across situations that are disassociated with the stimuli proposed to teach the underlying strategy in both format and structure. Likewise, the situations in which the strategy must be applied are not simple procedural grammatical extensions, for example. Rather, they are complex in that they may evoke pre-established opinions about the particular situation and, perhaps more importantly, the decision environment takes advantage of the innate predispositions to disengage information search processes when the solution within that environment seems intuitive. Likewise, we also have a tendency to search for evidence that confirms our hypotheses. Learning was defined as a permanent change in behavior exhibited by a decreased commitment towards the trap option in experienced (pre-training) and non-experienced (post-training novel) situations.

Anderson's ACT-R theory, since its inception (Anderson, 1981) has been revisited and reconfigured several times (Anderson, 1990; Anderson & Lebiere, 1998) to make the theory more adaptive given empirical results. Although ACT-R is a general cognitive architecture, it contains descriptions of processes that reveal how learning can occur. The ACT-R model is relevant to this project, because it describes a means for adaptive use of analogies for problem solving and learning. It is further relevant, because it does not incorporate such trait factors as need for cognitive closure (an information-processing trait) or decision style (a decision-approach trait). As explored in this project, these factors could further inform the process of skill acquisition such as why it is more/less likely to occur.

Although the ACT-R model is not fully explored in this project, it serves as a representation of what might be occurring when individuals are attempting to solve problems used in the current project. For instance, Anderson and Lebiere do address analogical problem solving as being enveloped under the most recent ACT-R framework. Anderson (1976) had specifically noted that a distinction between procedural and declarative knowledge would be of import for cognitive psychology. Likewise, Anderson seems to hold that procedural and implicit knowledge are synonymous. In this sense, appropriate rule induction is a function of cue recognition as part of a learned procedural set. Thus, once learned, the induction is automatic or implicit (not requiring dedicated conscious thought).

In this project, the training was developed such that engaging in the reasoning exercises were intended to instill a reasoning strategy that would engage a multiple hypothesis generation reaction to behavioral trap problems. If the strategy was learned it would be automatically engaged across behavioral trap decision scenarios. Whether the participant is aware that they are engaging a procedural rule would be unnecessary as long as the rule was applied correctly. For these problems, it would be engaging in multiple hypothesis generation in either the Immediate or Cumulative problem types. This would, in turn, lead to a reduction in

Hayes and Broadbent (1988) forwarded that hypothesis testing is likely conscious and controlled, while implicit learning is likely to be automatic and unconscious. The loose vernacular of 'automatic' implies that processes are simple and easily executed. Further, Curran and Keele (1993) imply that learning may occur without being conscious of it (and may occur without hypothesis testing). Although this debate is certainly on-going (see Nissen & Bullemer, 1987 and Seger, 1994b), my argument is that implicit learning can occur (unconsciously), but does require hypothesis testing. Specifically, if conscious, explicit processes that force the

engagement of drawing relations between situations (analogical problem solving) and also hypothesizing how changing parts of situations may change outcomes (counterfactual thinking).

Despite Mayer's success at utilizing Multimedia Theory to illustrate improved performance above and beyond other formats, it doesn't fully address how abstract (or how material could be learned implicitly) concepts may be learned. Mayer has been very effective at demonstrating how procedural knowledge (ie, how a bicycle pump works) can be learned using principles from Multimedia Theory; however, little work has been done to encompass more abstract concepts (leadership or decision strategies) that may be more difficult to wrap into a multimedia training format. In this project, an attempt was made to illustrate that an abstract, implicit strategy could be taught using the principles (such as reducing mental load and self-paced student acquisition of knowledge).

Constructivism

The fundamental characteristic that makes the constructivist teaching method effective is the idea that learning is an iterative and integrative process where the student builds upon extant knowledge by taking an *active* role in the construction of knowledge formation (Piaget, 1977). Piaget's first learning theories involved development of knowledge, via particular stages, in the infant (1936; 1937), but, at least, two necessary components can be extended to the older learner, *assimilation* and *accommodation*. Possession of knowledge was symbolized by schemas or representations of the world. During assimilation, the learner applies existing knowledge to the world and every interaction (including observation) is a potential episode for gathering information. However, existing knowledge is inherently confined and will be changed if the schema is limited and/or the environment does not correspond to the existing knowledge

structure. Thus, schemas are modified by accommodating (or integrating) the learner's experience with the world as well as the preexisting representation.

Although some of Piaget's postulations about development have been challenged, the reasoning processes above have been successfully incorporated by educators in constructivist learning environments which are "student-centered and learner controlled" (Mara, 2005), as in the current project. Likewise, teachers have been receptive to this approach for classroom usage in order to orient instruction towards the active student learner and away from the passive information gatherer (Yarrow & Millwater, 1995). The constructivist approach encompasses the idea that purposeful knowledge construction may be facilitated by learning environments which provide multiple representations of reality (Jonassen, 1994; Spiro, Coulson, Feltovich, & Anderson, 1988). Several independently important components that function together in an effective, integrative structure support this perspective; these include an active learner functioning in a complex learning environment where ideas are openly shared among the problem solvers, each learner, independently and collectively reflecting on the process of knowledge acquisition (Duffy & Jonassen, 1992). This constructivist learning paradigm has also been effectively extended to include technological innovations available in the contemporary classroom (Jonassen, 1991; Jonassen, Peck, & Wilson, 1999). In this respect, technology has been applied as a functional tool for supporting acquisition of both abstract knowledge (Zbylut, et al, 2007) and procedural skill (Shaddrick, Lussier, & Fultz, 2007).

Although assessment of long-term outcomes of learning in these environments is ongoing, there is evidence, using an animal model, supporting the idea that permanent learning can occur rapidly. For instance, Tse, et al (2007) showed that the consolidation of memory can occur very quickly, if an associative network has been pre-established. The establishment of a

network containing necessary task or domain knowledge can facilitate the rapid integration of new information, largely due to the fact that a memory representation has been created upon which to graft the new information. This is important for the present work, because the speedy integration of new information with established knowledge was an anticipated effect of the proposed training. Since the studies were completed in 1 to 1 ½ hours, the acquisition of the implicit strategy had to occur quickly.

Information Representation and Search

Johnson-Laird (1983) noted that we represent the world as it is personally true for us. In his *principle-of-truth*, he noted that we search for evidence that fits into this representation of the world, while ignoring evidence to the contrary. Being able to engage in a reconstructive process based on previous knowledge is an important and fundamental function, especially if external feedback is absent. And although this reconstruction may lead to errors of judgment (Gettys & Fisher, 1979), in some normative sense, the decision maker really has no choice, but to rely on results of this process to make decisions (Elwin, Juslin, Olsson, & Enkvist, 2007). Thus, irrelevant information may actually seem relevant for persons whom do not ignore it, and we may be inclined to confirm our initial reactions (Gettys, Pliske, Manning, & Casey, 1987).

Bartlett (1932) demonstrated the way we symbolize experiences in our memory is, in part, determined by our permanent knowledge of events, objects, and processes of experiences. This is relevant to the present work, because how information and past experience is represented in memory can influence what information is retrieved while solving a task involving both the relevance and irrelevance of past experience. Moreover, Rumelhart and Norman (1973) noted that recalling an event from memory will likely be strongly influenced or biased by an individual's basic knowledge of the world. This, of course, relates to Piaget's ideas of

accommodation and assimilation. Further, Tulving and Thomson (1973) illustrated, when we remember, it is a function of both information stored in the rememberer and information readily available in the rememberer's consciousness.

More simply, Reicher, Ligon, and Conrad (1969) showed that similar stimuli, related to initial target stimuli, (in their studies, words that rhymed) could interfere with retention of those stimuli. However, they also noted that individuals always selected words that belonged to the same rhyming class. Thus, we are good at abstracting information of patterns, even though specific informational recall is diminished. Posner (1973) noted that proactive interference and crowding may degrade our ability to retain the precise sequence of past events, but these same phenomenon allow us to detect invariance and commonality in a dynamic world. Detecting both variance and invariance (at least abstractly) in this project was deemed important as all problems possessed a common element of dealing with past investments (and potential, future costs and benefits). Some of these problems required ignoring these past investments for successful decision making, while other situations required paying attention to past investments in order to make rational decisions.

As Hackman and Wageman (2007) reiterated, the commission of errors and failures may create more chances for learning than success. As noted earlier, humans naturally engage in information search processes, in order to provide evidence supporting generated hypotheses. As Hackman and Wagemen noted, failure may lead to a defensive reaction and a direction of blame pointing away from personal error and towards situational or other-person factors. Further, persons are more likely to engage in this defensive strategy than a learning-oriented approach, where the opportunity to gain substantial knowledge as to how and why the error occurred is enhanced.

Likewise, initial representation of a problem may guide the entire process of problem solving, even though the path followed is incorrect or less adequate than if multiple routes were initially considered. Also, differences in the way two similar situations are construed can lead to a failure to match these situations, even though they may contain the same information (Gentner, 1989).

This idea of initial representation is extended further by Svenson (1999) in his Differentiation and Consolidation (DiffCon) theory. When a decision maker is engaged in deciding among a couple or more alternatives, a preliminary choice is generated which may guide the rest of the comparative process among potentially competing candidates. However, the process of differentiation will naturally favor the preliminary choice contender. Svenson's differentiation process is a means for the decision maker to filter out potential alternatives of choice and focus on a successful candidate that satisfies both rule application and goal attainment.

This project took advantage of two processes that are commonly utilized on an everyday basis (whether persons are always aware of it or not): analogical problem solving and counterfactual thinking. Thus, by engaging persons in each of these reasoning processes, information search would be directly affected as would information representation. This would, in turn, force participants to deliberately engage in more thorough hypothesis testing, decreasing the likelihood of relying on an intuitive reaction or choosing the trap option.

A Cognitive Theory of Learning with Media (CTLM)

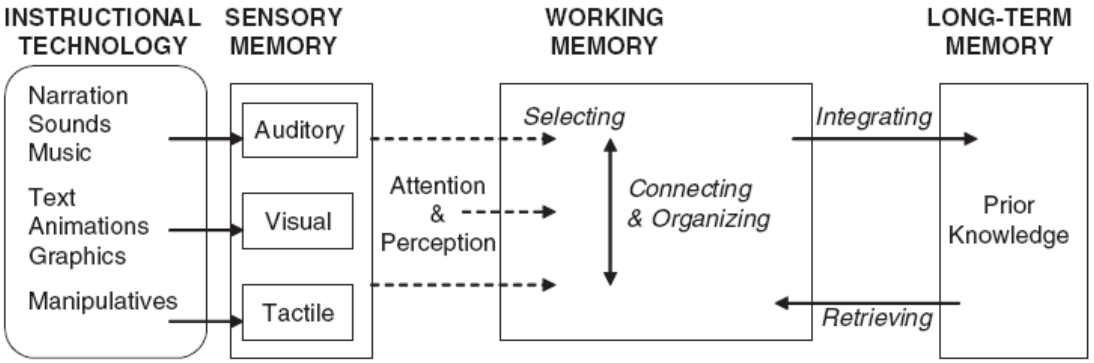
Moreno and Mayer (2002) noted two competing hypotheses concerning the interaction of the use of multimedia and method of instruction. The *media-affects-learning* hypothesis persists that instructional method is secondary to the learning process and the sophisticated technology is

the mechanism that promotes deeper cognitive learning. The *method-affects-learning* hypothesis promotes the idea that an appropriate method of instruction (within the media format) will initiate the necessary cognitive processing and the media format is only secondary. The conclusion from this work being the development of the hypothesis, *media-enables-method*, which, involves the idea that some learning methods are facilitated by respective media and these different instructional methods are differentially responsive to how humans process and utilize information. Nevertheless, this framework ignores (potentially) important individual differences such as information-processing disposition and unconscious processing.

Moreno (2006) developed, *A Cognitive Theory of Learning with Media (CTLM)* to address this potential conflict; in which situations methods and/or media will affect learning. A central concept to multimedia learning is the idea of reducing cognitive load, in order to free up processing resources, to improve the most accurate processing of information (Mayer & Moreno, 2003). Thus, the principles supporting CTLM fall out of this need for cognitive load reduction and resource allocation for necessary processing. For instance, this theory purports only a few pieces of information can be consciously processed at any given unit of time and conscious effort is necessary to integrate novel information with extant knowledge; an echo of earlier work by Miller (1951,1956).

The capacity limitations of working memory, of course, will affect the utilization of information regardless of the format it is in. In particular, *selecting*, *connecting & organizing*, and *integrating* information will be positively or negatively affected by retrieval of information from long-term memory or external guidance (i.e., question prompting from an instructor or computer).

Figure 3.1 Model of Principle Components within CTLM.



One component missing from Figure 3.1 is the effect of external guidance, which is stated by Moreno (2006) to have a similar effect on *selecting*, *connecting & organizing*, and *integrating*. Moreno failed to note that external guidance can actually affect the retrieval process itself. Retrieval will occur naturally (within the individual), but it might also be affected by specific reasoning processes which could affect acquisition of explicit or implicit strategy.

Another missing component is the lack of specification of the role of unconscious processing in knowledge acquisition. Recent work by (Dijksterhuis, Smith, van Baaren, & Wigboldus, 2005; Dijksterhuis, Bos, Nordgren, & van Baaren, 2006) has illustrated the importance that the unconscious can play in making both simple and difficult decisions. Exactly what and how that role is integrated into the decision process has yet to be defined. Thus, this project could provide, at least, descriptive evidence concerning specific prompts of the unconscious.

An appropriate question to ask is, what did the traditional model look like before the influx of multimedia technologies? Essentially, the module to the far left would be replaced with the efforts of an instructor without the assistance from technology. This approach of solely instructor-based education is still practiced and functional today, as most class-room material is

delivered as a lecture, simply with the assistance of PowerPoint. The integration of multimedia extends the reach of the instructor by offering opportunities to enhance instructional capacity beyond the traditional lecture format, specifically by reducing cognitive load and enhancing essential processing of materials by the learner.

Likewise, there are two fundamental processes that also need to take place if multimedia instruction is to be successful: feedback and reflection on cognitive activity (Moreno & Valdez, 2005). This relates directly to their *principle of interactivity* such that the opportunity for interaction with the materials being present does not necessarily imply the appropriate guidance and reflection are also present. For instance, prior research has indicated that reflective induction housed within an interactive learning environment may not always enhance learning. It was hypothesized that interactivity pre-empts initiation by reflection of both organizing and integrating novel information with pre-existing knowledge (Moreno & Mayer, 2005); a reflection of Piaget's earlier work. Thus, interactivity with the available learning materials, appropriate and functional reflection should lead to optimal knowledge acquisition. In this project, I am identifying interactivity as the engagement of reasoning processes that would lead to strategy acquisition, in absence of (external) guidance and feedback.

Procedural vs. Declarative Learning

The multimedia approach has been very successful for teaching procedural knowledge, such as how lightning occurs. There has also been work on teaching abstract elements as spatial distance involving the gradual construction of mental maps or images (Tversky, 1993). However there has been little empirical evidence of the effects that multimedia has on teaching abstract concepts or strategies. The teaching of abstract concepts of this sort would require more refined models than has been proposed by the mental map literature or that forwarded by Multimedia

Theory (Mayer, 2001). Some recent research suggests that multimedia training can, at least, enhance the utilization of information on particular abstract topics such as cultural awareness (Zbylut, et al, 2007). However, the specific cognitive processes and acquisition strategy for knowledge have not been fully defined, nor have the specific reasoning strategies needed to acquire this knowledge been fully explored.

This distinction is important for the current project, because behavioral trap scenarios evoke an ingrained procedural reaction. To elaborate, a participant reading the scenario typically focuses on the investment cue as the primary cue. The natural response to the scenario is to 'solve' the situation by choosing the option which has the largest (previous) investment (See the General Discussion for more on this point). Thus, most participants will select the trap option and commit the sunk cost effect. In Chapter 4, two specific processing mechanisms (generating analogies and counterfactual thinking) are discussed that are proposed to alleviate the effect from occurring. This project provides evidence about which reasoning strategies are needed to acquire abstract knowledge when multimedia examples are employed.

Training Reasoning Strategy

Nisbett and colleagues spent some years in attempts to train or teach reasoning. For instance, in one study (Larrick, Morgan, & Nisbett, 1990) the concentration was on getting persons to respond more rationally to investment traps. They have also noted that training should entail instruction on abstract logic and be enhanced by instruction on how to make a successful application of specific rules to a novel problem (Fong, Krantz, & Nisbett, 1986); coupling specific examples with abstract logic seems to be the most functional (Cheng, Holyoak, Nisbett, & Oliver, 1986).

However, Nisbett and colleagues make the assumption that training effective reasoning has to occur over a long period, formal class instruction on logic, for instance. Likewise, they make the argument that the reasoning processes engaged during training have to be explicit. In my Master's Thesis (Vowels, 2006), I also made the argument that training needed to be explicit, such that certain cues within the decision environment were the primary elements that needed to be trained in order to relieve the sunk cost effect (a form of investment trap); explicit training was minimally effective overall.

Part of the purpose of this project was to examine if a reasoning strategy could be trained quickly (within an 1 ½ hour experimental window) and if the training would transfer to novel problems the participant had not seen before. I also argue that training a reasoning strategy for behavioral trap decision environments can take the form of implicit learning, by employing natural reasoning processes. Thus, this broader strategy could be applicable to all types of behavioral traps.

The implicit strategy evoked by the reasoning exercises, involves both ignoring and paying attention to past investments. One of the main reasons that behavioral traps have an effect on decision making exist is that persons pay attention to past investments when they should not or ignore them when they should pay attention to them. Likewise, the main underlying reason traps evoke so much hold on the decision process is a lack of consideration of alternatives by the decision maker. Thus, the training protocol in this project was created to evoke multiple hypothesis consideration, in order to alleviate the effect of trap options.

The implicit learning strategy was postulated to work as a result of engagement of analogical problem solving, counterfactual thinking or both. With the assumption that implicit learning occurs as a result of associative mechanisms (See Frensch and Rünger, 2003), the

critical thinking exercises were selected based on their functionality to engage associative processing. Analogical problem solving requires a comparison of elements between two potentially disassociated situations. Thus, analogical problem solving is inherently a form of hypothesis generation, such that it entails testing or determining how situations are similar or dissimilar.

Counterfactual thinking is also a form of hypothesis generation serving as a testing process which simulates alternative situations that may take the place of given outcomes. The engagement in these processes was purported to allow participants to abstract an underlying reasoning strategy, specifically to engage in multiple hypothesis generation, (especially in a decision environment that forces an individual to typically consider only one alternative). Thus, the main reason traps are so effective at guiding decisions is the lack of consideration of alternatives. Given the above postulation, it was hypothesized that participants would react to behavioral trap decision environments, by exhibiting more commitment towards the non-trap option; thus, a direct exhibition of the implicit learning strategy.

CHAPTER 4 – Moderating Learning: Methodological and Individual Differences

Methodological

Analogical Problem Solving

The use of analogy is a form of reasoning used in everyday decision making and problem solving. Marchant (1989) noted that, "Analogy is a reasoning mechanism used to extend knowledge to a particular problem that is on the surface unfamiliar, by using relations contained in problems which are well understood and which have been solved." However, the actual utilization of analogy can be varied by a number of important elements that make up the process (Gentner, 1989). For instance, the current representation of the source and the target can limit potential analogical matching. Likewise, a learner's goals can influence analogical problem solving by affecting domain representations in working memory. However, the use of analogies can also occur outside of a goal-driven environment indicating its natural ease of engagement. Gentner further argues that once an analogy is generated, it will be processed completely; once a hypothetical relationship is generated it is fully mapped between the analogs and may be assumed to be correct. Thus, initial representation of a problem can be very important in terms of analog acquisition and utilization. If we are correctly thinking about a problem, it is advantageous, but disadvantageous otherwise. In behavioral trap decision making, it is more natural to represent the problem in terms of choice options based on immediate or cumulative investment amounts. However, the over reliance on either strategy can prove ineffective and is argued to be non-normative by contemporary standards.

Despite the potential that analogies might play in assisting with solving similar problems, Gick and Holyoak (1980) noted that participants were rarely able to directly draw upon the example (source) problem to solve the target problem. Rather, participants required a hint that

they should rely on the analogy to assist them. A major goal of this project was to teach an implicit strategy that could be used to solve novel problems, relying on analogical problem solving as one of the main reasoning exercises to teach the strategy. Though hints were not given (in order not to impinge on the potential effects of the implicit strategy), this project utilized a salient primary (filmed) example.

Marchant further noted both experts and novices can utilize analogical reasoning when attempting to generate hypotheses for situations in an unusual or unfamiliar scenario. This project included similar and novel problems to test if engaging in analogical problem solving could change behavioral trap decision making.

Ross (1987) argued, when giving persons new problems that possessed some of the same underlying elements as the source problem (i.e., example problem), this would allow participants to transfer knowledge gained from the source to the target problem. He proposed two testable views. The *principle-cuing view* holds when learners are reminded of an earlier example, they would think of the formula or principle illustrated by the earlier example. Thus, the earlier example cued the relevant abstract information. In the *example-analogy view*, the principle is understood only in the context of the earlier example. Thus, if a learner was given a principle or formula, they would use the particulars from the previous example to figure out how to apply the principle to the current problem. These views will be further tested in the current project. Ross relies on mostly examples of mathematical principles to solve mathematical problems. I am concerned with teaching a general implicit strategy and argue that the principle-cuing view will be supported since the implicit strategy will be applied across situations, not just example-specific situations.

Hypothesis 1: If participants are able to learn the underlying reasoning strategy, they will be able to apply it to a variety of scenarios (similar or near and dissimilar or far). This would provide support for the principle-cuing view. This would be indicated by a decrease in commitment score (indicating a shift towards the non trap option) across all scenarios.

In terms of memory theoretic accounts, the probability that a target will be cued depends on the degree of the match (between cue and target) *and* the confusability of the target information with information stored in memory. Likewise, when attempting to solve problems, learners may search their memory for relevant information. Novices are more likely to retrieve both relevant and irrelevant information, based on the probes they utilize for searching memory. Further, achieving a probe-target match, does not imply the information will be correctly used to solve a current problem. Thus, the reliance on superficial similarities (such as similar story lines or object correspondences) to increase transfer (from source to target) may not always be sufficient. Nevertheless, constructing analogies between source and target does appear to assist in problem solving, although one may intuitively consider only structural similarity to have the largest impact. A structural similarity changes how a solution is derived, while a superficial similarity would not (Ross, 1989). Although examples with superficial similarity were used in the current project, they were also postulated to engage the formation of a strategy that would allow a shift in how the problem was represented structurally.

Ross notes that there is an important distinction for the novice vs. expert comparison, specifically that novices lack the higher level knowledge structures of experts. Thus, novices solve novel problems by using superficial similarities from previous examples (Chi, Feltovich, & Glaser, 1981). And, at the very least, Ross' work on analogical problem solving illustrates that drawing an analogy between old and new problems is a function of salience, similarity, and

expertise. Though use of analogy is likely affected by level of expertise, novices may still utilize this method to solve problems (especially in everyday tasks). It is a natural comparative process and all humans engage in constructing analogies throughout intellectual (and skill) development. I argue that novices can use deeper structure when engaging in analogical problem solving is coupled with counterfactual thinking. Dunbar (2001) adds to this debate noting that novices can utilize analogies as a means to solve problems if given the right context that makes structural relations more salient. Likewise, he argues the main reasons participants in psychological experiments do not use deeper, structural processing is that they encode the source problem only for its superficial features. Thus, the level that the source problem is encoded at affects whether it is retrieved when attempting to solve a structurally similar target problem.

Thus, there is still a debate about how well novices can use analogies to solve similar and novel problems. This project examined how a specific training protocol enhanced the use of analogies for novice decision makers (undergraduate introductory psychology students). Specifically, by exploring how coupling analogical examples with counterfactual thinking may improve problem solving in behavioral trap decision-making contexts. Dunbar and Blanchette (2001) noted that the type of utilization of analogy can affect the use or nature of the mapping that takes place. Although, thought to be a function that only experts could employ, they noted that novices utilized analogies differentially as well. For instance, when novices are attempting to simply illustrate an idea, they may do so using superficial mappings or similarities, but use higher-order relational mapping when attempting to solve a problem.

The crux of using analogies to solve problems, especially in a learning context, is to get persons to connect the base story to the target problem or, at least, the component that will allow them to solve the current problem using the previous example. Further, to get persons to

accomplish this on their own for novel problems is one of the basic goals of this project. As Marchant (1989) noted, analogical reasoning is necessary for transferring knowledge from a known domain to an unknown (novel) domain, which invokes the extraction of 'regularities' between them; this extraction process forms the basis of a schema. Robins and Mayer (1993) attempted to show that training on examples involving relational structure versus those not involving relational structure was an important component for learning and that the type of transfer was also important (near vs. far). Near transfer involved solving problems of a similar relational type and far problems with a dissimilar relational type, of the initial examples.

Robins and Mayer pitted an *active-responding* theory against and *active-learning* theory. They argued that an active-responding theory fell out of the Skinnerian or *Behaviorist* paradigm (1968) such that a response from the learner is followed by an award or punishment. Further, a learner's behavior is required to be overt, while the teacher's behavior involves the administration of rewards and punishment. In this view, the generation of answers during the learning process and subsequently being shown the correct answer, when needed, assumes that this process will lead to better performance on both near and far transfer tests; the feedback causes a better acquisition of component skills.

In contrast, the active-learning theory is based on the idea of the learner being mentally active (not just overtly active) during the learning process and the teacher assisting in knowledge construction by helping to provide relational schemas, not just rewards or punishments; the learner is consciously (and probably unconsciously) trying to solve a problem. Thus, the generation of relational schemas is believed to foster learning because of the cognitive manipulation of information rather than simple overt physical activity. Robins and Mayer do note that literal, hands-on learning can encourage functional learning (e.g., actually solving

problems, rather than being shown problem and solution). However, when the learner is not fully aware of the processes that are to be learned, this may decrease available mental resources by filling up working memory capacity or cognitively overloading the learner. Thus, in an active-learning approach the student is shown problem and solution and attempt to draw relations between them. If a student does not understand the relevance of how and why a concept should be applied, the student may use up attentional resources on attempting to become unconfused. I argue, if the process is implicit, the learner wouldn't be able to verbalize what is being learned, nor would they need to. Likewise, if the learner isn't required to be aware of the process, only the immediate task goals will require focus, while an implicit strategy is being formed unconsciously. And, if the unconscious is limitless or, at least possesses more processing capacity then consciousness, then concerns of cognitive load become less relevant.

Robins and Mayer illustrated that the active learning theory view was superior, as predicted, when the problems involved a certain schematic theme or relational schema and when cognitive workload was low. However, as predicted, persons in the relational schema conditions did not perform well on far transfer problems, because these problems did not evoke the previously learned relational schemas; this is reminiscent of Gick and Holyoak's (1980) illustration that persons required hints to solve their 'novel' problems.

For Robins and Mayer's research, the low workload involved showing the participants worked out examples, as opposed to having them attempt to solve problems. They concluded when training on analogical reasoning, the main relations in the analogies should be made salient to the learner and that working memory should not be overburdened when attempting to form relational schemas.

Although these results are promising for some instructional situations, there is little indication that participants would be able to apply this strategy in novel situations or in future settings (beyond the experiment). Likewise, individual differences such as working memory capacity, NCC, and decision-making style were not tested as they were in the current project. Further, they assume the conscious acquisition and manipulation must be involved to learn. This project provides evidence that the unconscious can be drawn upon to learn to solve similar and novel problems. Nevertheless, the results may provide evidence for the active-learning theory (which is essentially, devoid of feedback).

A methodological manipulation by Thompson, Gentner, and Lowenstein (2000) revealed that engaging in a comparative process led to more functional use of analogies than when not engaging in this comparative process. They further argue that our ability to transfer knowledge from one situation to another is based upon our access to memory, although they did not actually test the effect of differences in working memory capacity in their study. Further, our capability to retrieve and utilize information from memory is dependent upon how we learn or encode that information. Likewise, simply engaging in an active learning process is not enough to secure knowledge transfer. For instance, solving a problem in a given context does not predict being able to solve a similar problem in a different context. Thus, they noted that engaging in a comparative process (solving at least two or more problems) during the learning process allows persons to develop a problem-solving schema. This schema can later be used for memory retrieval and knowledge transfer. These results support those from an earlier research program (Gick & Holyoak, 1983; as well as Robins and Mayer, 1993) that also noted when participants had worked with two previous analogs, they were more likely to abstract the underlying

principle. This idea of redundancy is, perhaps, one of the most fundamental characteristics of learning.

This project provides further evidence of using multiple examples (including an actual film example) as well as the integration of analogical problem solving with counterfactual thinking to extend these findings involving problem solving. Previous research has demonstrated that using multiple examples leads to improved use of the demonstrated analogies; in this project, a film/paper combination was used in contrast to most studies that only use paper-based examples. The intent of the critical thinking exercises was to provide an opportunity for participants to establish an implicit framework to guide decision making in similar and novel situations.

Not all research has provided supportive evidence of analogical problem solving as an infallible mechanism for problem solving. For instance (Glynn, Britton, Semrud-Clikeman, & Muth, 1989) cautioned that the use of analogy can lead to misunderstanding and potentially, poor predictions. Their main contention was that mapping could not be completely identical between situations and would, thus, eventually 'breakdown' at some point in the comparative process. Although a valid contention, the current training protocol does not require a one-to-one mapping, but rather an acquisition of and retaining the strategy (ignoring costs in investment traps or paying attention to past investments in ignorance and time-delay traps).

Likewise, even if good analogies are available, this does not imply they will be used when they are needed. Also, constructing an analogy is mentally expensive and taxes working memory capacity. The proposed training addressed both points. Answering the first, by relying on implicit strategy engagement and the second by providing salient analogies for the student learner and by measuring working memory capacity.

Analogies and Hypothesis Generation

Above it was argued that analogical problem solving is a useful method for generating relations among concepts. Constructing analogies between a source and target is a form of hypothesis generation. In order to map relations between two different objects, situations, etc, a discovery process must be utilized. For instance, if I was trying to relate an ostrich to a giraffe, I could go through a number of hypothesis tests, such as do neither, one, or both possess similar physical characteristics. They both have long necks and two eyes. However, using a super ordinate category elimination process, I would find that one is a bird and one a mammal. An even more general category classification leads to an ultimate similarity, both are animals. Thus, a number of hypotheses may be tested before a comprehensive, functional analogy can be constructed.

A peculiar characteristic of analogical problem solving is that the analogy itself may or may not be forgotten. Dunbar (2001) noted that analogies themselves are typically forgotten once they have served their purpose. For instance, once the analogy assists the user in a new way of thinking about a concept or allows a new clarification to be made, the actual analogy may be discarded. For the current project, the analogies may have been forgotten as long as the implicit strategy they were supposed to cultivate remains. Further, none of the participants may have known that an implicit strategy is being formed, even if the analogy is retained.

An important process needed to achieve problem solving solutions is hypothesis generation. It has been postulated that hypothesis generation may lie at the base of all human reasoning (Thomas, 2004). Likewise, the utilization of analogies has been noted as an important component or form of hypothesis generation. It seems logical that we would enact a process that allows us to effectively compare potentially new knowledge to old knowledge. By using

analogies, we are evoking such a process, especially when we are in a situation we have not previously encountered or have little experience with.

Clement (1989) noted that analogies can serve at least three purposes for the formation of the development of new hypotheses: (1) function as a heuristic, in turn, offering novel components to draw attention to; (2) can be used as a rough first model, which can be later modified; (3) a fully developed model is linked, via analogy, to the target situation.

Hypothesis 2: Analogical problem solving is viewed as a form of hypothesis generation in the present study, and engaging in multiple hypothesis generation is a means for shifting commitment towards non-trap options. If this form of training is effective, participants will exhibit a decrease in commitment score.

Counterfactual Thinking

Roese (1994) argued that counterfactual thinking is an adaptive mechanism common to human reasoning, specifically as a natural reaction to past events. The two most commonly studied aspects of counterfactual thinking are direction (upward, downward) and structure (additive, subtractive) both have been shown to influence affective experience and performance on various tasks. Roese further illustrates that additive counterfactuals are more synonymous with preparation for two reasons. Additive is more explicit in that it focuses the decision maker on a particular alternative that would likely result in a successful outcome, but engaging in the process of subtractive counterfactual thinking elements are simply removed from the situation in order to derive a successful outcome. Likewise, additive counterfactuals are viewed as more innovative or creative, because they are not part of the original situational premises; subtractive involves removing premises from the original set.

Some have recently argued that inducing persons to think counterfactually, allows improved problem solving (Markman, Lindberg, Kray, & Galinksy 2007). Markman, et al tested the idea that the different structural forms of counterfactual thinking (either additive or subtractive) differentially affect solving different types of problems. For instance, in additive counterfactual thinking, the decision maker adds elements to the representation of the situation in order to gain control over the situation (i.e., "If only I would have purchased an umbrella, I would not have gotten wet"). This form is considered to assist the solving of creative generation tasks, by broadening conceptual attention. Likewise, in subtractive counterfactual thinking, the decision maker must remove an item from the situation in order to gain control over the situation (i.e., "If only it had not rained today, I would not have gotten wet"). This form is contended to assist analytical problem solving by increasing the tendency to develop relationships and associations between problem components. Further, Roese and Olson (1993) have postulated that additive counterfactual thinking promotes the consideration of options that might be successful in similar future scenarios, whereas subtractive counterfactuals encourage removing available options. In other words, additive counterfactually thinking is forward-looking since it promotes the generation of potentially successful alternatives, whilst subtractive is backward-looking, focusing on the scenario elements that were available and removing the unsuccessful option. This is particularly important for behavioral trap decision making where the decision maker is often trapped by looking only at past investments or may also select trap options as a result of ignoring individual costs that are minute, but cumulatively detrimental. Thus, the following hypothesis is rendered:

Hypothesis 3: Since subtractive counterfactual is past-looking or focuses the individual on the past, asking participants to engage in subtractive counterfactual thinking will lead to a

decrease in commitment score (or an increase in selecting the non-trap option) specifically on immediate trap problems. By considering alternatives, this would relieve the effect of past costs on the decision process.

Hypothesis 3a: Additive counterfactual thinking will lead to a decrease in commitment score, specifically for cumulative trap problems. By considering the potential future effects of incremental costs, persons will exhibit more commitment towards non-trap options.

More specifically, Johnson and Sherman (1990) noted that inventing upward, additive counterfactuals might improve performance as a result of script production pointing to future alternatives. Moreover, this process allows for the generation of potentially successful situations based on the available evidence. Likewise, the act of generating outcomes, is more likely to lead to actual behavioral engagement. For instance, Sherman, Skov, Hervitz, and Stock, (1981) had participants imagine performing well or poorly and then write hypothetical explanations for the respective outcome (as opposed to controls whom did neither). Participants who anticipated performing well did so and those anticipating performing poorly did so (both compared to controls).

Although thinking counterfactually is commonly cited as being an adaptive mechanism for human reasoning, there are instances where it may be nonfunctional. Sherman and McConnell (1996) illustrated that it is much easier to generate counterfactuals for specific instances than it is for general cases. The overrepresentation of specific instances allows them to be over weighted and makes it easier to generate counterfactuals for past events; however, this over weighting also makes it easier to generate potential future scenarios as well. Sherman and McConnell cite this as being non-adaptive, because of the over reliance on these specific instances when trying to draw general conclusions. Related to this project, if the film used in

training exercises is over utilized, this may lead to a difficulty in solving problems involving a different context. Thus, counterfactual thinking may not always be an adaptive function to exploit. This project provides further evidence for this continuing debate.

Counterfactual Thinking and Hypothesis Generation

As noted, counterfactual thinking involves the generation of alternative scenarios that may substitute for reality; this project examined additive and subtractive counterfactual thinking. Hypothesis generation, as well, involves the creation of potential substitutes for reality; some may exist prior to an event (i.e., data collection in an experiment) and some may be post-hoc (figuring out what happened, since it wasn't what was expected to happen). Thus, both involve a similar reasoning process, the product of which is to achieve an explanation of reality or potential reality. In this regard, counterfactual thinking is a form of hypothesis generation and testing. By engaging in either form, one must generate counterfactuals or hypotheses that can serve as a functional alternative to reality.

Thus, counterfactual thinking is also a form of hypothesis testing by forcing a consideration of mutable (or functionally interchangeable) alternatives that may fit the current situation. The different forms utilized in this project (additive and subtractive) may achieve hypothesis generation somewhat differently. When engaged in additive counterfactual thinking, an individual must generate a mutable element that is not part of the original scenario or set of elements. For instance, "If only I had been wearing my good running shoes, I would have been able to catch the ice cream truck!" However, in subtractive counterfactual thinking an antecedent element is removed in order to re-create reality. For instance, "If only I hadn't fallen asleep waiting for the ice cream truck, I would have been able to get the two-scoop special."

Markman et al also noted that engagement in counterfactual mindsets encourages skepticism concerning a dominant hypothesis. Likewise Galinksy and Moskowitz (2000), noted this may lead to a reduction in a confirmation bias or the natural propensity to search for information that supports an extant hypothesis (recall the section on information representation and search). This is particularly important for the present project, because the purpose of the training was to encourage learners to acquire an adaptive strategy that forces them to challenge originally generated hypotheses or options that initially seem optimal. Thus, counterfactual thinking is proposed to be a useful mechanism (the other being analogical problem solving) for encouraging the use of such a strategy.

Individual Differences

Despite the potential effectiveness of any training, moderators exist that may influence the relationship between training exposure and actual learning. This section explores several factors that are especially important for many varieties of learning environments may influence the performance outcome measures of the proposed training, because they could either positively or negatively affect the obtainment and retainment of instruction.

Working Memory Capacity (WMC)

Miller (1951;1956) argued that our capacity of short-term memory is limited in the information it can maintain, specifically 5$\pm$ 2 items. Woodworth and Scholsberg (1954) noted that questions of limited capacity have been around since the late 1800's with studies involving stimulus information capacity conducted by Hamilton (1859). More recently, researchers have shown that working memory capacity also is predictive of the ability to attend to relevant information, whilst ignoring irrelevant information (Baddeley & Hitch, 1974; Ericsson &

Kintsch, 1995). Likewise, Cowan (2001) has illustrated that non-experts (the main participants in this project) likely have a reduced working memory capacity, specifically 4 ± 1.

Working memory capacity (WMC) has been studied extensively by cognitive psychologists and has been correlated with intelligence (Turner and Engle, 1989), analogical problem solving (Sternberg, 1977), and may also be related to domain knowledge (Hambrick and Oswald, 2005). WMC was predicted to be relevant for the current project, because it could affect hypothesis generation and potentially affect training involving analogical problem solving and counterfactual thinking.

Likewise, Baddeley and Hitch (1974), proposed that there are, at least, two processing systems necessary for information processing (See also Baddeley, 1986). The visuospatial sketchpad is believed to handle image information and the phonological loop handles the processing of verbal information. These 'slave' or 'subsidiary' systems are supervised by a central executive that allocates resource processing capacity. The executive system is also proposed to control the focusing and switching of attention as well as activating representations within long-term memory. This central executive would represent the mechanism that would be most affected by implicit strategy learning, because it determines which information is retrieved for further processing. If WMC is a measure of central executive function, person of higher WMC should perform better on a variety of tasks. Although

One of the present arguments is that analogical generation and counterfactual generation are forms of hypothesis generation; the ability to generate hypotheses has been directly related to working memory capacity, such that those higher in working memory capacity can generate more and better hypotheses (Dougherty & Hunter, 2003). However, most research involving

hypothesis generation has promoted only that an aptitude construct like working memory capacity is an important predictor of this process.

Hypothesis 4: Since persons higher in WMC should be able maintain more information in working memory, they would be more likely to consider alternatives in behavioral trap decision making environments. In behavioral trap decision environments, persons commit irrational behavior by focusing on only on option, the trap option. Persons scoring higher on WMC will show a lower commitment score, indicating a commitment towards non-trap options.

Need for Cognitive Closure (NCC)

The Need for Cognitive Closure (NCC) is a desire for acquiring definitive knowledge on a topic and aversion to ambiguity (Kruglanski & Webster, 1996). Webster and Kruglanski (1994) proposed that NCC is a latent variable that is related to several characteristics such as desire for predictability, preferences for order and structure, discomfort with ambiguity, decisiveness, and close-mindedness. Although they recognized that NCC may vary as a function of situation, they contend this construct may also reflect individual differences, indicating both a varying state and trait construct.

Kruglanski and Webster (1996) noted that the need for closure is driven by two forces: urgency and permanence. Urgency is one's desire to obtain closure on a subject as soon as possible. Permanence is one's desire to sustain closure for as long as possible. Further, these forces are sequential, such that persons will seek to "seize" on an answer and then "freeze" on it, in order to protect the derived solution from competing solutions. This process is believed to be a motivated tendency and does not result from a cognitive deficit; thus, closure may not be a universal experience or result from a general cognitive limitation (such as working memory capacity). Seizing precedes freezing such that prior to closure, persons will seek only necessary

information in order to obtain closure. The materialization of freezing would be marked by a lack of further information processing, especially that which may threaten the generated hypothesis (or proposed solution). Mayseless and Kruglanski (1987) showed that information search is restricted when need for closure is artificially heightened. Likewise, they also showed that participants in the high need for closure condition generated the fewest hypotheses.

This concept is directly relevant for the current project in that NCC influences the amount of information used to make a decision about generated hypotheses. Persons rely on an intuitive processing system that typically generates a single-cue hypothesis and only that hypothesis is tested (which option amount is larger)? Thus, information search is restricted to determining which amount is larger.

Hypothesis 5: Persons scoring high on NCC engage in less information processing and also generate fewer competitive hypotheses. Likewise, persons may feel overconfident in the hypotheses they do generate due to a lack of searching (i.e., sufficient search and testing process) for potential short comings in those hypotheses. In behavioral trap decision making environments, trap options engage an intuitive reaction. This intuitive reaction, leads to a failure to consider other hypotheses. Thus, persons scoring higher on NCC will be more likely to choose trap options, exhibited by higher commitment scores.

The acquisition of knowledge is potentially impeded by the learner's own systematic limitations, for instance by the difficulty of breaking away from initial representation, which guides information search to support original hypotheses. This could be a function of information-processing disposition and inherent limits in the individual (WMC). Dougherty and Hunter (2003) showed that hypothesis generation is directly affected by WMC such that those

scoring higher in WMC were able to generate more and, thus, better hypotheses than persons scoring lower on WMC.

These arguments, forwarded by Dougherty and Hunter, assume hypothesis generation is affected only by an innate capacity of the performer. However, this relationship might be further clarified considering individual differences in the Need for Cognitive Closure.

Hypothesis 6: NCC will moderate the relationship between working memory capacity and hypothesis generation. Individuals with a high need for cognitive closure will likely generate fewer hypotheses regardless of scoring high (or low) on a working memory capacity.

The current study will allow an illustration of a positive or negative relationship between NCC and WMC and incorporate a hypothesis generation task. If this relationship exists, it suggests potentially negative consequences for learning, especially a training paradigm involving a strategy of multiple hypothesis generation. It is more natural for humans to engage in a reasoning process to select a single hypothesis and then seek evidence to confirm it, rather than to select several hypotheses and seek evidence to confirm or disconfirm any/all of them. This selection occurs after an internal process of generation, evaluation, and testing based on signal strengths in memory (see Thomas, 2004 for a more complete discussion). Thus, once a hypothesis is selected, even if the wrong one, we are more likely to engage in a further search process that confirms it.

If those high on NCC are more likely to generate fewer hypotheses, what can be done as part of a training paradigm to relieve this seizing and freezing? One viable option is to have students engage in a counterfactual thinking process. Additive counterfactual thinking, in particular, should be helpful, because it requires the student to generate other possible alternatives (i.e., a creative or innovative process) that were not part of the generated set of

premises. However, subtractive counterfactual thinking would likely be less beneficial, or not at all, since the student only has to remove an antecedent from the generated premises.

Hypothesis 7: Persons scoring low on NCC are more likely to consider alternatives when making decisions. Persons scoring low on NCC will benefit more from training than persons scoring high on NCC by exhibiting larger changes in commitment score (away from trap options). All training was developed so that persons would engage in more deliberation over available options, which is usually absent in decision environments involving behavioral traps.

Arousal and Mood

Two pieces to an affective experience (arousal and mood – See Mano, 1992; 1994) have been denoted as being related to training effectiveness, such that students in a more aroused state and in a positive affective frame of mind, simply learn better (Murray, Harish, Hirt, & Sujan, 1990). Likewise, Isen (1984;1987) demonstrated that persons in a positive affective state are more "cognitively flexible" and, thus, more creative. However, there is also competing evidence that persons in a negative affective state may be more attentive and process relevant information to a greater extent (George, 2000).

Hypothesis 8: Though there is a debate between which affective state is more linked to learning, a specific hypothesis can be given as related to behavioral trap decision making. If persons in a higher affective state are more flexible in their approach to situations and creative, then they should also be more likely to engage in multiple hypothesis generation. Thus, persons in a positive affective state would be more receptive to training on a strategy involving multiple hypothesis generation; persons in a positive affective state will exhibit lower commitment scores.

Hypothesis 9: Likewise, if persons in a more aroused state do learn better, then they will also benefit more from training by exhibiting lower commitment scores.

CHAPTER 5 – Study 1, Fall 2007

Method

Participants

The participants were drawn from the general psychology population ($N = 63$). An effort was made to recruit ROTC students, but this effort was met with concerns of anonymity of participants (for 'security' purposes). Each participant was run individually and I was present to answer any questions during the experiment, to ensure that participants had a clear understanding of what each task required of them.

There were 43 female and 20 males with an overall mean age of 18.97 ($SD = 1.31$); fifty-six (89%) were ages 18-20. Fifty-six (89%) of the sample was either Freshman or Sophomore. Fifty-four participants (85.7%) had taken one or fewer classes in accounting, business, economics, or marketing, indicating that most participants were not likely to have had formal instruction on behavioral traps or how to deal with them.

Materials

Three pre-training measures of behavioral trap decision making, one measure of hypothesis generation, one analogical generation, one counterfactual generation, the NCC scale, and WMC assessments were collected for all participants. Demographics were also collected and used as covariates in some analyses. The hypothesis generation measure asked participants to provide potential outcomes for the primary example (*Power Hungry* film, discussed more below). Participants viewed the film up to a critical point and were then asked to write down as many potential endings to the film. For the analogical generation measure, participants completed the Duncker's Tumor/Dictator Set (1945), then were asked to provide potential

outcomes to a paper-pencil scenario involving behavioral traps, and finally were asked to draw analogies between the film and the paper-pencil example. For the counterfactual generation task, participants responded to the Mr. Jones problem (Kahneman, Slovic, & Tversky, 1982) by providing counterfactuals, and finally were asked to either provide additive or subtractive counterfactuals for the *Power Hungry* film they had viewed earlier. The scenarios for analogical problem solving and counterfactual thinking can be used in both studies are shown in Appendix C.

See Appendix D for the specific individual differences measures used. The Need for Cognitive Closure (NCC) scale was proposed to moderate the performance outcomes, especially behavioral trap decision making, such that persons scoring higher on NCC would be more likely to focus on the trap option and exhibit commitment scores towards the trap option. The NCC variable is represented as a single score with the top and bottom 25 percentiles representing high and low scorers, though the total scale score is also informative (Kruglanski &Webster, 1996). This dichotomy was used in the moderator analysis, as it points to the specific portion of interest between working memory capacity and hypothesis generation. However, in the multiple regression analysis the entire sample was used in order to assess how persons scoring at different points on the scale predict (or do not) the targeted behavior. There are five factors or subscales within the NCC scale that have been demonstrated previously and all were examined as potential predictors of behavior trap performance.

Working memory capacity (WMC) has been shown to be related to intelligence and domain knowledge. Likewise, those scoring higher on WMC measures are more likely to learn more and perform better on various outcome measures. Although individuals will vary in the amount of skill possessed for either reading or math, the Operation Span Task (OST) was

developed to capture WMC regardless of any extant skill differences (Unsworth, Heitz, Shrock, & Engle, 2005; Kane, Hambrick, Tuholski, Wilhelm, Payne, & Engle, 2004).

During the OST, participants received practice trials and subsequently, measured trials consisting of 3 sets of each set-size; a set-size could range from 3 – 7. Thus, there was a total of 75 letters and 75 math problems. The task operated as follows.

During the letter span practice trials, participants would see a string of letters (presented one at a time for 800 milliseconds) and then were subsequently shown a screen where they were asked to recall the order of the presented letters. After each recall, participants were given feedback as to how many letters (in the correct order) that they correctly identified.

During the math problem practice trials, participants would be shown a math problem on the computer screen, such as 3 + 7 for a brief period. Once participants knew the answer, they would click continue to proceed. This problem would disappear and a potential answer (e.g., "10") would appear with boxes marked "True" and "False" on either side. Participants would click either box to continue. During the practice trials a mean time to complete the math problems was calculated by the program. So, during the measured trials, participants would see both the math problem and the potential solution for the mean time calculated based on their practice trials.

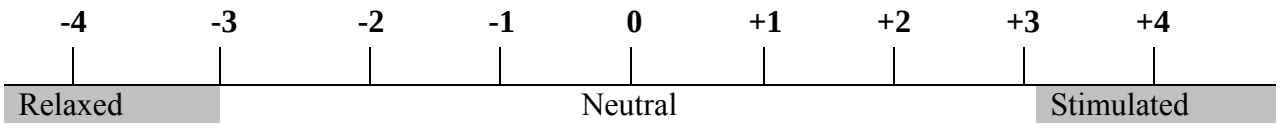
Then, participants practiced both parts of the task. They would be shown a math problem, presented a potential solution, for which they decided if the solution was true of false, and finally shown a letter after each selection. After a repetition of this sequence, participants were then shown a screen asking to recall the letters in the order they were presented. Again, participants were given feedback for the math problem and letter portion of the task. After

practicing both portions, participants were presented with the measured trials consisting of the order just described.

Participants were instructed to keep their math accuracy at or above 85% at all times; during feedback, a percentage in red was presented in the upper right-hand corner. Participants were instructed to keep a careful watch on the percentage in order to keep it above 85%. The variable is represented by a single "operation span score". Persons who have a higher operation span score have a greater working memory capacity. Essentially, persons with a higher working memory capacity can maintain and manipulate more information across a variety of situations.

Research on arousal and mood's relationship to training and training outcomes has illustrated that participants exhibiting moderate arousal and a positive affective state perform better on a number of tasks. However, there is also evidence that persons in a negative affective state will perform better on some tasks, especially those that require a more studious approach to the task (i.e., more time and effort processing specific information). In order to determine what arousal and affective state were more associated with better performance, two scales were used. The Arousal Scale served as a measure of arousal, represented by a mean of the five items in the scale. Participants indicated their response by circling the number which best described how they were feeling at that moment for each of the five items. An example is presented below.

1. I am…



The PANAS was used to measure each affective state. Positive Affect is represented by taking the mean of the 10 positive items and Negative Affect is represented by taking the mean of the

10 negative items. Participants were instructed to circle the number that best described how the adjective described their mood at that moment. An example is provided below.

The Arousal and PANAS scales are shown in entirety in Appendix D.

5 = Extremely 4 = Quite a Bit 3 = Moderately 2 = A Little 1 = Very Slightly or Not at All	**Extremely** **Quite a Bit** **Moderately** **A Little** **Very Slightly or Not at All**					
1. **ACTIVE**……		**1**	**2**	**3**	**4**	**5**

Power Hungry

The film *Power Hungry* involves a food distribution mission taking place in Afghanistan. A new Captain (CPT Young) replaces the acting CPT who exits the operation due to appendicitis. A number of obstacles present themselves that lead to ultimate mission failure, such as the new CPT being unfamiliar with the troops in the operation, a faulty command style, and poor interpersonal skills. The mission ends in failure, with an Afghan warlord seizing the food trucks.

This film was specifically chosen because it contained representations of the behavioral trap decision-making situations at the focus of this project. For instance, the film depicts an immediate scenario such that the primary character assumes the past investment is a good reason for continuing. CPT Young also gets caught in an cumulative trap, because he refuses to acknowledge that the seemingly disparate and minor events are slowly accumulating towards a

detrimental outcome. For further information on the film and its potential application as a training component, see Zbylut and Ward (2004b).

Design

Experimental schedules, located in Appendix B, give details as to the progression of the experimental sessions and approximate times for each of the components within them. Experimental schedules were adjusted slightly depending on which group it pertained to (analogical problem solving, additive counterfactual thinking, subtractive counterfactual thinking, or control). The main manipulation was the training which took one of the three forms noted above, though all were developed to engage a strategy of multiple hypothesis generation. In addition, participants in the control group did not receive any training; thus, there were four conditions and participants were randomly assigned to one of them.

There were three pre-training and five post-training behavioral trap decision making scenarios which all participants completed; participants in the control completed the five measures at the end of their experimental session. Three of the problems were the same for pre- and post-training, while two of the problems completed during post-training were novel. This allowed a test of training effects in both experienced and non-experienced decision situations.

Procedure

The experimental session for all groups lasted approximately 1 hour. In order to test any independent effects of reasoning processes, either analogical problem solving or counterfactual thinking, this initial study was composed of four groups. Participants in all groups were asked to generate hypotheses or how they thought the film might end. Participants in the control group

did not receive any training, but were asked to generate counterfactuals when the film concluded; they were not given a direction for completing counterfactual statements.

Those in the additive and subtractive counterfactual group were given two examples of counterfactual thinking scenarios and were first asked to generate counterfactuals for these examples. Subsequently, those in the additive group were asked to generate additive counterfactuals for the film and those in the subtractive group generated subtractive counterfactuals.

Participants in the analogical problem solving group were first given Duncker's Tumor/Dictator set (See Duncker, 1945) as an introduction to analogical problem solving. Second they were given an example of a filmed scenario, which incorporated both of the behavioral trap types (Immediate and Cumulative) and asked to generate potential outcomes for the film. Participants then generated potential outcomes for the Young Pilot scenario paper-pencil scenario. Finally, these participants were asked to recall that the film ended in a failed mission. They were asked to consider if anything from the Young Pilot problem could be used to generate an alternative outcome for the film that would have made the mission successful?

Power Analyses

The power analyses below were based on past research with the some of the behavioral trap measures as used in the current project as well as other training designs attempting to modify commitment scores on those measures. Methods issued in Cohen (1983) were used as to compute the power analyses. However, a power analysis is a best estimate based on best estimates. Thus, it at most gives the researcher a rough idea of how many participants to run, given the available parameter estimates. A mean change (or difference) of 10 points on the scale or 10 % was considered to be psychologically important and followed from results in previous

studies; standard deviation used was 25, based on previous results of the scale type and problems. Following Cohen's methodology, a *d* of .4 is derived, with $f = \frac{1}{2}d$; thus $f = .2$. Using Pattern 2, *f* was adjusted to .373(*d*) or .373(.4) = .15. Experimentwise alpha level was set at .05. It was assumed (given the semester time frame and the length of the experiment) that 25 participants would be randomly assigned to each of the four groups. In the first study, there were four groups; k = 4, u = k-1 or 3. Thus, expected power was set at .21. Data for Study 1 were collected until the end of the fall semester. Thus, the maximum number of participants was gathered within that time frame. However, given that only 63 participants were gathered across this time frame, power was reduced to .15. Statistical versus practical significance will be discussed more in the General Discussion.

To conduct the power analysis for the regression models numbers were adjusted. Since more variability (i.e., error from measurement) may be introduced. For the regression analysis, the effect size chosen was small ($f = .10$) given that some of the predicted variance in the criterion variables may be redundant, the relationship between predictors and criterion had not been empirically established, and measurement error could be present. Again, Cohen's methods were used to conduct the power analysis. Thus, assuming that $L = .1111(57)$ or 6.33, that $v = N-u-1$ or 100-5-1 = 94, and that alpha level was .05, the power was set to .68. Based on the actual sample size collected ($n = 63$), the adjusted power was .43.

Dependent Variables

The dependent variables were proposed to capture the training objective: Improve performance in behavioral trap situations via utilization of an implicit strategy that increased the consideration of alternatives. Mayer (2001) proposed, at least, three measures that would allow an assessment of learning from a multimedia format: retention, matching, and transfer. The

retention and matching assess whether or not participants can remember certain elements from the scenario. One of this project's foci was on assessing the use of training in similar and dissimilar situations. The transfer measures were assessments of whether participants could apply previously learned information to a new situation. This project had both "near" (similar situation) and "far" (novel situation) transfer problems. Robins and Mayer (1993) noted that including near and far scenarios would be necessary to capture learning. Although using the film in this project did not involve teaching a mechanistic procedure as with much of Mayer's work, it did make use of a filmed example. Thus, whether participants could use the strategy in novel and dissimilar contexts could be accurately tested.

Thus, participants responded to two similar and two dissimilar situations. The similar situations maintained both superficial similarities with the primary example (similar background, i.e., military setting) as well as the relational components (i.e., effect of trap options affecting current decisions). The dissimilar situations differed superficially (i.e., different background, non-military setting), but maintained similar relational components. Partly as a check if training was truly effective, an opportunity cost problem was used. This scenario appeared to be similar superficially, but required the participant to perform the opposite mapping of relational components or utilize them in a different manner in order to derive the solution (i.e., where past investments should be paid attention and further investment would be rationally based on those). All behavioral trap measures used in this project are shown in the Appendix A.

Dependent Variables: Scoring

The dependent variable for behavioral trap decision making in each assessment was represented as a "commitment score" between 0-100 using a visual analog scale anchored on either end by available options (See Appendix A). Further, all hypotheses related to commitment

score involve a postulation that a 10-point change (or 10 % of the scale) is an important psychological change, based on previous research (Vowels, 2006; Vowels & Pientka, under review).

The psychological measure or dependent variable for this study was commitment score as indicated on the scale provided with each behavioral trap problem. All scales were scored in such a way that lower commitment scores were indicative of more commitment towards the *non*-trap option and higher commitment towards the trap option. Participants were given three pre- and five post-measures of behavioral trap problems. Thus, three of these problems could be analyzed for change from pre-training exposure to post-training. Change scores allowed the determination of whether or not participants shifted their commitment scores on given scenarios. The extra two post-training problems were considered novel (transfer problems), since participants had not seen them before and these allowed an independent measure of any transfer of learning.

In order to accurately assess where participants indicated responses from pre- to post-test, their original scores were recalculated from a common point; the scale used measured 100 points and, thus, the 50 point mark was used as a common point for all participants. This recalculation allowed participants to be assessed by which option (non-trap or trap) they were showing more commitment for both before and after training (ie, whether participants were on the lower half or upper half of the scale). This is a rudimentary, yet important point in terms of measurement. For instance, on pre-assessment measurement (and post) a participant indicating a lower score on the scale is not exhibiting the same option commitment as a participant indicating a higher score. Since there were only two options, this allowed a measurable division between participants.

To determine whether training was having an effect and to accurately capture participant's responses three response elements had to be assessed: (1) where were participants responding on the scale (2) how much did they move, and (3) did their scores shift up or down (towards or away from the trap option); the third element was used as a covariate in some of the analysis to determine effect of training. Calculating the covariate allows a test of the interaction between Thus, allowing an independent comparison of whether persons who were increasing or decreasing in commitment score differed in the magnitude of their commitment score. Without the covariate, a repeated measures analysis grants only a comparison of the difference on the dependent measure for the between subjects variable. In these scenarios, commitment towards (or away from) the trap option was a key component in determining if training was effective.

Hypothesis generation was scored as the number of relevant hypotheses for the film. The dependent variable for counterfactual generation was represented as the number of relevant counterfactuals generated. Analogical generation was measured as the number of analogs between the Young Pilot example (source) and the film (target). Hypothesis generation, analogical generation, and counterfactual generation activities were scored by the author at two points in time. In the coding schemes the responses were scored in a dichotomous Yes/No manner. Either the response fit into the specific coding category or it did not; thus, the *phi coefficient (φ)* was used to compute reliability. Computed reliabilities for each generation activity were, hypothesis generation $\varphi = .79$, analogical generation, $\varphi = .76$, and counterfactual generation, $\varphi = .82$. I resolved any discrepancies in the coding by making a final sort of the discrepant cases. If I could not resolve the difference in coding, the responses were dropped.

Analysis: Basic Screening

For the individual differences measures, reliabilities were computed and reported for each measure as well as the correlation coefficient between measures. For the Between-subjects analysis, Levene's test for homogeneity of variance was used to ensure that variance across groups was not significant; if significant variance between comparison groups was found, other forms of ANOVA (i.e., Welch's *F* and Dunnet's *t* for post-hoc comparisons) were used to help control for this heterogeneity of variance. Any violations of homogeneity of variance and use of specific corrective tests are noted, otherwise assume standard ANOVAs were used.

For the regression analyses, in order to check for violations of the general linear model, missing values were examined and checked for distribution throughout the sample. When necessary, missing values were replaced by another value (i.e., using a regression model to replace the data point). In only a couple cases, participants had not filled out a scale item; the missing item was replaced with the value obtained from the regression model. Skewness and kurtosis were examined for violations of normality. There were not violations of normality in this data set. Box plots were also used to check for significant outliers.

For the regression analyses, in order to check for multivariate outliers, Cook's distance was used to detect outliers prior to conducting the analyses, with the intent that outliers discovered using this method would not be used in the formal analysis. None of Cook's values were greater than 1, thus all cases were included in the analyses. Though in some instances, if Cook's distance value was markedly higher, the analyses were re-run, without the cases(s). In all situations, where this occurred, the results did not change; thus, all cases were included in the full analyses.

Examination of scatterplot matrices, residual scatterplots, and normal-probability plots were used to check for violations of multivariate linearity, normality, and homoscedasticity. All appeared to exhibit normality. As a further check, the variance inflation factor (VIF) was checked and the means, across almost all such analyses, were less than one indicating a lack of multicollinearity. No data transformations were needed. Violations of normality and multicollinearity were checked for each regression analysis. Any violations are noted at the specific analysis, otherwise no violations can be assumed.

Results

Initially, overall differences between groups were assessed for the initial three common problems using commitment score as the dependent variable. There were no significant overall differences between groups on the initial commitment scores of these common problems; this was a check to make sure pre-existing differences between groups would not bias further analyses.

Next, to test the effect of training experimental group and whether scale shift (decrease or increase) interacted with change in commitment score, experimental group was used as the independent variable, and scale shift in commitment score (increase or decrease) was used as a covariate with commitment score serving as the dependent variable. Repeated-measures ANCOVAs indicate that, there was a significant change in Ski Trip commitment score F (1,58) = 6.92, $p < .01$, *partial* $\eta^2 = .11$ and a significant interaction between scale shift and commitment score F (1,58) = 19.19, $p < .001$, *partial* $\eta^2 = .25$, but not a significant interaction between commitment score and experimental group F (3,58) = 1.22, $p = .312$, (Refer to Figure 5.1 for comparison). There was no main effect of scale shift F (1,58) = 1.41, $p = .24$, nor a main effect of experimental group F (3,58) = .44, $p = .73$.

Likewise, there was not a significant difference in the number of persons who exhibited increase or decrease in their commitment scores across the groups, χ^2 (3, N = 63) = 3.85, $p > .05$ (Refer to Figure 5.2 for comparison).

Repeated-measures ANCOVAs indicate that, there was a significant change in CEO commitment score F (1,58) = 10.56, $p < .01$, *partial* η^2 = .16 and a significant interaction between scale shift and commitment score F (1,58) = 42.01, $p < .001$, *partial* η^2 = .42, but not a significant interaction between commitment score and experimental group F (3,58) = 1.08, p = .366. There was no main effect of scale shift F (1,57) = .70, p = .40, nor a main effect of experimental group F (3,57) = 2.60, p = .06.

Given the large mean differences between experimental groups on the CEO problem, further analyses were conducted. Fisher's Least Significant Difference test, revealed that there were significant mean differences between Analogy and CF Additive and Analogy and Control, with the Analogy group having a significantly lower mean score than either CF Additive or Control. There was not a significant overall difference in the number of persons who exhibited increase or decrease in their commitment scores across the groups, χ^2 (3, N = 63) = 3.42, $p > .05$; though, the majority of persons (n = 11) in the Analogy group showed an increase in scores compared to those who decreased (n = 3).

Repeated-measures ANCOVAs indicate that, there was a significant change in Planet commitment score F (1,58) = 12.78, $p < .001$, *partial* η^2 = .18, and a significant interaction between scale shift and commitment score F (1,58) = 30.50 $p < .0001$, *partial* η^2 = .35, but not a significant interaction between commitment score and experimental group F (3,58) = .593, p = .622. There was no main effect of scale shift F (1,56) = .76, p = .39, nor a main effect of experimental group F (3,56) = .09, p = .97.

Likewise, there was not a significant difference in the number of persons who exhibited increase or decrease in their commitment scores across the groups, $\chi^2 (3, N = 63) = 4.39, p > .05$.

Although many of the training comparison results were not significant, trends in the data revealed that the overall intended effect was accomplished as illustrated in figures 5.3 and 5.4. Recall the goal of the training was to decrease commitment score, which is an indication of commitment shift towards the non-trap or more rational option. Both of these graphs illustrate an overall decrease across the three problems completed both pre- and post-training as well as across training groups. For the means and standard deviations across all problems used in Study 1 refer to Tables 5.2 and 5.3 below.

Figure 5.1 Study 1: Comparison of Mean Scale Shift in Commitment Score

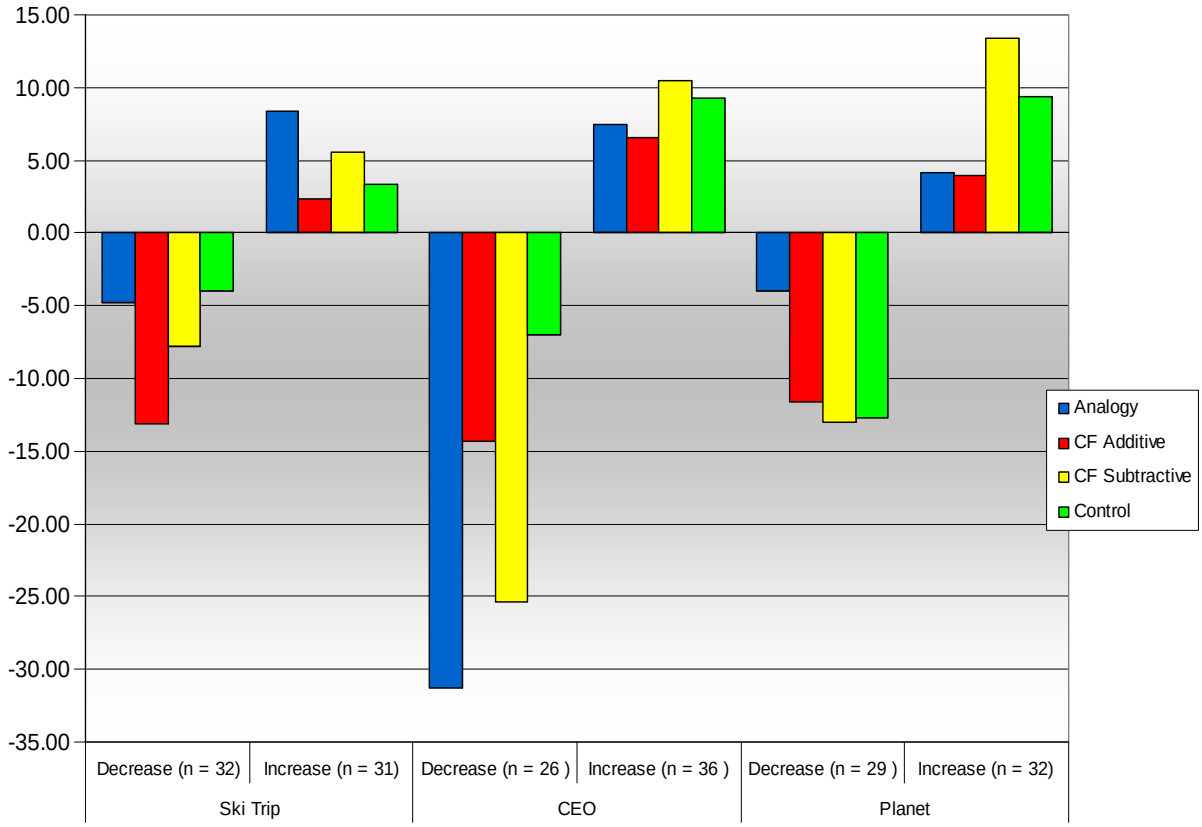
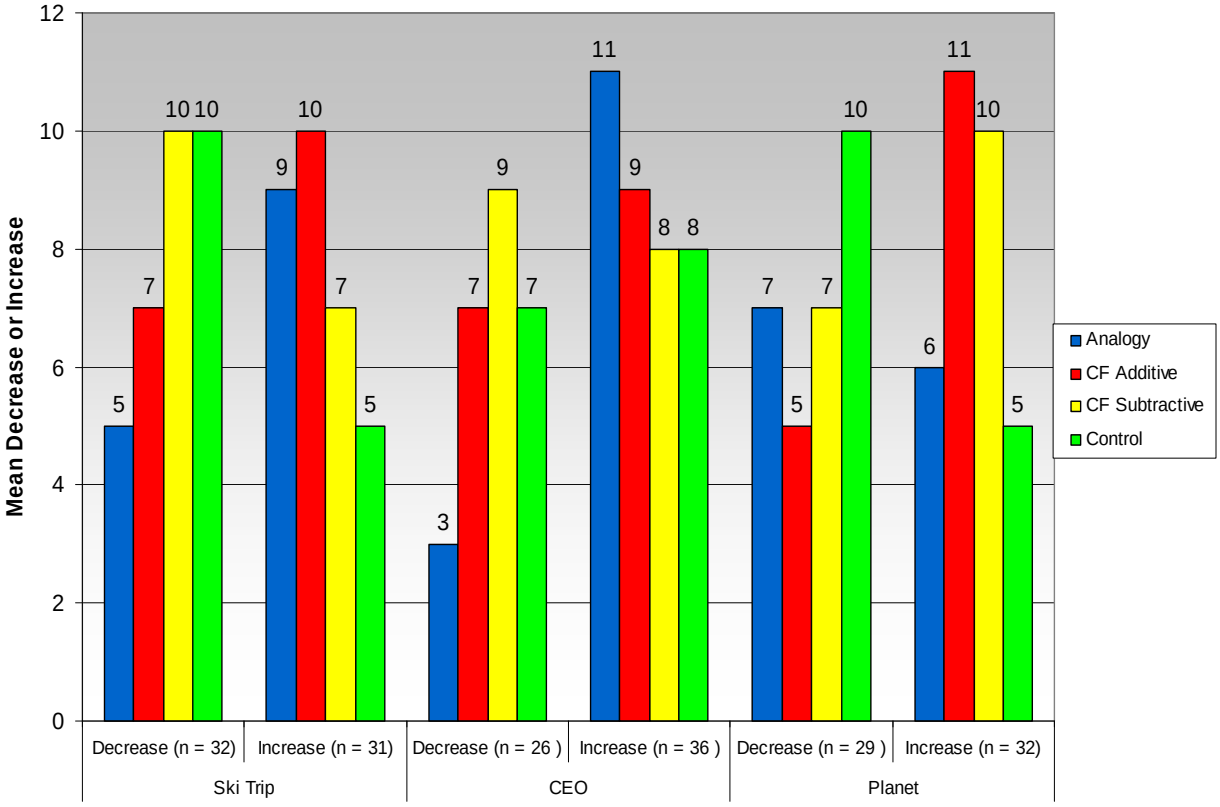


Figure 5.2 Study 1: Frequency of Increase or Decrease in Commitment Score



The control group engaged in counterfactual thinking after the film, but was not directed to engage in additive or subtractive. Using commitment score changes as the primary dependent variable and whether scores increased or decreased as a covariate, separate ANCOVAs were run to test any differences between the three groups. Results indicate that, there were not statistically significant results between control and either counterfactual training groups on any the three common problems, Ski Trip, F (2,43) = .194, p = .825, CEO, F (2,42) = .136, p = .874, Planet, F (2,42) = 1.20, p = .310.

Figure 5.3 Overall Decrease in Commitment Score Across Three Common Scenarios.

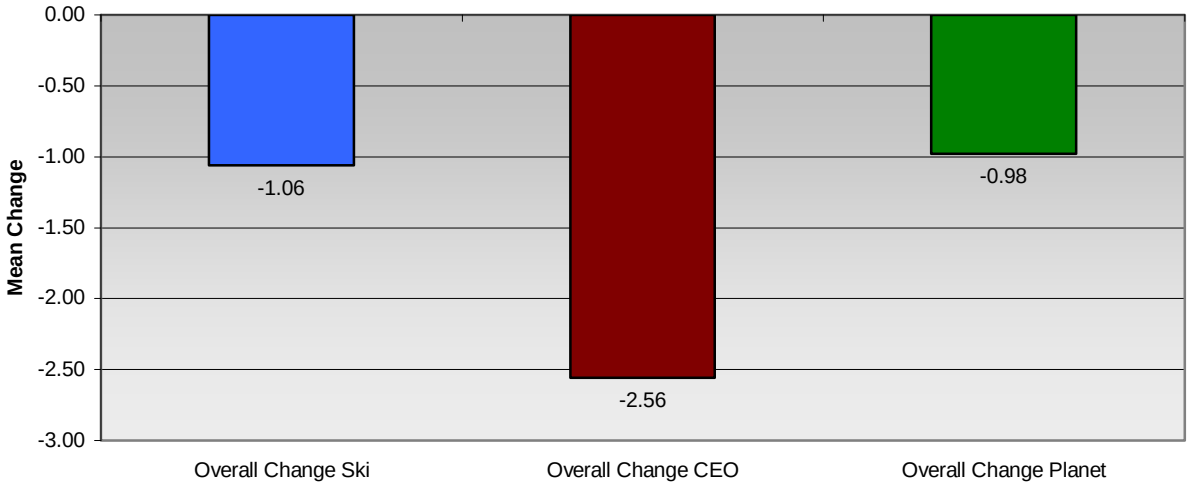
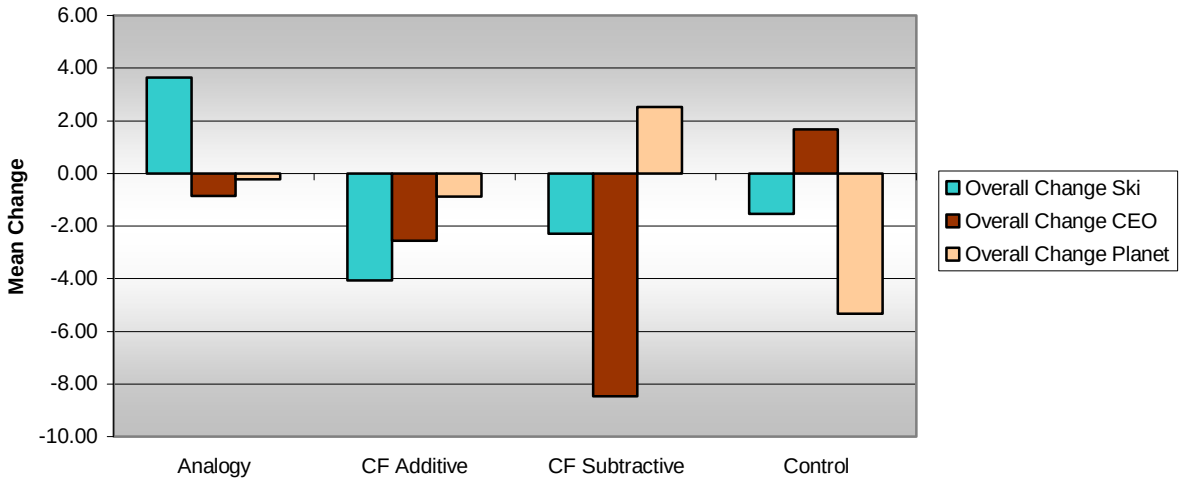


Figure 5.4 Overall Decrease Trend By Group Across Three Common Scenarios.



Transfer Problems

There were no significant differences between training groups on either of the two transfer of learning: Pizza problem (Far Type) F (3,59) = 1.16, p = .33, Strategy Problem, (Near

Type), $F(3,59) = 2.59$, $p = .06$. On the Strategy problem, participants in the CF Subtractive training group had a mean commitment score 16-24 points higher than the other three training groups; a higher commitment score indicated a higher commitment for the sunk cost option. Fisher's Least Significant Difference test, revealed that there were significant mean differences between the Control and CF Subtractive groups and between the CF Additive and CF Subtractive.

Table 5.1 Means and Standard Deviations Across Three Common Scenarios.

Scenario	Ski Trip		Ski Trip 2*		CEO		CEO 2*		Planet		Planet 2*	
Training Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Analogy	45.21	*39.17*	48.86	*38.49*	60.36	*25.90*	59.50	*28.83*	39.62	*26.96*	39.38	*28.50*
CF Additive	44.88	*35.21*	40.82	*36.57*	78.25	*16.79*	75.69	*21.76*	39.13	*23.52*	38.25	*25.13*
CF Subtractive	41.76	*29.86*	39.47	*30.54*	70.71	*22.03*	62.24	*26.51*	34.47	*24.02*	37.00	*27.43*
Control	52.87	*33.52*	51.33	*33.35*	75.07	*16.97*	76.73	*18.35*	38.87	*22.97*	33.53	*21.17*

*These represent the post-training results.

Table 5.2 Means and Standard Deviations Across Two Transfer Problems.

	Pizza		Strategy	
	M	*SD*	*M*	*SD*
Analogy	64.43	*18.18*	38.07	*29.35*
CF Additive	51.53	*23.33*	29.82	*24.66*
CF Subtractive	54.35	*18.49*	54.29	*32.29*
Control	59.13	*21.51*	33.20	*22.96*

Scales

The Need for Cognitive Closure (NCC) was shown to be reliable (α = .81), *M* = 148.32, *SD* = 15.99. Pre-arousal (α = .85), *M* = .59, *SD* = 1.65, pre-positive affect (α = .84), *M* = 3.12, *SD* = .64 and negative affect scales (α = .79), *M* = 1.52, *SD* = .456 were shown to be reliable as were post-arousal (α = .84), *M* = .08, *SD* = 1.29 and post-positive affect (α = .87), *M* = 2.64, *SD* = .76 and negative affect scales (α = .85), *M* = 1.46, *SD* = .52. The working memory task yielded a Mean Ospan score of 24.87, *SD* = 13.29.

Assessment of Individual differences variables

There were only a few significant correlations between these scales and commitment score and graphical analysis revealed no discernible pattern. Neither gender nor class total were significant predictors on any regression analyses using commitment score as the outcome variable. There was a significant correlation between NCC and commitment score on the near transfer problem (Strategy), r (63) = .33, p = .008 and between NCC Close-Mindedness and Ski Trip commitment score, r (63) = -.27, p = .031.

To assess if hypothesis generation, analogical generation, and counterfactual generation pertaining to the film were related to, and subsequently to commitment score, correlation and regression analyses were conducted. Correlation analyses revealed that hypothesis generation was significantly correlated with counterfactual generation, r (49) = .44, p = .001. Subsequent regression analyses revealed that neither hypothesis generation nor counterfactual generation significantly predicted commitment score on any of the problems. However, given the significant correlation, between these predictors, the regression analyses suffered from multicollinearity, revealing VIFs above 1. The theoretical contention was that these variables would be correlated and, for statistical purposes, no other variable could replace either in the regression models.

Analogical problem solving generation was not correlated with hypothesis generation, r (14) = .40, p = .15; note, there were only 14 participants in the analogical problem solving group. Since the subsequent regression analyses only included 14 participants, the analyses were suspect. Likewise, these analyses did not reveal that analogical problem solving generation nor counterfactual generation were predictive of commitment score.

It was proposed that NCC would moderate the relationship between and WMC and hypothesis generation. Using the cautionary note by Baron and Kenny (1986) to use regression coefficients rather than correlation coefficients, Cohen and Cohen (1983) were consulted to test the difference between regression coefficients, before testing slopes independently. The resulting t-test revealed, $t(29) = 1.08$, $p > .05$. However, the moderator analysis, revealed that NCC did not significantly moderate the WMC-hypothesis generation relationship.

Further, a regression analysis revealed, that NCC was the only significant predictor of commitment score change and only in two of the five comparisons. For Ski Trip, the regression

model achieved significance, $R^2 = .16$, $F(5, 43) = 3.32$, $p < .01$; NCC significantly predicted commitment score, $\beta = -.25$, $t(61) = -2.01$, $p < .05$ and for the Strategy problem, $R^2 = .16$, $F(5, 43) = 3.32$, $p < .01$; NCC significantly predicted commitment score $\beta = .34$, $t(61) = 2.76$, $p < .01$. A chi-square analysis revealed that there was a significant difference in the number of participants scoring Low or High on NCC and whether they increased or decreased commitment score on the Planet problem, $\chi^2 (1, N = 31) = 9.31$, $p < .01$; persons scoring low on NCC were more likely to show a decrease in commitment score, while persons scoring high on NCC were more likely to show an increase in commitment score (Refer to Table 5.1).

Table 5.3 Comparison of Persons Low and High on NCC for the Planet Problem.

	NCC		
	Low	High	Total
Decrease	11	4	15
Increase	3	13	16
Total	14	17	31

To explore whether NCC would act as a covariate between training group and commitment score, repeated measures analyses were conducted on the three common problems and ANCOVAs were conducted on the two transfer problems. None of the repeated-measures ANOVAs revealed statistically significant differences. The ANCOVA for the Strategy problem revealed that there was a main effect of training group, $F(3,25) = 5.69$, $p < .01$, *partial* $\eta^2 = .41$ and a main effect of the NCC covariate $F(1,25) = 7.20$, $p < .01$, *partial* $\eta^2 = .22$, but not a significant interaction, $F(3,25) = 1.49$, $p = .24$.

Correlation analysis revealed, the first and second measures of arousal were not correlated, but the first and second measures of negative affect, r (61) = .28, p = .03; and the first and second measure of positive affect were related to each other r (61) = .66, p < .001. However, none of the regression analyses using arousal and mood as predictors revealed significant regression models when using commitment score as the outcome or dependent variable.

Discussion

According to the statistical analyses from Study 1 it could be argued that the training was not very effective in terms of shifting commitment scores towards the non-trap option. However, consider that the hypotheses were based on a change in commitment score of 10 points or 10 percent of a given scale. There were several instances of a difference of 10 points or greater between groups (Refer to Figure 5.1).

Results from this study partially supported Reber and Allen's contention that intelligence may not always be related to performance. Working memory capacity did not predict performance on behavioral trap decision problems. Though the measure was developed to be a general measure of WMC (to obtain information about both language and mathematical skill), it did not relate to task performance. This, likewise, contradicts work by Stanovich (2001) who also argued that measures of intelligence are important for predicting behavioral performance, including a form of behavioral traps, sunk cost traps. Further evidence is provided below as to what appear to be better predictors of behavioral trap decision making behavior.

Before discussing information processing disposition, differences in training group will be discussed as related to the hypotheses given earlier. Ross proposed a principle-cuing view which includes the idea that a learned strategy, as a result of engaging in analogical problem

solving or drawing relations between situations, can be applied to both similar and dissimilar situations. The purpose of the training was to decrease commitment scores or shift persons away from the trap options. In one of the five scenarios (a near or similar scenario), the analogy group had the largest decrease in commitment score; the decrease was over 30 points, well beyond the expected 10-point difference. The same was not necessarily true for the transfer problems, though the Analogy group did have a mean commitment score below the mid-point of the scale on the near or similar transfer problem. These results appear to provide evidence for Ross' example-analogy view in this context. Thus, the training was effective only for problems similar to the primary example (the film).

Likewise, attempting to relate or map elements between two situations is argued to be a form of hypothesis generation and engaging in this would shift commitment scores towards the non-trap options. One of the main reasons that behavioral traps have such an effect on decision making is the lack of consideration of alternatives. However, the training on analogical problem solving was only partially effective as persons in this (and the other training groups) exhibited both the projected decreases, but also increases in commitment score. Thus, this form of multiple hypothesis generation may not have been sufficient to create change in behavior trap decision making.

In a fourth hypothesis, I argued that subtractive counterfactual thinking forces an individual to be past looking, while engaging in additive counterfactual thinking engages a forward-looking perspective. Thus, subtractive counterfactual thinking would be most beneficial for Immediate problems or past-attending, while additive would be most beneficial for Cumulative or past-ignoring. Though the results were not consistent across the five behavioral trap problems, one result provides partial evidence for this hypothesis. On the Strategy problem

(a cumulative problem), the subtractive counterfactual group had a higher mean than all other groups; the additive counterfactual group, likewise, had the lowest mean commitment score of all groups. This situation involved a hypothetical situation where the participant was asked to provide support or against whether military troops should be withdrawn or increased in an on-going military campaign. This situation may have been particularly personal for participants given two actual on-going military campaigns by our government covered daily by our media (in all forms). Likewise, a near-by military installation would also increase the chances that students knew or had contact with military personnel on a frequent basis. These factors may have made the problem itself more salient to participants and, thus, enhance the effectiveness of the training; participants may have been more motivated in the actual outcomes and transferred this motivational level to the problem.

The three forms of hypothesis generation (the pre-training generation, analogical generation, and counterfactual generation) were expected to independently predict changes in commitment score. However, results revealed that none of the forms correlated with each other, nor were any predictive of commitment score. This could have resulted because each form was specifically related to the primary filmed example, rather than being a general measure of hypothesis generation. Likewise, the behavioral trap problems, though some were similar to that of the training context, were not directly related to the film.

Demographics such as gender and number of related classes taken, nor arousal and mood were predictive of changes in commitment scores. As noted earlier WMC was not predictive of commitment scores either, nor did WMC inform the relationship between hypothesis generation and commitment score.

Need for Cognitive Closure was the one individual differences variable that was predictive of change in commitment scores on a number of problems though it did not moderate the relationship between WMC and hypothesis generation; this is mainly due to the fact that WMC was not related to any of the forms of hypothesis generation as discussed earlier. On two of the behavioral trap problems, NCC significantly predicted commitment score on two and was also shown to be related to persons who increased or decreased commitment score on a third.

On the Ski Trip problem (an Immediate problem), an increase on NCC led to a decrease in commitment score which is contrary to what was predicted. The developers of the NCC scale postulated that as persons increase on the NCC, they are less likely to engage in extended information processing, especially when a hypothesis has been formed concerning a problem solution. However, the Ski Trip problem involves a decision between ski trip destinations which this sample may have some personal familiarity with (Colorado and/or Wyoming). Thus, participants were more likely to exhibit a decrease in commitment score, despite level of NCC.

Both problems where persons who scored high on NCC and also had higher commitment score were cumulative problems. On cumulative problems, the likelihood of ignoring past costs is greater than on Immediate problems. Persons scoring higher on NCC exhibit an information processing tendency of processing less information on a given problem, once they feel a solution has been derived (even when the incorrect or less optimal solution). The Planet problem is similar to the Strategy problem (described above) in that participant may have an established opinion on the matter, prior to the experiment. The problem involves deciding whether or not to financially sanction countries who are known to produce large amounts of pollution, which may be leading to global warming. Since this represents a major contemporary, worldwide issue, some participants may already have a personally-defined position on the matter. If so, it would

follow that persons scoring higher on NCC would show an increase in commitment, while persons scoring lower on NCC would exhibit a decrease; persons low on NCC would be less likely to have a pre-defined position.

Subsequent analysis examining potential interactions with training group and NCC revealed that NCC did not serve as a significant covariate on any of the common problems. NCC was a significant covariate on the Strategy problem, however did not significantly interact with training group. These analyses may have suffered from a reduced sample size, given that not all participants scored low or high on the NCC scale.

Nevertheless, trends in the data did not reveal that persons scoring high on NCC benefited the most from additive counterfactual thinking or analogical problem solving, nor did persons scoring low on NCC exhibit a marked difference in commitment score from persons scoring high on NCC. Given that the training was disparately effective, it is also possible that the training was not effective enough to shift persons away from trap options, regardless of level of NCC demonstrated.

A change in design that was proposed to provide further insight into the above relationships was the combination of both reasoning processes into the same training format. Thus, participants would be exposed to both forms of multiple hypothesis generation in order to integrate the potential effects that each form possessed alone. This was further explored in Study 2.

But, what do the results of Study 1 reveal about implicit learning? Participants engaged in tasks with explicit instructions for one of the two primary exercises, analogical problem solving or counterfactual thinking. However, none were told the purpose was to train an underlying implicit reasoning strategy and, when asked, none articulated that they were learning

an implicit strategy. Implicit learning is postulated to occur without knowledge of it occurring or without being able to verbalize it has taken place. Thus, participants' qualitative responses to what the experiment was about is, at least, descriptive evidence that implicit learning occurred.

I argued earlier that the acquisition of the implicit strategy would be directly exhibited by a change in commitment score, specifically a decrease (as problems were scored such that lower scores were closer to the non-trap option). The illustration of the implicit strategy appears to be tied to the problem as results were disparate across the various problems used. For instance, although fewer participants indicated a decrease (than increase) on the CEO problem, the decrease was much greater across three of the four groups then the increase.

The occurrence of the effect can depend directly upon the metric used to measure it. I believe I have illustrated a metric that captures more of the natural variability participants depict when given the chance; a forced-choice response format misses this. Further, if choices are degrees of commitment, then, as shown here, we would expect to see large variation in the data. Although this is not a conclusive argument, it does illustrate the importance of the metric used to capture behavior in decision environments involving traps.

The hypothesis generation measure was related to a specific example. Some measures of hypothesis generation are more general in nature. Thus, it is possible that the hypothesis generation measure used in this study did not fully capture this ability and the reason it was not significantly related to other variables nor predictive of commitment score.

To expand on the original idea to teach an implicit reasoning strategy, in two of the groups for Study 2, analogical problem solving and counterfactual thinking were combined. Thus, an examination of whether or not the combination of these reasoning processes would be more beneficial than when applied independently, was a primary focus of Study 2.

CHAPTER 6 – Study 2, Spring 2008

Personal Communications

Contemporary researchers who have conducted work involving behavioral traps and individual differences were contacted to gauge what instruments, constructs, and predictors might prove useful for the project. Particularly, these researchers were asked for instruments that could be administered within the timeframe of the experimental session window and serve as potential predictors of performance on behavioral trap decision-making problems. Hal Arkes, Keith Stanovich, and Wandi Bruine de Bruin were contacted on January 15th, 2008 and asked to provide advice and suggestions. Each reply is given in turn. Hal Arkes pointed to Stanovich as possessing a measure that might allow prediction of individual performance (based on intelligence). Bruin cited her recent involving Decision Making Style scale, which was a developed tool with good reliability and validity. Since working memory capacity (a correlate of intelligence) did not predict performance in Study 1 and the need for cognitive closure was indicated as a predictor of behavioral trap decision making, it was postulated that individual differences related to information processing disposition and individual style of decision making rather than other correlates with intelligence would be an important predictor in this continued work.

Hypotheses

Similar hypotheses as tested in Study 1 were again tested in the second study with some modifications. Additional hypotheses are also noted below, since the experimental protocol was modified to capitalize on the potential reasoning exercise effects.

Training

Analogical Problem Solving and Counterfactual Thinking

In analogical problem solving, one attempts to establish a relational structure between seemingly disparate items by engaging in hypothesis generation and testing. If the analogy is salient (and functional), it will likely be generated again during memory search and retrieval in future situations. However, the resultant mapping of an analogical process may not always be equally functional across all situations and, thus, the established pattern across comparative situations needs a direct challenge. I argue that a counterfactual thinking process would be a direct and natural form of reasoning to engage in to discover a more accurate model of the world. Thus, where analogical problem solving is efficient at establishing relational structure between situations, counterfactual thinking is efficient at directly testing potential alternative outcomes.

In the first study, these different forms of hypothesis generation were tested separately to determine if either was individually a more effective reasoning process to engage in as measured by change in commitment score. In the second study, the potential effectiveness of the interaction of analogical problem solving and counterfactual thinking was tested. Both processes are postulated to foster learning by engaging a process of considering multiple alternatives. It is predicted, if these processes can build upon each other, then they could enhance the effective consideration of alternatives.

In Study 2, participants were randomly assigned to the analogical problem solving and additive counterfactual thinking (APS_CFadd), analogical problem solving and subtractive counterfactual thinking (APS_CFsub), or the control group (no training). Given that engaging in subtractive counterfactual thinking has been associated with assisting in solving analogical problems, the following hypothesis is given:

Hypothesis 1: Although subtractive counterfactual thinking may be past looking, it may be more beneficial for behavioral trap decision making when coupled with analogical problem solving. Thus, the in the second study the group receiving analogical problem solving and subtractive counterfactual thinking as part of the same training protocol, will show a lower mean commitment score on the cumulative problems than the group receiving analogical problem solving and additive counterfactual thinking.

Scales

Both the Need for Cognitive Closure and Decision Making Style were included in Study 2. Again, it was postulated that persons scoring higher on NCC would also exhibit higher commitment scores.

Decision Making Style

This individual differences measure was added to the second study. Recent work suggests that the Decision Making Style scale is both reliable and valid for predicting decision making, specifically behavior on problems involving past investments; see Scott & Bruce (1985) for reliability and validity analyses of the instrument. The Decision Making Style scale is composed of five subscales representing various decision styles necessary to capture individual decision style characteristic: Rational, Intuitive, Dependent, Avoidant, and Spontaneity.

The inclusion of this scale was deemed appropriate being based on the idea that people utilize different styles of reasoning when making decisions. Two important elements which Driver (1979) illustrated were the differences in: the amount of information considered and the number of alternatives recognized as a result of the integration of information. These two

components of Driver's model are particularly relevant for this project, because behavioral trap decision environments typically take advantage of intuitive responses. In other words, persons typically assume that the trap option is the 'right' answer. Likewise, given the intuitive reflex of these decisions, the amount of information considered is often limited to only a characteristic of the available options (ie, the amount of investment of time, money, and/or personal commitment) and, thus, alternatives are rarely considered.

Decision Making Style was developed to measure different approaches persons might take to make decisions. The scale is composed of five subscales, representing various decision styles: Rational, Intuitive, Dependent, Avoidant, and Spontaneity. It is commonly argued that persons typically act irrationally and rely on an intuitive response system when making decisions involving behavioral traps, doing so in a spontaneous manner. Likewise, persons who are dependent on others may not fully process the necessary information in a decision trap environment as is true for persons who have a tendency to avoid making decisions. Thus, responses from these subscales will be related to behavioral trap decision making as follows.

Hypothesis 2: Higher scores on the Rational subscale will predict lower commitment scores, while higher scores on the Intuitive, Dependent, Avoidant, and Spontaneity subscale will predict higher commitment scores.

The same coding scheme and method as used in Study 1 was used to code hypothesis generation, analogical generation, and counterfactual generation in Study 2. Again these responses were scored by the author at two points in time. Computed reliabilities for each generation activity were, hypothesis generation $\varphi = .74$, analogical generation, $\varphi = .71$, and

counterfactual generation, $\varphi = .73$. Again, discrepancies were resolved by making a final sort of the discrepant cases.

Method

The variables and methodology used in Study 2 were the same as used in Study 1, except for the changes listed below. Likewise, the experimental groups were adjusted in order to capitalize on the potential effects of both reasoning processes.

There was no assumption of an effect of order of training phase. Although this could be argued to be a limitation of the current project, the order of training was selected based on the idea of training a specific strategy. Analogical training was issued first to establish a base of broader relational examples to be utilized later. The counterfactual thinking component was issued second, because it is proposed to solidify the adaptive strategy by providing a specific counter-reasoning exercise. The counterfactual exercise could only benefit the broader relational schema, established by the analogical training, if it is produced second in the order. All participants in the experimental groups received training on analogical problem solving and then counterfactual thinking in that order. A third group of participants, that received no training, served as the control group.

Participants

The participants were drawn from the general psychology population ($N = 74$). Participants were run in small groups with no more than five participants per session and I was present to answer any questions during the experiment, to ensure that participants had a clear understanding of what each task required of them.

There were 53 females and 21 males with an overall mean age of 19.27 (*SD* = 2.00); sixty-five (87.8%) were ages 18-20. Sixty-four (87.7%) of the sample was either Freshman or Sophomore. Fifty-four participants (73.0%) had taken one or fewer classes in accounting, business, economics, or marketing, indicating that most participants were not likely to have had formal instruction on behavioral traps or how to deal with them.

Procedure and Power Analyses

In order to test effects of combined training involving analogical problem solving coupled with additive or subtractive counterfactual thinking, this second study was composed of three groups. Refer to the Experimental Schedule for Study for an idea of the entire procedure used in the experiment. Participants in all groups were asked to generate hypotheses or how they thought the film might end. Participants in the control group did not receive any training, but were asked to generate counterfactuals when the film concluded. The procedure was the same as that used in Study 1, except participants in the experimental groups received training on both analogical problem solving and counterfactual thinking.

Other than the above modification of combining training on both reasoning processes, the exclusion of the WMC task, and the inclusion of the Decision Making Style scale, the protocol was the same as used in Study 1. Since effects of training did not create mean differences between training groups, except in a few analyses, beyond what was predicted by Study 1 (a mean difference of 10 scale points), the power analyses were the same, adjusting from four to three groups.

For the mean difference analysis, the groups were reduced to 3, thus, $u = 2$ and total sample size collected was 74 or, at least, 24 per group. Thus, power for ANOV analysis was set

at .18. For the regression analysis, similar terms were used as in Study 1, except, v = 74-5-1 = 69, L = 7.55, alpha level was .05, the power was set to .56.

Scales

Scales used were shown to be reliable across administrations: Need for Cognitive Closure (α = .81), M = 140.82, SD = 16.11, DMS (α = .74), M = 3.18, SD = .37, first-arousal (α = .73), M = -.33, SD = 1.26, first-positive affect (α = .90), M = 1.39, SD = .45, and first-negative affect scales (α = .84), M = 2.87, SD = .82, second-arousal (α = .81), M = -.10, SD = 1.28 and second-positive affect (α = .89), M = 2.69, SD = .77 and second-negative affect scales (α = .78), M = 1.28, SD = .33, third-arousal (α = .90), M = .01, SD = 1.54 and third-positive affect (α = .93), M = 2.47, SD = .88 and third-negative affect scales (α = .75), M = 1.40, SD = .43, fourth-arousal (α = .91), M = -.05, SD = 1.54 and fourth-positive affect (α = .92), M = 2.33, SD = .81 and fourth-negative affect scales (α = .70), M = 1.36, SD = .40.

Results

Initially, overall differences between groups were assessed for the initial three common problems using commitment score as the dependent variable. There were no significant overall differences between groups on the initial commitment scores of these common problems; this was a check to make sure pre-existing differences between groups would not bias further analyses.

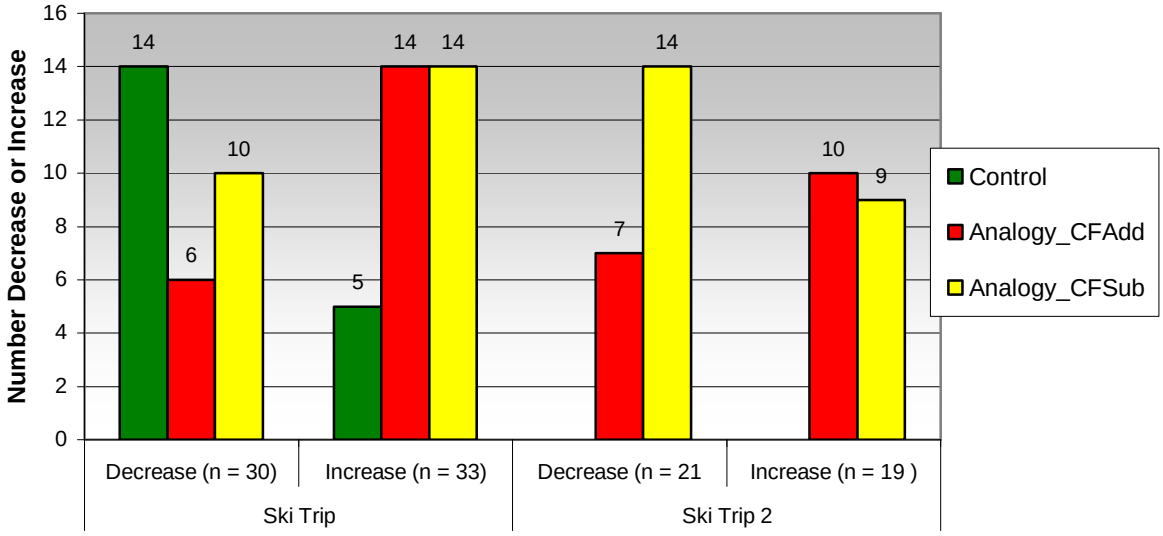
Next, to test the effect of training experimental group and whether change in scale shift interacted with change in commitment score, experimental group was used as the independent variable, and scale shift in commitment score (increase or decrease) was used as a covariate with commitment score serving as the dependent variable.

The following analyses were conducted such that the first repeated measures analysis for each problem assesses the change from initial problem to any change after training on analogical problem solving and the second analysis assesses any change in responses from after analogical problem solving to responses after counterfactual thinking.

Repeated-measures ANCOVAs indicate that, there was a significant change in Ski Trip 1 commitment score F (1,59) = 28.63, $p < .001$, *partial* $\eta^2 = .33$ and a significant interaction between scale shift and commitment score F (1,59) = 36.01, $p < .001$, *partial* $\eta^2 = .38$, but not a significant interaction between commitment score and experimental group F (2,59) = .827, $p = .442$. There was a main effect of scale shift F (1,59) = 5.43, $p < .05$, *partial* $\eta^2 = .08$, but not a main effect of experimental group F (2,59) = .053, $p = .95$.

There was a significant difference in the number of persons who exhibited increase or decrease in their commitment scores across the groups, χ^2 (2, $N = 63$) = 8.01, $p < .05$ (Refer to Figure 6.1 for comparison).

Figure 6.1. Decrease and Increase Frequency in Commitment Score on Ski Trip Scenario.



Repeated-measures ANCOVAs indicate that, there was a significant change in Ski Trip 2 commitment score F (1,37) = 11.92, $p < .001$, *partial* $\eta^2 = .25$ and a significant interaction between scale shift and commitment score F (1,37) = 12.46, $p < .001$, *partial* $\eta^2 = .24$, and a significant interaction between commitment score and experimental group F (1,37) = 4.21, $p < .05$, *partial* $\eta^2 = .10$. Likewise, there was not a significant difference in the number of persons who exhibited increase or decrease in their commitment scores across the groups, χ^2 (1, $N = 40$) = 1.52, $p > .05$.

Repeated-measures ANCOVAs indicate that, there was a significant change in CEO 1 commitment score F (1,57) = 15.74, $p < .001$, *partial* $\eta^2 = .22$, and a significant interaction between scale shift and commitment score F (1,57) = 34.38, $p < .001$, *partial* $\eta^2 = .38$ and a significant interaction between commitment score and experimental group F (2,57) = 3.61, $p < .05$, *partial* $\eta^2 = .11$. There was not a main effect of scale shift F (1,57) = 2.48, $p = .12$, nor a main effect of experimental group F (2,57) = .28, $p = .76$.

There was not a significant difference in the number of persons who exhibited increase or decrease in their commitment scores across the groups, χ^2 (2, $N = 61$) = .123, $p > .05$.

Repeated-measures ANCOVAs indicate that, there was a significant change in CEO 2 commitment score F (1,39) = 4.99, $p < .05$, *partial* $\eta^2 = .11$ and a significant interaction between scale shift and commitment score F (1,39) = 17.52, $p < .001$, *partial* $\eta^2 = .31$, but not a significant interaction between commitment score and experimental group F (1,39) = .002, $p = .97$. There was not a main effect of scale shift F (1,39) = 2.19, $p = .15$, nor a main effect of experimental group F (1,39) = .49, $p = .48$.

There was not a significant difference in the number of persons who exhibited increase or decrease in their commitment scores across the groups, χ^2 (1, $N = 42$) = .001, $p > .05$.

Repeated-measures ANCOVAs indicate that, there was a significant change in Planet 1 commitment score F (1,62) = 38.72, $p < .001$, *partial* $\eta^2 = .38$ and a significant interaction between scale shift and commitment score F (1,62) = 57.38 $p < .0001$, *partial* $\eta^2 = .48$, but not a significant effect of experimental group F (2,62) = .52, $p = .60$. There was not a main effect of scale shift F (1,62) = 3.02, $p = .09$, nor a main effect of experimental group F (2,62) = 1.13, $p = .34$.

There was not a significant difference in the number of persons who exhibited increase or decrease in their commitment scores across the groups, χ^2 (2, $N = 66$) = .74, $p > .05$.

Repeated-measures ANCOVAs indicate that, there was a significant change in Planet 2 commitment score F (1,38) = 28.03, $p < .001$, *partial* $\eta^2 = .43$ and a significant interaction between scale shift and commitment score F (1,38) = 34.26 $p < .0001$, *partial* $\eta^2 = .47$, but not a significant interaction between commitment score and experimental group F (1,38) = .65, $p = .43$. There was not a main effect of scale shift F (1,38) = .19, $p = .67$, nor a main effect of experimental group F (1,38) = .18, $p = .68$.

There was not a significant difference in the number of persons who exhibited increase or decrease in their commitment scores across the groups, χ^2 (1, $N = 41$) = .98, $p > .05$.

The following tables (6.1-6.3, 6.5-6.6) depict the *Means* and *Standard deviations* for all scenarios in Study 2. Note that the Control only completed the scenarios at the beginning and end of the experimental session and did not engage in any form of training.

Table 6.1 Means and Standard Deviations for Ski Trip Scenario Across Groups.

	Ski Trip		Ski Trip 2*		Ski Trip 3**	
	M	*SD*	*M*	*SD*	*M*	*SD*
Control	41.04	*32.61*	35.42	*31.01*	.	.

CF Additive	51.64	*36.13*	52.04	*37.65*	48.80	*38.03*
CF Subtractive	47.25	*32.76*	42.88	*36.00*	42.92	*36.18*

*Scenario was completed after analogical problem solving training.
**Scenario was completed after analogical problem solving and counterfactual training.

Table 6.2 Means and Standard Deviations for CEO Scenario Across Groups.

	CEO		CEO 2*		CEO 3**	
	M	*SD*	*M*	*SD*	*M*	*SD*
Control	62.17	*31.93*	70.25	*27.32*	.	.
CF Additive	76.44	*23.45*	71.28	*27.86*	73.60	*26.21*
CF Subtractive	61.63	*29.07*	60.29	*31.44*	63.04	*31.17*

*Scenario was completed after analogical problem solving training.
**Scenario was completed after analogical problem solving and counterfactual training.

Table 6.3 Means and Standard Deviations for Planet Scenario Across Groups.

	Planet		Planet 2*		Planet 3**	
	M	*SD*	*M*	*SD*	*M*	*SD*
Control	42.17	*30.59*	38.50	*34.34*	.	.
CF Additive	27.72	*25.13*	28.80	*26.69*	26.64	*27.48*
CF Subtractive	32.38	*24.62*	29.67	*25.38*	28.42	*24.21*

*Scenario was completed after analogical problem solving training.
**Scenario was completed after analogical problem solving and counterfactual training.

Transfer Problems

In conjunction with the three common behavioral trap problems, two additional problems were completed after the analogical problem solving training and again after the counterfactual training.

Repeated-measures ANCOVAs indicate that, there was a significant change in Strategy commitment score F (1,41) = 16.47, $p < .001$, *partial* $\eta^2 = .29$ and a significant interaction between scale shift and commitment score F (1,38) = 62.60 $p < .0001$, *partial* $\eta^2 = .60$, but not a significant interaction between commitment score and experimental group F (1,41) = 1.74, $p =$

.19. There was not a main effect of scale shift F (1,41) = 1.37, p = .25, nor a main effect of experimental group F (1,41) = 1.30, p =.26.

There was not a significant difference in the number of persons who exhibited increase or decrease in their commitment scores across the groups, χ^2 (1, N = 44) = .06, p > .05; though there were more persons across each group exhibiting a decrease in commitment score (as depicted in Table 6.4).

Table 6.4 Comparison of Number of Decrease and Increase on Strategy Problem.

	Experimental Group		
	APS_CFadd	APS_CFsub	Total
Decrease	14	16	30
Increase	6	8	14
Total	20	24	44

Repeated-measures ANCOVAs indicate that, there was not a significant change in Pizza commitment score F (1,39) = 3.33, p =.08, but a significant interaction between scale shift and commitment score F (1,39) = 13.21 p < .0001, but not a significant interaction between commitment score and experimental group F (1,39) = .55, p = .46. There was not a main effect of scale shift F (1,39) = .95, p = .34, nor a main effect of experimental group F (1,39) = .93, p =.34. There was not a significant difference in the number of persons who exhibited increase or decrease in their commitment scores across the groups, χ^2 (1, N = 42) = .07, p > .05. Table 6.5 provides the descriptive results for the two intermediary problems which were completed only after the analogical problem training and the counterfactual training.

Table 6.5 Means and Standard Deviations for Two Intermediary Scenarios

	Pizza		Pizza 2		Strategy		Strategy 2	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Control	51.96	*16.36*	.	.	40.92	*36.49*	.	.
CF Additive	58.48	*27.18*	61.60	*28.73*	35.04	*32.93*	36.16	*34.05*
CF Subtractive	47.25	*22.40*	48.71	*25.62*	26.54	*21.58*	26.00	*24.13*

Three final transfer problems were completed by participants in all groups at the end of the experimental session. ANOVAs revealed that there was a significant difference between experimental groups on the Steam Press problem F (2,70) = 3.75, $p < .05$, not on the Scholarship problem F (2,70) = .76, $p = .47$, nor the Old Stadium problem F (2,70) = 1.54, $p = .22$. Using Fisher's Least Significant Difference test, revealed that there was a significant mean difference between Control and Analogy_CFSubtractive on the Steam Press problem with the Control group having a significantly lower mean score than Analogy_CFSubtractive.

Table 6.6 Means and Standard Deviations for Two Final Scenarios Across Groups.

	Steam Press		Scholarship		Old Stadium	
	M	*SD*	*M*	*SD*	*M*	*SD*
Control	35.38	*31.47*	56.21	*32.34*	37.46	*32.21*
CF Additive	53.64	*37.83*	46.00	*33.62*	25.44	*24.64*
CF Subtractive	60.75	*29.38*	47.96	*25.00*	25.42	*25.18*

Assessment of Individual differences variables

To explore effect of overall shift in commitment scores NCC and DMS scores were used as predictors for all behavioral trap problems. In five of the eleven regression models a significant amount of variance was achieved ($p < .05$) and, in all five of those models, only DMS

score was a significant predictor of change in commitment score as follows: SkiTrip 1 $\beta = .28$, $t(69) = 2.32$, $p < .05$, CEO 2 $\beta = -.29$, $t(46) = -2.40$, $p < .05$, Planet 1, $\beta = .42$, $t(70) = 3.79$, $p < .001$, Planet 2 $\beta = .32$ $t(46) = 2.27$, $p < .05$, and Strategy $\beta = .40$, $t(46) = 2.94$, $p < .01$.

The regression analyses above were used to predict overall change in commitment score. To explore whether either NCC or DMS could predict membership of participants as either *increasers* or *decreasers* (in terms of scale shift), logistic regression analyses were used. Of the eight logistic regression analyses, only two models achieved significance and in both models only DMS score was a significant predictor. For Ski Trip 2, *-2 log likelihood* = 47.57, χ^2 (2, N=30) = 7.78, $p < .05$; the model predicted a moderate amount of variance in scale shift, *Nagelkerke's* $R^2 = .24$ and correctly classified 65% of the total cases. Odds ratio reveal that as DMS score increases there is a 95.2% decrease in likelihood of showing a scale shift towards the trap option. For Planet 2, *-2 log likelihood* = 45.53, χ^2 (2, N=41) = 8.32, $p < .01$; the model predicted a moderate amount of variance in scale shift, *Nagelkerke's* $R^2 = .25$ and correctly classified 63.4% of the total cases. Odds ratio reveal that as DMS score increases there is a 96.3% decrease in likelihood of showing a scale shift towards the trap option.

Next subscales of NCC and subsequently DMS were explored in separate regression analyses to examine if either could predict change in commitment score. NCC is composed of five subscales: Order, Predictability, Decisiveness, Ambiguity, and Closed-Mindedness. In three of the eight regression analyses, overall significance was achieved. For CEO 2, NCC subscales explained a significant portion of variance $R^2 = .28$, $F(5, 43) = 3.32$, $p < .01$; Predictability significantly predicted change in commitment score, $\beta = -.42$, $t(43) = -2.70$, $p < .01$ as did Decisiveness $\beta = .31$, $t(43) = 2.02$, $p < .05$. For Planet 2, NCC subscales explained a significant portion of variance $R^2 = .31$, $F(5, 43) = 3.84$, $p < .01$; Ambiguity significantly predicted change

in commitment score, $\beta = .55$, $t(43) = 3.89$, $p < .01$. For Strategy, NCC subscales explained a significant portion of variance $R^2 = .33$, $F(5, 43) = 5.62$, $p < .001$; Order significantly predicted change in commitment score, $\beta = -.36$, $t(43) = -2.19$, $p < .05$, Predictability significantly predicted change in commitment score, $\beta = .38$, $t(43) = 2.62$, $p < .01$, and Ambiguity significantly predicted change in commitment score, $\beta = .45$, $t(43) = 3.39$, $p < .01$.

DMS is composed of five subscales: Rational, Intuitive, Dependent, Avoidant, and Spontaneity. In three of the eight regression analyses, overall significance was achieved. For Ski Trip 1, DMS subscales explained a significant portion of variance $R^2 = .22$, $F(5, 67) = 3.85$, $p < .01$; Dependent significantly predicted change in commitment score, $\beta = .44$, $t(68) = 3.78$, $p < .001$. For Planet 1, DMS subscales explained a significant portion of variance $R^2 = .18$, $F(5, 67) = 3.05$, $p < .05$; Avoidant significantly predicted change in commitment score, $\beta = .28$, $t(68) = 2.21$, $p < .05$. For Planet 2, DMS subscales explained a significant portion of variance $R^2 = .25$, $F(5,43) = 2.86$, $p < .01$; Intuitive significantly predicted change in commitment score, $\beta = .36$, $t(44) = 2.54$, $p < .05$ and Spontaneity $\beta = .42$, $t(43) = 2.90$, $p < .01$.

Given that the four measures of arousal were positively correlated with each other, $r > .30$, $p < .05$, an overall arousal score was computed by taking the mean of the four mean arousal scores; the same was true for negative and positive affect and the same procedure was used to create an overall score for each of these predictors. These three predictors were subsequently used in regression analyses to determine if any/all could predict change in commitment score. Only one of eight regression models achieved significance. For CEO 1, arousal and affect explained a significant portion of variance $R^2 = .13$, $F(3, 69) = 3.33$, $p < .05$; Overall Negative Affect significantly predicted change in commitment score, $\beta = -.32$, $t(69) = -2.38$, $p < .05$.

Discussion

Though the training was not as effective as predicted, there were certainly trends in changes in commitment score. Commitment scores were scored in such a manner that lower scores were indicative of commitment towards a non-trap option. In many of the scenarios, the mean commitment scores for the experimental (or trained) groups were lower than the control group. The purpose of the training was to reduce commitment towards the trap option and this is what the trend reveals.

Whether combining the reasoning processes as part of the same protocol was a main question in this study. In only two of the analyses was there evidence that training had an effect. In the Strategy problem, there was a significantly greater number of persons exhibiting a decrease in their commitment score; lower scores indicated a commitment towards the non-trap option. Though it was expected that only the combination of analogical problem solving and subtractive counterfactual thinking would benefit Cumulative problems, both training groups showed a decrease in commitment score on this problem.

On the second problem with significant results involving training, the group engaging in analogical problem solving and subtractive counterfactual thinking had a higher mean commitment score than the control group. Though this is the opposite of the desired training effect, it might be explained by the fact that the problem was an Immediate type problem. Engaging in analogical problem solving along with subtractive counterfactual thinking was believed to benefit Cumulative problems, because it would engage attention towards past investments. Thus, it is also possible that this form of training would have an opposite effect on Immediate problems, which were hypothesized to benefit most from looking forward to future consequences.

Results involving the individual differences variables illustrated that both a trait which guides amount of information processed (NCC) and decision style (DMS) which determines how an individual approaches a decision predicted change in commitment score. In the overall analysis, DMS was a significant predictor of commitment score change such that an increase in DMS score was related to an increase in commitment score. More specific regression analyses revealed that subscales for NCC and DMS were predictive of change in commitment score, but not consistent enough to predict that persons exhibiting any of these traits would respond to the given scenarios in a certain manner. For instance, the only two subscales that predicted a significant change in commitment more than once, were Ambiguity and Predictability. When persons exhibited increases in Ambiguity they also exhibited increases in commitment score. This fits the earlier prediction; persons higher on Ambiguity tolerate more uncertainty when making decisions. Further, both problems were Cumulative and are characterized such that costs are ambiguous or in relatively minor amounts that do not individually predict the overall outcome.

However, for the two scenarios where Predictability was a significant predictor, in one situation increases in Predictability led to decreases in commitment score, while the second situation the reverse was true. The first problem was an Immediate problem, where explicit costs and consequences are apparent. Thus, it would be expected that persons scoring high on a need for Predictability in decision making situations would show a decrease in commitment score. The second problem was a Cumulative problem, where explicit costs and consequences are not apparent. Thus, individuals scoring high on need for Predictability would have a difficult time deriving a solution to a problem with uncertain outcomes, regardless of the choice made.

One commonality among the NCC subscale results is that the subscales predicted change in commitment score only after both training phases (analogical problem solving and counterfactual thinking) had been completed. Though this may not be sufficient evidence that the training protocol was effective, it does appear to indicate after participants go through both phases of the training, their responses are more calibrated to the questions. This calibration is thus predicted by an individual difference in the amount of information one wishes to process before deciding on a solution.

A similar result was revealed for the subscales of DMS such that for the three regression models that were significant, each indicated different subscale predictors as important for predicting change in commitment score. For the Immediate Problem (Ski Trip), the Dependent subscale predicted change in commitment score; as Dependent score increased, so did commitment score (or the commitment towards the trap option). Since the Ski Trip problem is a matter of making a choice between available options, not requiring further investment, participants higher on Dependency may have viewed both the available options as desirable; thus, they would be most comfortable with allowing others to make decisions for them in this context.

For the Cumulative problem (Planet), different subscales were predictive across both measures of potential change commitment score. The one common characteristic of these subscales is that they would predispose persons that rely on intuitive responses to these situations. As shown in the results, increases on each of these subscales predicted an increase in commitment score (or commitment towards selecting the trap option). This would be expected, especially if more rational decision making involving this problem would be to consider

alternatives; an intuitive response style would predispose persons to be unlikely to consider alternative options.

Arousal and affect were not predictive of change in commitment score, except for a few disparate results. Thus, it appears that arousal and affect were not related to performance in this context or, at least, not in a consistent pattern in order to warrant definitive conclusions.

It was predicted that individual differences measures would predict change in commitment score and, thus, inform decision behavior involving behavioral traps. Given the results, although some statistical models achieved significance, there was not a consistency that allows the conclusion that these particular individual differences measures are indicative of behavior in this decision environment.

CHAPTER 7 - General Discussion

This project combined both individual differences and experimental manipulations in order to assess if engaging in both analogical problem solving and counterfactual reasoning would affect behavioral trap decision making. The major premise of this project was to quickly train an implicit reasoning strategy using specific reasoning exercises, namely analogical problem solving and counterfactual thinking. Was the primary objective achieved? Many of the statistical tests were not significant, but the likelihood of achieving significance given the variability in the scale and the low sample size were certainly factors in the outcome of most of the analyses conducted. Considering that expected, meaningful differences were a 10 % difference in commitment score, many of the comparisons could be considered of practical importance.

Despite the contention that behavioral trap decisions result from an irrational thought process or, as was assumed in this project, is an effect that needs to be alleviated by some aid, is it possible that the effect is not irrational after all? The effect of traps in Immediate contexts is commonly construed as follows. A decision maker utilizes past investments (or ignores them when they should be paid attention) as the primary source of information for making the present decision. However, these past investments will not affect future costs nor benefits, and, thus, should not enter the decision process as functional information. Thus, if a decision maker argues that the reason for continuing on the same decision path is due to past investments or that an option was chosen because it had larger investment attached to it, s/he is acting (economically) irrational.

For Cumulative problems, the reverse is true. Persons act irrationally, because they do not pay attention to past investments. For instance, the small, individual health consequences of

smoking a single cigarette are inconsequential, unless the ultimate effect is realized. Unfortunately, in such situations, the ultimate consequence is not realized until the effects of the behavior are irreversible. Thus, if a decision maker argues that the reason for continuing along the same decision path is to ignore past investments, then s/he is behaving irrationally.

Following an evolutionary point of view, we find that most functions, whether physical or psychological (conscious or unconscious) are commonly argued to still be obtained in the present form of our species, because they were adaptive previously. Consider, for instance, our innate ability to recognize patterns and faces. Both of these processes occur via an autonomic response and help us to make sense of our environment and navigate through our world. Nevertheless, persons are exposed to situations involving past investments and what to do with them on a regular basis (ie, waiting on the phone, waiting in line, planned engagements, just one more cigarette, etc).

The ability to simulate situations and imagine potential outcomes is key to human existence. Behavioral trap decision making is a decision environment where this evolved ability is inherently limited. Mostly, because certain cues (ie, amount invested) are over-utilized and the choice is made before other alternatives are considered. A training protocol was developed to address this topic using implicit learning as the centerpiece to encourage the acquisition of a strategy for considering alternative options before making a decision.

Although the strategy was not completely successful (statistically), there were demonstrated differences between groups and before and after training. The implications of this are important for our educational system which appears to be losing ground compared to other countries. Some argue that kids are too disengaged with a typical classroom setting (as a result of cultural shifts, including various forms of available media and its consumption). Perhaps, if

students do not know they are learning, they may actually be more inclined to participate. Thus, contemporary classrooms may be more successful if they encourage implicit skill and knowledge acquisition along with explicit activities.

In this project, training was developed in order to change a decision behavior that is strongly affected by a decision environment, which takes advantage of a natural propensity to maintain the status quo. There are at least two main themes that can be used to explain the outcomes of this project. In order to change this decision behavior the training could take an abstract form with the desired effect that the learners could apply the concepts in concrete situations. The second form or avenue for training to take is to provide concrete examples in the hope that the learners will be able to learn the abstract concept and apply in future and novel settings.

The three potential outcomes would be: training on abstract concepts leads to improved behavior in concrete situations, training on concrete concepts leads to improved behavior in situations requiring abstract utilization or the decision behavior is such an immovable force that neither form of training would be able to invoke a substantial behavioral change. Perhaps, the training manipulation was simply not strong enough to evoke change.

Though the scenarios were gathered and developed to mimic situations that the participant population (undergraduate students) would have experience with, it is possible that they were not used to dealing with the such problems in the provided format (word problem). For instance, work by Shanteau and Harrison (1991) illustrated that problem format was more informative for a form of behavioral trap, sunk traps, than was background knowledge (i.e., training on accounting principles). Only when accounting students were presented with a spreadsheet did they exhibit the most rational decision behavior; when presented with a word

problem format, they performed irrationally. Thus, exploring the translation of knowledge (and experience) from one problem format to another is a potential avenue for further study. If training is believed to be effective, examining it across various problem types, which may evoke differential information processing, would be an extensive test of training efficacy.

Along these same lines, familiarity with the problem could provide further implications for training outcomes. In this project, one problem that the participants performed well on was a situation which they were likely to be familiar with; a situation involving a decision to order (and a decision to consume) pizzas at different financial costs. Despite contentions that participants in this population respond less than normatively (See Arkes & Blumer, 1985), participants in both studies performed rationally. This, perhaps, provides a further approach that could lead to improved training on behavioral trap decision behavior. Incorporating situations that are familiar to the participants in the training itself could provide a substantial foundation to build on reasoning processes such as drawing analogies between situations and engaging in counterfactual thinking.

One of the misfortunes for Psychology is the delineation of the unconscious or processes (and mechanisms) assumed to take place within its realm to be 'effortless'. Although many mechanisms or learned processes such as face recognition, symbol manipulation, etc, take little time to execute, there is certainly some form of effort taking place (even if we are not aware of it). Consider a scanned brain image (oft seen in contemporary journals) that illustrates the areas of the brain that are 'lit up' while the individual is performing one task, yet also is attending to another. If we could tease apart all of the neuronal activity associated with unconscious processing, we might find it is quite a lot. If this postulation is true, then how can unconscious

processing not be effortful? Perhaps, future studies by neurocognitive scientists will assist in explaining unconscious and conscious processing.

Or, more readily, consider sleep. All humans engage in this restorative phase of life every single day (give or take a few). Now, we are certainly not conscious then, but the brain is certainly not inactive. In fact, the brain is quite alert with activity across many different regions. The brain uses up a good percentage of energy that our body produces and I would argue that most of that goes toward unconscious processing. Thus, it would probably behoove Psychology to be cautious of so easily attaching a lack of effort with the unconscious. As Frensch and Runger (2003) concluded, fully demonstrating what implicit learning is and is not may take the combined assistance of philosophers, neuroscientists, and cognitive psychologists.

Some have argued that committing the sunk cost effect for instance may not be as irrational as once construed (Lopes, 1982; Walton, 2002). This argument involves the idea that paying attention to past information is perfectly rational when considering the goal of the decision maker. Further, if that goal is reward or satisfaction paying attention to past investments in Immediate situations or ignoring past investments in Cumulative situations may lead to the easiest path of goal attainment.

CHAPTER 8 – Limitations, Recommendations, and Future Directions

Limitations

The training was designed so persons would shift there commitment score to the non-sunk alternative by engaging in exercises that promoted multiple hypothesis generation and alternative consideration. This project involved both individual differences, and a specific manipulation of training components to enhance training and better understand what components may influence overall effectiveness in an instructor-less environment. Many contemporary organizations, including the military, academic, and industry rely on minimally-guided instruction to improve workforce capability. By assessing the components noted above, this project could provide a benefit to all of these areas that utilize distance education and/or minimal guidance format for continuing education. However, given the project outcome, several elements are discussed in this Chapter that may improve future research.

A potential limitation of the response metric is that there were only two options available. What would happen if there were multiple options to consider? Would this affect the results of the present study? Thus, participants were responding within a forced-choice response format; the response scale utilized was a visual analog scale (VAS) that was anchored on each side with one of two options. Would a different response scale yield different results? This is a legitimate question, not just for the present project, but all psychological experiments. There are, at least, a few reasons why this particular response format was chosen. Thus, future studies could assess how the VAS compares to forced-choice formats, Likert, and others. Also related to the methodology is the fact that participants responded to some of the same problems more than once. One of the good features about using a visual analog scale is that participants made a mark

along a non-numbered scale. Thus, participants could not trace (remember) a specific digit, only a general location. This reduces helps to reduce any memory bias. Likewise, in order to test whether the training was effective, the same problems were used.

Likewise, how might the availability of other options better inform behavioral trap decision making? This project used scenarios with, only two available choice options. Perhaps the training would have been more effective if scenarios also incorporated a variety of choice options with gradations between the trap and non-trap options. I have begun exploring this question of gradation as a between-subjects variable (i.e., amount of investment per option), but not as a within-subjects variable. Response options, beyond two, would also require a change in the scenarios used to measure the effects of trap options. Thus, increasing the number of response options could be a means of shifting the research focus in this area from dichotomous choice sets to multiple; this would fit well with exploring how commitment shifts towards and away from available options, as in the current project.

One such limitation is the lack of a specific comparison of how the training might be affected (i.e., either improved or worsened) by the presence of a human instructor. The training in this project was delivered without the assistance of the instructor in order to assess a distance education platform in its purest sense. This is especially certain for our military who operates around the globe and is undergoing an organizational restructuring, especially in terms of decentralized training. Nevertheless, a viable test would be to also have the training delivered by an instructor in order to test the importance (or lack of) a human agent in this context.

Likewise, the topic of who the participants are, when discussing research is an oft overlooked topic. In the initial planning stages of this project, the desired population was military personnel and then ROTC cadets. However, for various logistic reasons, undergraduate

students from the general psychology pool were used. Though not an uncommon practice throughout Psychology, it does not excuse the fact that an undergraduate from rural Kansas might respond differently than a seasoned professional or soldier; thus, results and conclusions based on those results may be variable. Though, training in organizations is usually task specific, the reasoning exercises were chosen, as was the decision problem, because they are applicable to a variety of audiences, regardless of context.

Did implicit learning occur? Often studies involving implicit learning have checked the verbal reports of participants or used forced-choice tests to determine whether or not participants were indeed engaged in implicit learning. Of course, verbal reports may not correlate with the information used to actual allow the learning to occur in the first place. Further, forced-choice tests may not actually be an adequate representation of the learning process, as persons may rely on some form of intuition to solve the problems. Despite the drawbacks of either method, one of the hallmarks of implicit learning is that participants are unaware that learning occurred. In this project, participants were asked what they thought the experiment was about; no participants related that they were being asked to abstract an underlying reasoning strategy to assist in multiple hypothesis generation as a result of engaging in the critical thinking exercises.

Future Directions/Recommendations

In this section, some proposed directions for future research are described which the current project may directly assist. The directions considered are both basic and potential applied settings.

What of the unconscious in all of this? If persons are relying on an unconscious processing mechanism to react to these situations, the cues for initiating the process are likely automatic. Further, these reaction are thought to be illustrations of an error in our innate

processing ability to commonly select the option with the most invested or ignoring investments when they should be paid attention. Even when one consciously compares the options, the outcome is likely the same and this is utilized by the purveyors of the errors and biases literature that humans are hopelessly irrational. However, recent surges have denoted that we may not be as fate-bound as once thought. Although this project, at best, examined the influence of the unconscious in a tertiary sense, further work on behavioral traps and similar psychological phenomenon may prove quite informative. One pathway for future research is to examine a shortened response time (ie, 10 seconds) to scenarios involving trap options as compared to an extended response time (ie, several minutes). Likewise, extending the interim period between pre-test and post-test from one day to a week or longer may provide evidence as to how long the training can last and how concrete the effects are from it.

Extending the work to a non-normal population may also prove enlightening for this topic of judgment and decision making. Consider the 'disorder' Obsessive Compulsive Disorder (OCD) where the individual gets caught in a cycle of behaviors (perhaps turning a light switch on and off several times before leaving a room) that are non-functional. Of the little clinical psych. literature that I have read, there appear to be only general models of therapeutic intervention that do not tailor themselves well to individual experiences. This disorder is, largely, anxiety driven. The individual becomes stuck in a behavioral trap, attempting to relieve the anxiety by through some compulsive act. One method of treatment is finding the trigger that causes the anxiety and attempting to relieve the association between the trigger and subsequent anxiety episode. Perhaps, work on behavioral traps could be informative as some require ignoring past investments, while others are better solved when past investments are paid attention. Exploring the continuum between these trap situations could be informative and lead

to better treatment of the disorder on top of the neuroanatomic and psychopharmacological management.

Training Platform: Think Like a Commander: (TLAC-XL)

The training material will be presented to participants in a multimedia platform known as Army Excellence in Leadership or AXL.Net. This platform was preceded by, Think Like a Commander: Excellence in Leadership (TLAC-XL). Both platforms were responses to requests for a training tool that could deliver necessary components needed by contemporary junior officers (particularly Lieutenants and Captains). The Army has shifted more responsibilities to junior officers without necessarily providing an educational framework that would allow these officers to readily assume such responsibilities.

The main component of the TLAC-XL and AXL.Net systems is the case study approach (Zbylut & Ward, 2004a; Metcalf & Zbylut, 2007). The case study approach allows a school-house environment where leaders can learn the skills necessary to function optimally in the contemporary military. This technique has been shown to be effective in training needed skills, such as cultural awareness, in an expedited manner (Zbylut, Metcalf, Kim, Hill, Rocher, & Vowels, 2007). The current case study method (using Hollywood-caliber films and interactive elements) breaks from traditional formats by engaging the emotions of the student, delivering well-developed characters, providing believable dialogue and nonverbal communication, and providing a realistic scenario that applies directly to its audience (Zbylut & Ward, 2004a).

TLAC-XL involves the utilization of a case-based film (*Power Hungry*) as a foundation upon which to build lessons among a variety of topics (Zbylut & Ward, 2004a). The film includes a number of teaching objectives, such as: *Command influence, Communication, Cultural Awareness,* and *Respect for Experience.* This film depicts a good example of a

behavioral trap scenario; as investments mount, the main decision maker becomes more and more trapped.

Previous Results (TLAC-XL)

Part of the validation of the TLAC-XL system involved an examination of whether participants would benefit greater from different delivery formats, specifically the TLAC-XL version compared to a version created using Microsoft PowerPoint. The main research question was to denote whether or not TLAC-XL provided a training benefit above and beyond comparative technologies. The major differences between the two versions were, TLAC-XL utilized the entire vignette, while the TLAC-PP version used frames of the film overlaid with the same audio as the full film version. The character interview feature in the TLAC-XL was freer to vary, in that participants could ask any question possible, while the TLAC-PP listed a set of questions that could be answered by each character.

Zblyut and Ward (Study 2, 2004b) illustrated that the TLAC-XL version was superior in terms of positive, self-reported reactions to the film, ratings of ease of interactivity, memory, and learning. An important finding of this study was the structuring of questions involving the character interview feature. Participants noted a large discrepancy in the mentor and characters being non-responsive to a number of relevant questions. This limitation was addressed and modified in the newer system.

This system has been validated by Shaddrick, Lussier, and Fultz (2007) for use as a system to train tactical and situational skills in Officers at various levels (Lieutenant through Lieutenant Colonel). They importantly noted that deliberate training with the TLAC-XL system, at least for tactical skill, can improve performance for Soldiers without deployment experience. Although, the findings of their research do not eradicate the importance of gaining experiential

knowledge by actually engaging in the behavior, it does provide a sound supporting structure for conducting training with such platforms to facilitate learning (in a safe environment) before Soldiers have to engage in a real-world, military campaign.

Training Platform: Army Excellence in Leadership (AXL) System

The AXL.Net platform followed the TLAC-XL system and improved upon many of components such as flexibility (allowing instructors an infrastructure to author lessons on a variety of topics) and some of the interactive components (the character-interview feature was strengthened by making it more functional and user-friendly). Likewise, many instructors made requests for a system that utilized the interactive qualities of the TLAC-XL system, but allowed them to control more of the authoring or developing of lessons, in order to utilize pieces of the system in a more personalized manner. The AXL.Net system is an answer to that.

The AXL.Net system has been used in conjunction with films (i.e., *Power Hungry, Tripwire*) to enhance the capability of delivery of information, just as the TLAC-XL system was. *Tripwire* also contains a variety of teaching themes, such as: *Directing and supervising subordinates*, *Establishing trust*, *Communication*, and *Cultural Awareness* (Metcalf & Zbylut, 2007).

Previous Results: Army Excellence in Leadership (AXL) System

As part of the usability and validation efforts for the AXL.Net system various modules were created and tested to examine the functionality and potential training benefit to Soldiers. Zbylut, Metcalf, Kim, Hill, Rocher, and Vowels (2007) illustrated that a module on Cultural Awareness, built with the AXL system, did increase the emphasis placed on cultural issues after completing the module compared to before. Further, emotional indicators (positive and negative affect) were related to some of the learning measures. For instance, positive affect was

positively, significantly correlated with a post-training behavioral judgment test score. Likewise, positive affect was positively, significantly correlated with post-training emphasis on cultural awareness issues. Thus, the experience of positive affect appears to be related to better performance in the learning measures utilized in that study. A negative relationship emerged between high levels of arousal and the training, such that Officers indicating higher levels of arousal were more confused about issues in the film and had an overall negative reaction to the film. Thus, arousal level may be an important predictor of training success. Another important result was that level of engagement was positively related to learning such that, Officers who found the characters to be complex and believable and found the film involving performed better on the judgment posttest. The results of positive affective experience and engagement with the training are replications of previous results involving the *Power Hungry* film (Zbylut, Ward, & Mark, 2005).

Likewise, as shown by Barlett, Vowels, Raacke, and Shanteau (2008), strategic team training was more effective than traditional training in an air traffic control simulation. Thus, another avenue to explore the specific training strategy would be to extend the findings from individual to team settings.

Both of the platforms (TLAC-XL and AXL.Net) could be viable technological routes, that would allow further study of the training components used in the current project. These platforms could also provide further options for exploring both instructional format as well as instructor and instructor-less formats.

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Appendix A – Behavioral Trap Measures

CEO

Instructions: Treat the scenarios as if they were actually happening to **you** and respond as you would if this were a real life situation.

As the CEO of a submarine manufacturing company, you have invested 10 million dollars of the company's money into a research project. The purpose was to build a submarine that was undetectable by conventional sonar, in other words, the enemy couldn't see the submarine until it was too late. When the project is 90 % complete, another firm begins marketing an undetectable submarine that is much faster and far more economical than the submarine your company is building. The question is:

Now indicate your choice below.

To indicate your choice, make a **single vertical mark anywhere** on the line.

Example:

A **B**

Should you invest the last 10 % of the research funds to finish your submarine?

Invest Do Not Invest

Old Stadium

You may have heard that the university is currently planning the demolition of the old stadium behind the new Alumni center. The argument has been made, however, that the building was extremely expensive to build for its time and that it is wasteful simply to destroy it. The counterargument is that renovation in the case of this building is more expensive than construction.

Now indicate your choice below.

To indicate your choice, make a **single vertical mark anywhere** on the line.

Example: |

A **B**

What do you think the university should do?

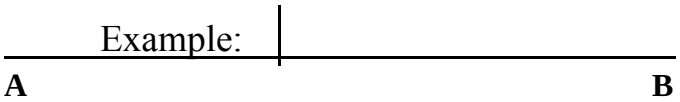
Definitely destroy the building — Definitely keep the building and renovate it

Pizza

The local fast food restaurant is having a special on their personal pan pizzas. If you buy one at regular price for $5, you get one free. Since they are only small pizzas and you are hungry, you think you could eat both of them. When you get home you decide to call a friend to see if he wants to watch the game on television. Your friend states that he hasn't eaten yet and could probably eat two personal pan pizzas as well. Since, the restaurant is right across the street, you decide to go over and buy two more pizzas. However, the sale ends just before you arrive and you will have to pay $10 for both pizzas. You buy two at regular price anyway, because you like your friend and do not want him to starve. When you get back home your friend calls and tells you he is not coming. You can't eat all four pizzas and can't save them because you are leaving town for a week starting tomorrow.

Now indicate your choice below.

To indicate your choice, make a **single vertical mark anywhere** on the line.



Which pizzas will you eat?

Definitely eat the pizzas purchased for $5.

Definitely eat the pizzas purchased for $10.

Planet

On the planet Hatre, the occurrences of certain weather phenomenon are beginning to be recorded more frequently. Weather forecasters have noted an increase in the intensity and occurrence of storms and other weather events such as hurricanes and tornadoes. A decrease in the ozone layer and an increase in temperature have also been recorded. Some argue that this is a result of increased omissions of pollutants from the inhabitants of the planet. Others argue that the planet has gone through several cycles in the past, based on the geological record. These cycles included both calm weather and more severe as well as increases and decreases in temperature. Several governments have active members delegated to a global oversight committee that will be voting soon on whether to impose severe monetary sanctions on countries that do not reduce their pollutant emissions or to maintain the current state of affairs.

Now indicate your choice below.

To indicate your choice, make a **single vertical mark anywhere** on the line.

Example:

A **B**

If you were a member of this committee which option would you choose?

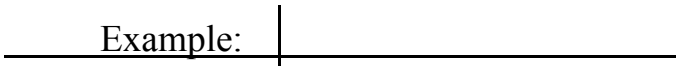
Impose Sanctions Maintain Current State

Scholarship

Some university financial planners at Kansas State anticipate that jobs for younger persons may soon be more numerous than in the recent past, for the simple reason that a much smaller fraction of the population is in the younger age group. One implication is that pay will increase for entry-level jobs in all kinds of industries. The argument has been made that the university should respond to this situation by offering more money for scholarships in order to lure low-income students away from starting work and toward continuing their education.

Now indicate your choice below.

To indicate your choice, make a **single vertical mark anywhere** on the line.



What do you think the university should do?

Scholarships should be kept kept competitive with salaries

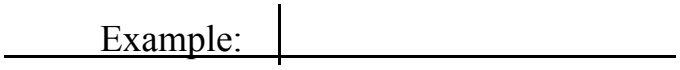
Scholarships should maintain pace with inflation and not respond to competitive inducements

Ski Trip

Assume that you have spent $300 on a ticket for a weekend ski trip to Colorado. Several weeks later you buy a $250 ticket for a weekend ski trip to Wyoming. You think you will enjoy the Wyoming ski trip more than the Colorado ski trip. As you are putting your just-purchased Wyoming ski trip ticket in your travel bag, you notice that the Colorado ski trip and the Wyoming ski trip are for the same weekend! It's too late to sell either ticket, and you cannot return either one. You must use one and not the other.

Now indicate your choice below.

To indicate your choice, make a **single vertical mark anywhere** on the line.



Which ski trip will you go on?

Colorado Wyoming

Steam Press

Pat is the owner of a local dry cleaning establishment and is in need of another steam press. Pat has the opportunity to buy one for $50,000 that works twice as fast as the current one. After buying the new steam press, Pat's competitor goes out of business and wants to sell his for $10,000. The competitor's press is a newer model than the one Pat just purchased and runs at twice the speed. Pat cannot sell the steam press just purchased, because it was built specifically for the building, but does have $10,000 in savings.

Now indicate your choice below.

To indicate your choice, make a **single vertical mark anywhere** on the line.

Example:

A **B**

Should Pat buy the competitors newer press?

Definitely Buy

Definitely Won't Buy

Strategy

As part of a military committee appointed by the President, you have been asked to review a current situation involving a military conflict. To date, several thousand soldiers have been killed or taken prisoner. The conflict has cost a larger than projected amount of money to maintain a military presence. Some argue that pulling the military out now would dishonor the soldiers who had fallen because their lives would have been a waste. Sending more troops would be the only way to honor them properly. Others argue that the mission has not been successful and maintaining a presence is also wasteful. Part of your responsibility is to advise the President to either maintain the current strategy, which involves sending more troops to the conflict, or to switch strategies that involves withdrawing troops.

Now indicate your choice below.

To indicate your choice, make a **single vertical mark anywhere** on the line.

Example:

A **B**

Would you recommend maintaining the current strategy or changing the strategy?

Maintain Current Strategy Change Strategy

Appendix B – Experimental Schedules

Study 1 - Control

1. Introduction – 3 minutes
2. Consent Form – 1 minute
3. Demographics Survey – 1 minute
4. NCC – 4-5 minutes
5. WMC (*E-prime*) – 13 -16 minutes
6. Arousal – 1 minute
7. Mood – 1 minute
8. Two Baseline Problems for Behavioral Trap + Opposite Test 2-3 minutes each (approx. 6 minutes)
9. View Video (*Power Hungry*) – total film time: 7 ½ minutes
    a. Stop film at 7 minutes and ask for hypothesis generation of potential conclusions of the scenario. Add 3 – 4 minutes
    b. After film, engage in counterfactual generation. Add 3 – 4 minutes.
10. Arousal – 1 minute
11. Mood – 1 minute
12. Behavioral trap Test (Similar, Different, Similar, Different) – 2-3 minutes each (approx. 8 minutes)
13. Test (Opposite) – 2-3 minutes
14. Debrief – 2-3 minutes

Total Experiment Time **Approx (60 minutes) 1 hr**

Study 1 – Analogical Problem Solving

1. Introduction – 3 minutes

2. Consent Form – 1 minute

3. Demographics Survey – 1 minute

4. NCC – 3-4 minutes

5. WMC (*E-prime*) – 13 -16 minutes

6. Arousal – 1 minute

7. Mood – 1 minute

8. Two Baseline Problems for Behavioral Trap + Opposite Test 2-3 minutes each (approx. 6 minutes)

9. View Video (*Power Hungry*) – Total film time: 7 ½ minutes
10. Stop film at 7 minutes and ask for hypothesis generation of potential conclusions of the scenario. Add 3 – 4 minutes

11. Initiate Training on Analogical Problem Solving (Online - *AXL.Net)* – 10 -12 min.

12. Introduction to Analogical Problem Solving (approx. 6 minutes)
13. Example Analogy Problem, Chance to Solve, and Presentation of Solution (Duncker's 1945 problems)

14. Measure of Analogical Problem Solving – 3-4 minutes

15. (Participants in Group 2 will receive 1 more example, adding another potential 3 – 5 minutes)

16. Arousal – 1 minute

17. Mood – 1 minute

18. Behavioral trap Test (Similar, Different, Similar, Different) – 2-3 minutes each (approx. 8 minutes)

19. Test (Opposite) – 2-3 minutes
20. Debrief – 2-3 minutes

Total Experiment Time **Approx (69 minutes) 1 hr 9 minutes**

Study 1 – Counterfactual Thinking

1. Introduction – 3 minutes

2. Consent Form – 1 minute

3. Demographics Survey – 1 minute

4. NCC – 4-5 minutes

5. WMC (*E-prime*) – 13 -16 minutes

6. Arousal – 1 minute

7. Mood – 1 minute

8. Two Baseline Problems for Behavioral Trap + Opposite Test 2-3 minutes each (approx. 6 minutes)

9. View Video (*Power Hungry*) – Total film time: 7 ½ minutes
10. Stop film at 7 minutes and ask for hypothesis generation of potential conclusions of the scenario. Add 3 – 4 minutes

11. Initiate Training on Counterfactual Thinking (Online - *AXL.Net)* – 10 -12 min.

12. Introduction to Counterfactual Thinking (6 minutes)
13. Example Counterfactual Thinking Problems, Chance to Solve, and Presentation of Solution

14. Measure of Counterfactual Thinking (Additive or Subtractive) – 3-4 minutes

15. Arousal – 1 minute

16. Mood – 1 minute

17. Behavioral trap Test (Similar, Different, Similar, Different) – 2-3 minutes each (approx. 8 minutes)

18. Test (Opposite) – 2-3 minutes

19. Debrief – 2-3 minutes

Total Experiment Time **Approx (70 minutes) 1 hr. 10 minutes**

Study 2 – Control

1. Introduction – 3 minutes
2. Consent Form – 1 minute
3. Demographics Survey – 1 minute
4. Two Baseline Problems for Behavioral Trap + Opposite Test 1-2 minutes each (approx. 6 minutes)
5. NCC – 4-5 minutes
6. Decision Making Style 1-3 minutes
7. Arousal – 1 minute
8. Mood – 1 minute
9. View Video (*Power Hungry*) – Total film time: 7 ½ minutes
10. Stop film at 7 minutes and ask for hypothesis generation of potential conclusions of the scenario. Add 3 – 4 minutes
11. Arousal – 1 minute
12. Mood – 1 minute
13. Behavioral trap Test (Similar, Different, Similar, Different, and Opposite) – 1-2 minutes each (approx. 16 minutes)
14. Debrief – 2-3 minutes

Total Experiment Time **Approx (53 minutes) 1 hr**

Study 2 – Analogical and Counterfactual Thinking

1. Introduction – 3 minutes

2. Consent Form – 1 minute

3. Demographics Survey – 1 minute

4. Two Baseline Problems for Behavioral Trap + Opposite Test 1-2 minutes each (approx. 6 minutes)

5. NCC – 4-5 minutes

6. Decision Making Style 1 - 3 minutes

7. Arousal – 1 minute

8. Mood – 1 minute

9. Read first part of *Power Hungry* scenario – total time: 8 minutes
10. After reading first part (4 minutes), engage in hypothesis generation of potential conclusions of the scenario. Add 3 – 4 minutes
11. Finish reading second part (4 minutes).

12. Arousal – 1 minute

13. Mood – 1 minute

14. Introduction to Analogical Problem Solving 3-4 minutes
15. Example Analogy Problem, Chance to Solve, and Presentation of Solution (Duncker's 1945 problems)

16. Test Problem (Analogy between SC and *Power Hungry* scenario – 3-4 minutes

17. Counterfactual Thinking – 6-8 minutes
18. Introduction to Counterfactual Thinking (*additive or subtractive)*
19. Example Counterfactual Thinking Problem, Chance to Solve, and Presentation of Solution

20. Measure of Counterfactual Thinking – 2-3 minutes

21. Behavioral trap Test (Similar, Different, Similar, Different) – 1-2 minutes each (approx. 6 minutes)
22. Test (Opposite) – 1-2 minutes
23. Debrief – 2-3 minutes

Total Experiment Time **Approx (68 minutes) 1hr. 8 minutes**

Appendix C – Analogical and Counterfactual Scenarios

Duncker's Tumor/Dictator and Young Pilot Analogy Scenarios

Tumor Scenario

Suppose you are a doctor faced with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient, but unless the tumor is destroyed the patient will die. There is a kind of ray that can be used to destroy the tumor. If the rays reach the tumor all at once at a sufficiently high intensity, the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue the rays pass through on the way to the tumor will also be destroyed. At lower intensities, the rays are harmless to the healthy tissue, but they will not affect the tumor either. What type of procedure might be used to destroy the tumor with the rays, and at the same time avoid destroying the healthy tissue?

Please attempt to generate as many possible solutions that you can think of that would result in a successful outcome.

Dictator Scenario

A small country was controlled by a dictator. The dictator ruled the country from a strong fortress. The fortress was situated in the middle of the country, surrounded by farms and villages. Many of the roads radiated out from the fortress like spokes on a wheel. A general arose who raised a large army and vowed to capture the fortress and free the country of the dictator. The general knew that if his entire army could attack the fortress at once it could be captured. The general's troops were gathered together at the head of one of the roads leading to the fortress, ready to attack. However, a spy brought the general a disturbing report. The ruthless dictator had planted mines on each of the roads. The mines were set so that small bodies of men could pass over them safely, since the dictator needed to be able to move troops and workers to and from the fortress. However, any large force would detonate the mines. Not only would this blow up the road and render it impassable, but the dictator would then destroy many villages in retaliation. It there seemed impossible to mount full-scale direct attack on the fortress. How might the general attack and seize the fortress?

Please attempt to generate as many possible solutions that you can think of that would result in a successful outcome.

Young Pilot Scenario

A young pilot, recently made captain, was placed in charge of what should have been a short voyage on a course through a rough bit of ocean in the North Sea. There was only one known course through the pass which the ship had to traverse in order to reach the destination port and deliver its cargo. The pass was narrow and had to be navigated almost perfectly in order to not run the ship aground in the shallow waters. Before the captain left, his commander emphasized that only this route was to be used. Also before leaving its home port, the ship had acquired a wealthy passenger demanding that he reach his home that evening. The crew was attempting to contact the commander at the destination port, because his office overlooked the pass and he could help determine whether to proceed or not.

Unfortunately, the crew was in one of the worst storms they had ever experienced and communication with the shore office was broken and difficult to understand. Since the storm involved intense lightning, the navigation system had been on the fritz all evening and they had lost their heading several times. The ship was approaching a point where once passed they could not turn back. The captain had to decide now whether to risk wrecking the ship or set a course for a safe harbor. Since the cargo was perishable, it would spoil if the destination port was not reached that evening, as none of the neighboring safe harbors had any means of keeping it fresh.

On the next page, consider some options for the young pilot and why they might be tried.

Counterfactual Scenarios

Mr. Jones Scenario

Again generate as many possible solutions that would satisfy what the problem asks for. Mr. Jones was 47 years old, the father of three and a successful banking executive. His wife had been ill at home for several months. On the day of the accident, Mr. Jones left his office at the regular time. He sometimes left early to take care of the home chores at his wife's request, but this was not necessary on that day. Mr. Jones did not drive home by his regular route. The day was exceptionally clear and Mr. Jones told his friends at the office that he would drive along the shore to enjoy the view.

The accident occurred at a major intersection. The light turned amber as Mr. Jones approached. Witnesses noted that he braked hard to stop at the crossing, although he could have easily gone through. His family recognized this as a common occurrence in Mr. Jones' driving. As he began to cross after the light changed, a light truck charged into the intersection at top speed, and rammed Mr. Jones' car from the left. Mr. Jones was killed instantly.

It was later ascertained that the truck was driven by a teenage boy, who was under the influence of drugs.

As commonly happens in such situations, the Jones family and their friends often thought and often said, "If only…", during the days that followed the accident.

How might they have continued this thought? Please write one or more likely completions of this thought.

Jane Scenario

Jane is attending a rock concert of her favorite band. After the first set, it is announced that a lucky fan is going to win a free trip to Hawaii. The winner will be determined by the seat number which this individual is currently occupying. Just moments ago, Jane had switched seats with a tall gentleman in order to get a better view of the stage. Over the loud speaker, she hears, "The lucky fan who just won a fabulous trip to Hawaii is seated in 34B. Jane wasn't sure what seat she was in, since she switched. Several people shouted out that Jane had won the free trip. Jan looked down at her seat number. She was now in seat 34B and had won the free trip!

Now that you have read the scenario, although the outcome was positive, please write down any thing you can think of that could have been different, thus, changing Jane's outcome.

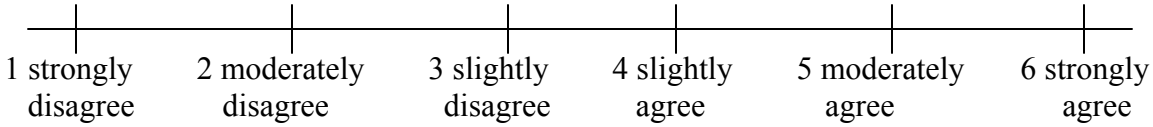
Appendix D – Individual Differences Measures

Demographics Survey

1. Age _____
2. Gender _____
3. Year in School _____
4. Number of classes taken in Accounting _____
5. Number of classes taken in Business _____
6. Number of classes taken in Economics _____
7. Number of classes taken in Marketing _____

"Attitude, Belief, and Experience Survey" - Need for Cognitive Closure

Read each of the following statements and decide how much you agree with each according to your beliefs and experiences. Please respond according to the following scale. Write your response in the blank to the left of the statement.



_____ 01. I think that having clear rules and order at work is essential for success.

_____ 02. Even after I've made up my mind about something, I am always eager to consider a different opinion.

_____ 03. I don't like situations that are uncertain.

_____ 04. I dislike questions which could be answered in many different ways.

_____ 05. I like to have friends who are unpredictable.

_____ 06. I find that a well ordered life with regular hours suits my temperament.

_____ 07. I enjoy the uncertainty of going into a new situation without knowing what might happen.

_____ 08. When dining out, I like to go to places where I have been before so that I know what to expect.

_____ 09. I feel uncomfortable when I don't understand the reason why an event occurred in my life.

_____ 10. I feel irritated when one person disagrees with what everyone else in a group believes.

_____ 11. I hate to change my plans at the last minute.

_____ 12. I would describe myself as indecisive.

_____ 13. When I go shopping, I have difficulty deciding exactly what it is I want.

_____ 14. When faced with a problem I usually see the one best solution very quickly.

_____ 15. When I am confused about an important issue, I feel very upset.

_____ 16. I tend to put off making important decisions until the last possible moment.

_____ 17. I usually make important decisions quickly and confidently.

_____ 18. I have never been late for an appointment or work.

_____ 19. I think it is fun to change my plans at the last moment.

_____ 20. My personal space is usually messy and disorganized.

_____ 21. In most social conflicts, I can easily see which side is right and which is wrong.

_____ 22. I have never known someone I did not like.

_____ 23. I tend to struggle with most decisions.

_____ 24. I believe orderliness and organization are among the most important characteristics of a good student.

_____ 25. When considering most conflict situations, I can usually see how both sides could be right.

_____ 26. I don't like to be with people who are capable of unexpected actions.

_____ 27. I prefer to socialize with familiar friends because I know what to expect from them.

_____ 28. I think that I would learn best in a class that lacks clearly stated objectives and requirements.

_____ 29. When thinking about a problem, I consider as many different opinions on the issue as possible.

_____ 30. I don't like to go into a situation without knowing what I can expect from it.

_____ 31. I like to know what people are thinking all the time.

_____ 32. I dislike it when a person's statement could mean many different things.

_____ 33. It's annoying to listen to someone who cannot seem to make up his or her mind.

_____ 34. I find that establishing a consistent routine enables me to enjoy life more.

_____ 35. I enjoy having a clear and structured mode of life.

_____ 36. I prefer interacting with people whose opinions are very different from my own.

_____ 37. I like to have a plan for everything and a place for everything.

_____ 38. I feel uncomfortable when someone's meaning or intention is unclear to me.

_____ 39. I believe that one should never engage in leisure activities.

_____ 40. When trying to solve a problem I often see so many possible options that it's confusing.

_____ 41. I always see many possible solutions to problems I face.

_____ 42. I'd rather know bad news than stay in a state of uncertainty.

_____ 43. I feel that there is no such thing as an honest mistake.

_____ 44. I do not usually consult many different options before forming my own view.

_____ 45. I dislike unpredictable situations.

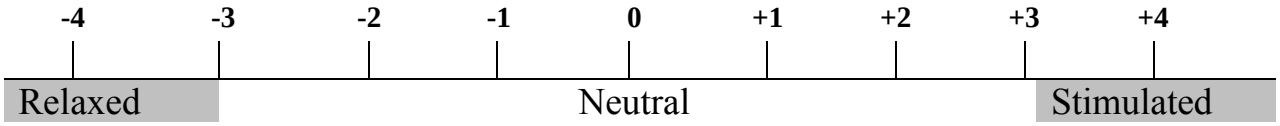
_____ 46. I have never hurt another person's feelings.

_____ 47. I dislike the routine aspects of my work (studies).

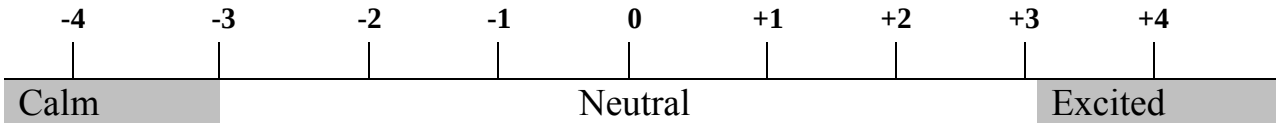
Arousal Scale

***For each of the five statements below, please circle the number that best describes how you feel* RIGHT NOW.**

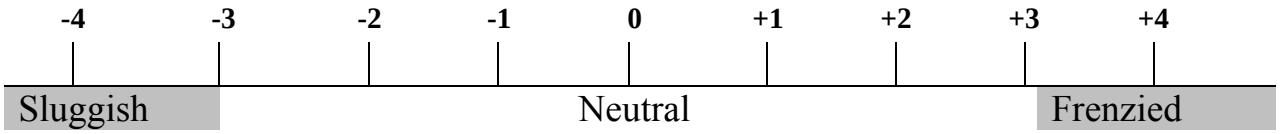
2. I am…



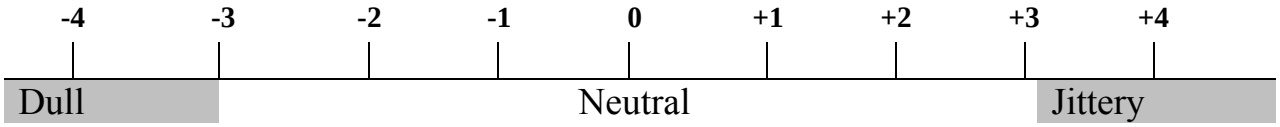
3. I am…



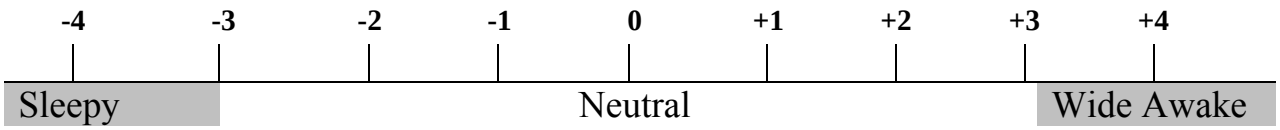
4. I am…



5. I am…



6. I am…



Mood Scale

This scale consists of a number of words that describe different feelings and emotions. For each emotion listed, please circle the number that best reflects how you feel **RIGHT NOW**.

5 = Extremely 4 = Quite a Bit 3 = Moderately 2 = A Little 1 = Very Slightly or Not at All		**Extremely** **Quite a Bit** **Moderately** **A Little** **Very Slightly or Not at All**				
1.	**ACTIVE**……	**1**	**2**	**3**	**4**	**5**
2.	**AFRAID**……	**1**	**2**	**3**	**4**	**5**
3.	**ALERT**…….	**1**	**2**	**3**	**4**	**5**
4.	**ASHAMED**……	**1**	**2**	**3**	**4**	**5**
5.	**ATTENTIVE**…….	**1**	**2**	**3**	**4**	**5**
6.	**DETERMINED**……..	**1**	**2**	**3**	**4**	**5**
7.	**DISTRESSED**……	**1**	**2**	**3**	**4**	**5**
8.	**ENTHUSIASTIC**……	**1**	**2**	**3**	**4**	**5**
9.	**EXCITED**…….	**1**	**2**	**3**	**4**	**5**
10.	**GUILTY**……...	**1**	**2**	**3**	**4**	**5**
11.	**HOSTILE**…….	**1**	**2**	**3**	**4**	**5**
12.	**INSPIRED**……	**1**	**2**	**3**	**4**	**5**
13.	**INTERESTED**……..	**1**	**2**	**3**	**4**	**5**
14.	**IRRITABLE**…….	**1**	**2**	**3**	**4**	**5**
15.	**JITTERY**…….	**1**	**2**	**3**	**4**	**5**
16.	**NERVOUS**……	**1**	**2**	**3**	**4**	**5**
17.	**PROUD**……	**1**	**2**	**3**	**4**	**5**
18.	**SCARED**……..	**1**	**2**	**3**	**4**	**5**
19.	**STRONG**…….	**1**	**2**	**3**	**4**	**5**
20.	**UPSET**……	**1**	**2**	**3**	**4**	**5**

Decision Making Style (DMS) Scale

Instructions:
Listed below are statements describing how individuals go about making *important decisions.* Please indicate how much you agree with each statement by circling a number on the accompanying scale. It ranges from 1 (Strongly disagree) to 5 (Strongly agree).

	Strongly Disagree				Strongly Agree
1. I double-check my information sources to be sure I have the right facts before making decisions.	1	2	3	4	5
2. I make decisions in a logical and systematic way.	1	2	3	4	5
3. My decision making requires careful thought.	1	2	3	4	5
4. When making a decision, I consider various options in terms of a specific goal.	1	2	3	4	5
5. When making decisions, I rely upon my instincts.	1	2	3	4	5
6. When I make decisions, I tend to rely on my intuition.	1	2	3	4	5
7. I generally make decisions that feel right to me.	1	2	3	4	5
8. When I make a decision, it is more important for me to feel the decision is right than to have a rational reason for it.	1	2	3	4	5
9. When I make a decision, I trust my inner feelings and reactions.	1	2	3	4	5
10. I often need the assistance of other people when making important decisions.	1	2	3	4	5
11. I rarely make important decisions without consulting other people.	1	2	3	4	5
12. If I have the support of others, it is easier for me to make important decisions.	1	2	3	4	5
13. I use the advice of other people in making my important decisions.	1	2	3	4	5
14. I like to have someone to steer me in the right direction when I am faced with important decisions.	1	2	3	4	5
15. I avoid making important decisions until the pressure is on.	1	2	3	4	5
16. I postpone decision making whenever possible.	1	2	3	4	5
17. I often procrastinate when it comes to making important decisions.	1	2	3	4	5
18. I generally make important decisions at the last minute.	1	2	3	4	5
19. I put off making many decisions because thinking about them makes me uneasy.	1	2	3	4	5
20. I generally make snap decisions.	1	2	3	4	5
21. I often make decisions on the spur of the moment.	1	2	3	4	5
22. I make quick decisions.	1	2	3	4	5
23. I often make impulsive decisions.	1	2	3	4	5
24. When making decisions, I do what seems natural at the moment.	1	2	3	4	5