EFFECTS OF EMOTION, EMOTIONAL TOLERANCE, AND EMOTIONAL PROCESSING ON REASONING

by

AMANDA MICHELLE HARVEY

B.A., University of Colorado Colorado Springs, 2010

A thesis submitted to the Graduate Faculty of the

University of Colorado Colorado Springs

in partial fulfilment of the

requirements for the degree of

Master of Arts

Department of Psychology

2018
This thesis for the Master of Arts degree by

Amanda Michelle Harvey

has been approved for the

Department of Psychology

by

Michael A. Kisley, Chair

Lori James

Edie Greene

Date: 12/3/2018
Emotion plays a significant role in our reasoning even without awareness, perhaps especially for individuals who have a high affect intolerance (i.e., difficulties tolerating strong, negative emotions). For such individuals, the ability and opportunity to reflect on emotion may help clarify when emotions should influence reasoning. Two studies were conducted in an attempt to clarify the nature of the relationships between reasoning, emotions, and affect intolerance. The first examined the effect of affect intolerance on performance on an emotional reasoning task. Participants were asked to determine whether conclusions logically follow from both emotional and neutral conditional (“if-then”) statements. Emotion had a small effect on performance on the reasoning task; however, affect intolerance did not moderate the relationship. The second study questioned whether reflecting on one’s emotional responses affects performance on the same reasoning task. Participants who were asked to reflect on their emotions performed more poorly on the reasoning task than participants asked to reflect on cognitive aspects of the task. Affect intolerance moderated this effect such that people who were more tolerant of their emotions performed better in the cognitive reflection condition than in the emotional reflection condition, but individuals who were less tolerant of their emotions performed the same in both conditions. Overall, these studies support previous findings that emotion can negatively impact performance on reasoning tasks but suggest a more complex relationship for affect intolerance.
DEDICATION

This thesis is dedicated to my children. To my son, who has asked profound questions about the universe since he could ask questions. And to my daughter, who will accomplish whatever she wants in life. I have no doubts.
ACKNOWLEDGEMENTS

First and foremost, I would like to recognize my family who have supported me through this program and made it possible for me to pursue this degree. You gave me space and support when I needed them, and I could not have done this without you all. I would also like to acknowledge the amazing insights and critiques from my committee who pushed me further than I believed I could go. An additional and special “Thank You” to my mentor for believing in my ideas and patiently listening while I put them into words. Thank you to the many excellent professors in the program who facilitated discussion in the classroom which expanded our concepts of psychology and the world. I’d also like to thank the Graduate School for selecting me for the 2017-2018 Graduate Student Research Fellowship, which greatly helped in funding this project. Finally, I’d like to express my deeply felt appreciation for all the individuals who spoke up for me during every step of this process, from those beginning recommendation letters to the very end.
# TABLE OF CONTENTS

**CHAPTER**

I. **INTRODUCTION** ...................................................................................................1
   - The Illogical Wise Human ...........................................................................2
   - When Emotions Get Involved ......................................................................5
   - The Moderating Effect of Metaemotion ......................................................9
   - Current Study .............................................................................................13

II. **STUDY 1** ...............................................................................................................14
   - Method .......................................................................................................14
     - Participants ..........................................................................................14
     - Materials ..........................................................................................15
       - Reasoning Task ..............................................................................15
       - Reading Comprehension .................................................................16
       - Affect Intolerance Scale (AIS) .........................................................17
     - Procedure ..........................................................................................17
     - Dependent Variable ...........................................................................18
     - Analysis .............................................................................................19
   - Results ........................................................................................................20
     - Descriptives .......................................................................................20
     - Correlations .......................................................................................21
     - Hypothesis Testing .............................................................................21
Reference Model (Model 1) ................................................................. 21
Residual Structure (Model 2) ................................................................. 22
Fixed Effects (Model 3) ................................................................. 23
Hypothesis 1 ........................................................................... 24
Hypothesis 2 ........................................................................... 24
Post-Hoc Exploratory Analysis ................................................................. 24
Correlations ........................................................................... 25
Linear Mixed Modelling ................................................................. 26

III. STUDY 2 ................................................................................................. 28

Method ................................................................................................. 28

Participants ................................................................................... 28
Materials .......................................................................................... 29
Procedure ...................................................................................... 30
Dependent Variable ......................................................................... 31

Results ................................................................................................. 31

Descriptives ................................................................................... 31
Correlations ................................................................................... 32
Hypothesis Testing ........................................................................ 33

Reference Model (Model 1) ................................................................. 34
Residual Structure (Model 2) ................................................................. 34
Fixed Effects (Model 3) ................................................................. 35
Hypothesis 1 ........................................................................... 35
Hypothesis 3 ........................................................................... 36

IV. GENERAL DISCUSSION ........................................................................ 38
Limitations and Future Study.................................................................43
Conclusion ...............................................................................................44
REFERENCES ..............................................................................................46

APPENDICES

A. Conditional Statements modified slightly from Blanchette (2006) ............51
B. Reading Comprehension Task .................................................................53
C. Items from the Affect Intolerance Scale .................................................56
D. IRB Approval ..........................................................................................58
LIST OF TABLES

TABLE

1. Commonly Assigned Attributes for System/Type 1 and System/Type 2 ......................6
2. Possible Conclusions (Both Valid and Invalid) for Conditional Statements ..........16
4. Correlation Matrix for Variables in Study 1 ..........................................................21
5. Models 2 and 3 for Linear Mixed Modelling in Study 1 ...........................................23
6. Correlation Matrix for Variables in Study 1 Exploratory Analysis .........................26
7. Models for Exploratory Analysis in Study 1 ............................................................27
9. Correlation Matrix for Variables in Study 2 ............................................................33
10. Final Model (Model 3) for Linear Mixed Modelling in Study 2 .........................36
LIST OF FIGURES

FIGURE

1. Trolley Car Problem ........................................................................................................12

2. Example of Classic ANCOVA Results...............................................................................34

3. Interaction Between Condition and Affect Intolerance ..................................................37

4. Interaction Between Condition and Affect Intolerance (Emotional Questions)..............41

5. Interaction Between Condition and Affect Intolerance (Neutral Questions)...............42
CHAPTER I

INTRODUCTION

Reason – encompassing every day decision-making, problem solving, and formal logic (Galotti, 1989) – is involved in many human activities from deciding which clothes to wear to voting on complicated social issues. Although we assume that our conclusions (and thus our actions) are informed by “good,” deliberative reasons, we may find it surprisingly difficult to explain ourselves if challenged by others. Recently, researchers have argued that many of our daily choices and conclusions are not so well-thought out but instead are made intuitively (Haidt, 2001; Mercier & Sperber, 2011). Intuitive reasoning includes the inputs of fast, largely unconscious processes, including immediate emotional responses (Evans, 2008). Unchallenged by ourselves or by others, intuitions, in part driven by emotional input, are likely to satisfy our self-imposed requirements for a “good conclusion” (Mercier & Sperber, 2017). Unfortunately, the emotions that a situation may stir up are not always important inputs and may interfere with reasoning. Emotional stimuli have been shown to influence people’s ability to think logically (Blanchette, 2006; Blanchette & Richards, 2004; Jung, Wranke, Hamburger, & Knauff, 2014; Lerner, Li, Valdesolo, & Kassam, 2015), contributing to the common conception that emotion and reason are opposite. If, however, emotional stimuli are relevant to the task (such as viewing pictures of tortured animals when asked to complete a task about animal abuse), emotions can enhance performance on reasoning tasks (Blanchette, Gavigan, & Johnston, 2014). This result begs some questions: Can people consciously
assess whether their emotions are relevant inputs for their conclusions? Would doing so influence those conclusions?

Of course, to reflect on one’s emotions, one must acknowledge those emotions and be willing to confront them. For some, this prospect is challenging. Individuals who view their emotions as threatening and unwelcome, a concept called affect intolerance (Stapinski, Abbott, & Rapee, 2014), may be less likely to engage with their emotional responses, begging a final question: Does affect intolerance influence our reasoning about emotional topics? This paper explores these three concepts: the intuitive nature of reasoning, the influence of emotion on different types of reasoning, and the possible effect of our attitudes and feelings towards emotion. It suggests that the relationship between emotion and reason is complex and asks whether emotional tolerance may play a role in how emotions interact with reasoning.

**The Illogical Wise Human**

The name of our species, Homo sapiens, was designated by Carl Linnaeus in 1758 and literally means “wise man.” It highlights humanity’s ability to reason and arguably elevates it to our defining feature (Quammen, 2010). Reason can be defined as “mental activity that consists of transforming given information… in order to reach conclusions” (Galotti, 1989, p. 333). Galotti argued that the term and process of “reasoning” encompasses a broad range of cognitive tasks, from daily decision-making to problem solving and formal logic. In the history of philosophy and science, reason has often been perceived as a pure, intellectual tool with which humanity can understand the true nature of the universe (Gottlieb, 2016). Truly, many impressive examples of pure human logic have emerged during the millennia of recorded history. Ancient Greek Eratosthenes
calculated the diameter of the earth within a narrow margin using the distances between
two cities and the mathematics of shadows (Mercier & Sperber, 2017). Similarly,
Empedocles and his student Democritus anticipated modern atomic theory by reasoning
that matter must consist of many very small, irreducible units (Gottlieb, 2016).

Despite our accomplishments, the last several decades of research on human
reasoning have suggested that reason sometimes fails to reach “correct” conclusions.
Kahneman and Tversky (1973) found that people tend to ignore objective probability
once seemingly relevant information is provided. Participants were given a character
vignette of a student (Tom) and asked to estimate the likelihood that he was a graduate
student in each of nine graduate programs. The pattern of likelihood rates more closely
resembled judgements on whether Tom’s description matched the stereotype of a typical
student in that program than estimates of the base rates of attendance for those programs.
This similarity persisted even though participants reported low confidence that traits
could accurately predict one’s graduate program.

More recently, Brotherton and French (2014) found that 93.4% of their sample
made at least one error in a 24-item conjunction fallacy task, with an average of 8.17
errors. The conjunction fallacy occurs when individuals rate the probability of two events
occurring together as more probable than one of the two events occurring alone. For
example, participants might be told information about Linda, an intelligent woman who is
concerned about social issues. Given this information, participants are more likely to
presume that she is both a bank teller and active in feminism than that she is only a bank
teller (Tversky & Kahneman, 1983). These conclusions run contrary to classical
probability rules stating that a single event will always be more probable than that event
plus another event. Regardless of Linda’s personality traits, she is more likely to be only a bank teller than a bank teller AND a feminist.

Mistakes such as those found in reasoning research may appear relatively trivial, but faults in reasoning can have high impact for both decision-making and critical thinking. Individuals who performed poorly on a battery of reasoning and self-awareness tasks (e.g., failed to correctly judge risk, failed to recognize their own limits, failure to apply decision rules to situations) were more likely to regret their decisions, avoid decisions, or make spontaneous decisions (de Bruin, Parker, & Fischhoff, 2007).

Individuals who do not reflect on their thinking are more likely to endorse superstition, pseudoscience and conspiracy theories (Brotherton & French, 2014; Pennycook, Fugelsang, & Koehler, 2015; Swami, Voracek, Stieger, Tran & Furnham, 2014).

Conspiratorial thinking can contribute to science denial, the general suspicion of ideas well-accepted by the scientific community such as climate change (Lewandowsky, Oberauer, & Gignac, 2013) and vaccination efficacy (Jolley & Douglas, 2014).

In much of the above research, intuitive thinking has been nominated as a significant contributor to mistakes in logic. Frederick (2005) introduced the Cognitive Reflection Test (CRT), a series of questions that have intuitively satisfying but incorrect answers. For example, if told that A) a bat and a ball cost $1.10 together and that B) the bat costs $1.00 more than the ball, participants are intuitively drawn to the assumption that the ball costs $0.10 and the bat $1.00. However, the ball must cost $0.05 and the bat $1.05 because that is the only way both premises are satisfied \([A: $1.05 \text{ (price of bat)} + $0.05 \text{ (price of ball)} = $1.10; B: $1.05 \text{ (price of bat)} = $1.00 + $0.05 \text{ (price of ball)}]\). When presented with questions from the CRT, many people will provide the incorrect,
intuitive responses. Poor performance on these tasks may reflect a tendency to rely on heuristics (or cognitive shortcuts) while solving problems (Toplak, West, & Stanovich, 2011).

The idea that heuristics often lead to errors in thinking remains somewhat controversial (Gigerenzer & Gaissmaier, 2011; Kahneman & Tversky, 1996), but such errors provide some of the core arguments for dual-system theories. The specifics of the dual-system (or dual-process) family of theories vary depending on the theorist, but all of them hold that humans have two distinct modes of information processing (Evans, 2008). The first, widely called System/Type 1 (Stanovich, 1999), is fast, unconscious, and vague, encompassing intuition and emotion. The second, System/Type 2 (Stanovich, 1999), is slow, deliberate, and requires considerably more effort. Different theorists often label Type 1 and Type 2 processes with opposing titles (e.g., Automatic vs. Controlled, Intuitive vs. Analytic, Impulsive vs. Reflective) and assign them similarly opposing attributes (see Table 1). For example, Type 1 processes are described as fast and automatic whereas Type 2 processes are slow and controlled. Although dual-process theories are not identical in their assumptions, many of them present the two modes as diametrically opposed and assume that “fast” and “slow” processes operate independently. In general, these theories explain how deliberate Type 2 processes override intuitive Type 1 processes, but less often consider the influence of inferences made by intuitive processes on deliberative conclusions.

When Emotions Get Involved

The process of reasoning (transforming information to reach conclusions) can be invoked for several types of task, such as decision-making, logical conclusions, and
Table 1

*Commonly Assigned Attributes for System/Type 1 and System/Type 2*

<table>
<thead>
<tr>
<th>System 1 Traits</th>
<th>System 2 Traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unconscious (preconscious)</td>
<td>Conscious</td>
</tr>
<tr>
<td>Implicit</td>
<td>Explicit</td>
</tr>
<tr>
<td>Automatic</td>
<td>Controlled</td>
</tr>
<tr>
<td>Low Effort</td>
<td>High Effort</td>
</tr>
<tr>
<td>Rapid</td>
<td>Slow</td>
</tr>
<tr>
<td>High Capacity</td>
<td>Low Capacity</td>
</tr>
<tr>
<td>Default Process</td>
<td>Inhibitory</td>
</tr>
<tr>
<td>Holistic, perceptual</td>
<td>Analytic, reflective</td>
</tr>
</tbody>
</table>

*Note.* System 1 (or Type 1) is associated with fast and largely unconscious processes, including emotional responses. System 2 (or Type 2), in contrast, encompasses slow, effortful processes and typically includes deliberative reasoning. From Evans, J. St B. T. (2008). Dual-processing accounts of reasoning, judgement, and social cognition. *Annual Review of Psychology, 59,* 255-78.

Moral judgements (Galotti, 1989). In each of these, the effect of emotion can differ in both degree and quality. From the perspective of dual-process theories, emotion is categorized as a Type I mechanism that people often must overcome to be reasonable. However, emotion may facilitate some types of reasoning, such as decision-making (Damasio, 1994; Zajonc, 1980). Damasio (1994) used evidence from brain lesion patients to suggest that feelings and emotions were critical to decision-making. Individuals who had experienced brain damage to areas processing internal sensations consistently made disadvantageous choices. For instance, they were frequently unreliable, demonstrated an inability to stay on task or even begin tasks, and made damaging social and financial decisions. Neuropsychological examination of these individuals revealed deficits in their own emotional expression and awareness despite understanding emotional and social norms and being otherwise intellectually normal.

With this information, Damasio concluded that much of emotion results from the interpretation of our bodily states in context with our environment and, critically, these
interpretations are included in our reasoning and decision-making processes. He
developed the somatic marker hypothesis that posits that reasoning is aided by
unconscious and immediate emotional responses to the predicted outcomes of specific
behaviors. Predicted outcomes that create aversive bodily responses are “marked” as
undesirable, and their corresponding behaviors are discarded. This process allows us to
reduce the overall number of possible choices and helps to explain certain phenomena,
such as the “gut reaction.” Damasio precipitated a variety of neuro- and cognitive
psychological research suggesting that cognition and emotion are processed by
interdependent regions of the brain and are not as easy to disentangle as previously
assumed (e.g., Dolan, 2002; Pessoa, 2008)

Although emotion helps us make decisions, it may interfere with logical
conclusions. For example, people are more likely to make mistakes in logic tasks when
the tasks include emotional words than when the words are neutral (Blanchette &
Richards, 2004). Contradictory evidence that emotion aids in decision-making but leads
people to be poor logical reasoners have led some theorists to adopt positions
highlighting the role of intuitive inference. Early on, Wason and Evans (1975) established
that people rationalize intuitive conclusions after the fact. More recently, Mercier and
Sperber (2011) introduced the argumentative theory of reason that, in part, asserts that
humans make immediate conclusions based off unconscious inferences and attitudes,
including emotion. A person (Jane) may sense that her friend (Sarah) is angry. The
specific inferences that made up this conclusion are likely not conscious. Jane probably
did not consciously perceive minute changes in Sarah’s voice, facial expressions, or
behavior and then combine those perceptions with existing knowledge on how anger has
been expressed to her in the past, concluding (finally) that Sarah was angry. The intuitive approach to reasoning suggests that Jane’s brain did all of this immediately and produced the conclusion without providing details on “why.” Furthermore, the “why” may include the influence of Jane’s own negative emotional state caused by the lecture she had just received from a parent. However, if asked, Jane could probably provide reasons why she believes Sarah is angry, retroactively explaining her immediate, intuitive conclusion. Jane’s reasons may or may not resemble the unconscious inferences that created her intuition in the first place. For many conclusions, people do not feel the need to produce reasons to support their positions unless pressed to do so by others even though they can recognize that their own conclusions may be inadequate (Trouche, Johansson, Hall, & Mercier, 2016).

Moral reasoning is a specific type of reasoning in which the influence of intuitions, and emotion specifically, has been extensively researched. Haidt (2001) espoused the importance of intuitive thought processes and post-hoc reasoning when making moral decisions. This theory, called social intuitionism, suggests that people have immediate emotional responses to moral dilemmas and apply social and personal values after the fact to explain these responses. His theory counters a rationalist perspective suggesting that conclusions emerge from reasoned deliberation (Williams, 2006). Instead, Haidt and other intuitionists suggest actively reasoning towards a conclusion is more the exception than the rule (Haidt, 2001, 2007).

Critically, intuitionist perspectives like Haidt’s acknowledge that emotional and social factors, though not always “logical,” are often relevant to situations about which people might reason. Emotional factors can influence our decisions; we should not
automatically assume that emotions are irrelevant in forming reasoned conclusions (Lerner et al., 2015). Emotional content can impact how people evaluate persuasive messages, even if the emotional impact of the stimuli is not salient (Petty & Briñol, 2015). A critical aspect of reasoning and argumentation is the ability to assess the validity of an offered reason. Emotion-based responses may be important factors in accepting a conclusion or they may not. Blanchette, Gavigan, and Johnston (2014) found that explicitly relevant emotional stimuli, such as images of starving children when asked a question about food, can enhance performance on a classic reasoning task. Incidental, or unrelated, emotion from a previous irrelevant stimulus, such as a traffic accident when asked about food, interfered with reasoning. Combined, these results suggest that emotion itself is not necessarily detrimental but is not always a relevant input for reasoning. It may be especially detrimental when individuals are not accepting or even aware of their emotional reaction. Without awareness, individuals would be unable to evaluate emotion’s relevance to the task because emotion’s effects would not be identified. This is sometimes the case for people who hold negative metaemotional philosophies.

**The Moderating Effect of Metaemotion**

Occasionally, people may get angry and lose their temper with someone and then immediately feel ashamed about their anger. They may feel sad and then become angry at their sadness. People may tell themselves they should not feel a particular way or that their emotions are unsafe. These are all examples of metaemotion. Metaemotion can briefly be described as feelings about feelings, though some argue that the phenomenon could include knowledge and strategies about feelings (Norman & Furnes, 2016). The term “metaemotion” was introduced by Gottman, Katz, and Hooven (1996) to address
differences in how parents viewed and reacted to the emotions of their children. They demonstrated differences in academic, social, and health outcomes for children whose parents were intolerant of their children’s emotions and behaved by denying them or shutting them down (Gottman et al. 1996; Katz, Maliken, & Stettler, 2012).

More recently, researchers have measured metaemotional philosophies and found they correlate to several deleterious outcomes. Mitmansgruber, Beck, Höfer, and Schüßler (2009) viewed positive metaemotion as a willingness of people to engage with their emotions. People may take interest in their emotions and react with compassion for themselves. Alternatively, people may become upset by strong emotions, deride themselves, or even attempt to suppress their emotions altogether. Negative metaemotion (the latter set of behaviors) was found to be associated with lower life satisfaction and psychological well-being (Mitmansgruber et al., 2009). Manser, Cooper, and Trefusis (2012) conceptualized metaemotion as a metacognitive function regarding beliefs surrounding emotional states. Individuals may feel their emotions are embarrassing, useless or overwhelming. They may express concern that others will “catch” their emotions or that emotions will spread within themselves. Such beliefs were found to be associated with anxiety and depression (Manser et al., 2012). Similar to these conceptualizations and others is emotion intolerance, the focus of the Affect Intolerance Scale (AIS; Stapinski et al., 2014). Intolerance indicates the degree to which one believes that one’s negative feelings are threatening, could bring on disastrous consequences, and should be avoided or suppressed. As measured by the AIS, both feeling threatened by emotions and attempting to avoid them are related to depression, anxiety and stress
While metaemotion is a relatively novel approach to understanding emotion’s influence on cognition, related factors such as emotion regulation have been examined. Emotion regulation consists of a wide variety of strategies people employ to manage emotional reactions (Gross, 1998). Strategies can occur at different moments in emotional processing and are associated with different cognitive outcomes (Gross, 2002). For instance, in one study, suppressing emotions stunted memory and attention while reappraising the situation in a more positive light did not (Richards & Gross, 2000). In another study, individuals who tended to use a reappraisal strategy were less likely to judge certain situations as immoral than those who simply suppressed their emotions (Feinberg, Willer, Antonenko, & John, 2012). This suggests that people who engage with their emotions can separate their immediate emotional reactions from the tasks they are being asked to perform.

Some evidence suggests that metaemotion may mediate the relationship between emotion and some types of reasoning. For instance, Koven (2011) introduced participants to the classic trolley problem (see Figure 1). The trolley problem presents a story where five individuals (often strangers or workers) are standing on a train track. They are blissfully unaware that a train is rapidly approaching. On an adjoined track stands a single individual, also unaware of the oncoming train. The participant is asked whether they would allow the train to continue down its original track, killing the five people but removing the participant’s involvement, or switch the track so that the train kills the solitary person, saving the five other lives but also making the participant culpable in a
death. Koven (2011) found that people who scored higher in clarity of emotion (defined as the ability to understand and distinguish between emotions) were less likely to report they would switch the track in the trolley problem. In other words, people with a better understanding of their emotions elevated social rules (e.g., killing is wrong) over maximizing the number of lives saved (e.g., saving the life of five vs. one person).

![Trolley Car Problem](https://en.wikipedia.org/wiki/Trolley_problem)

**Figure 1.** Trolley Car Problem. The trolley car problem presents participants with an option to allow a train to kill five people or switch the track so that the train kills one person instead. Image retrieved from https://en.wikipedia.org/wiki/Trolley_problem.

Koven’s results suggest that people who are more in touch with their emotions allow those emotions to interfere with a strategy of “cold reasoning.” However, Koven’s task examined moral reasoning for which the relevance of emotion can be complicated. It is difficult to suggest that the wide range of emotional experience can or should be separated from moral evaluations (Tangney, Stuewig, & Mashek, 2007); in fact, some argue that removing emotion from moral evaluations is used as a strategy to deny the experiences of others (Wolf, 2017). To date, intolerant metaemotion has not been tested as a moderator in the relationship between emotion and logical reasoning, nor has explicitly encouraging individuals to engage with their own emotions. Perhaps if people actively acknowledge emotion’s role in their reasoning, the emotion’s relevance could be more easily determined. However, individuals who are uncomfortable with their
emotions may choose not (or be unable) to reflect on or acknowledge that an emotional reaction is occurring.

**Current Study**

The goals of the current research are three-fold. First, it seeks to replicate previous findings that activating strong emotions in participants interferes with the ability to perform logical reasoning tasks. Second, it proposes intolerant metaemotional perspectives as a potential moderator that helps to explain conflicting evidence on how emotion influences reasoning. I hypothesize that individuals who are intolerant of their emotions will be more susceptible to emotional interference with reasoning. Third, the current research aims to examine the effects of self-reflection on reasoning. I hypothesize that having the opportunity to assess feelings prior to performing logical reasoning tasks will allow participants to perform better on those tasks.
CHAPTER II
STUDY 1

Study 1 specifically examined the effect of intolerant metaemotion on a logical reasoning task. Participants were first presented a series of emotional and neutral conditional statements (if-then premises). For each, participants were asked to select which conclusions could correctly be drawn from the premises. Participants’ degree of affect intolerance was then assessed. If intolerant metaemotion interfered with the ability to evaluate or effectively implement emotional responses during a reasoning task, individuals with a high affect intolerance were expected to perform more poorly on emotional items than individuals with a low affect intolerance.

Method

Participants

Participants were recruited from the University of Colorado, Colorado Springs using the Sona System, an online research management program. For participating in the study, participants were compensated half an extra credit point. Three-hundred thirty-two participants were recruited. Of these, four were removed for failing to complete the entire survey and five were removed for missing data. Of the remaining 323, 177 (54.8%) answered both of the reading comprehension questions correctly. Planned analyses were performed using these 177 participants.

The 177 participants were largely female (74.0%) with a mean age of 21.74 (SD = 4.56). One-hundred nineteen (67.2%) participants identified as European
American/White, 11 (6.2%) as Asian American/Pacific Islander, 7 (4%) African American, 28 (15.8%) Hispanic/Latino, and 11 (6.2%) as another or more than one race. One-hundred sixty-five participants (93.2%) reported that English was their first language.

Materials

**Reasoning Task.** All participants were given a series of emotional and neutral conditional statements modified slightly from Blanchette (2006; see Appendix A). Blanchette reported that independent raters rated the emotional statements ($M = 5.04, SD = 1.29$) as significantly more emotional than the neutral statements ($M = 2.63, SD = 1.19$). Conditional statements are “if-then” premises in the form of “if $P$, then $Q$” and have four possible conclusions of which only two are logically valid (see Table 2). For example, a premise may state, “If a shape is a square, then it will have four sides.” A *modus ponens* (MP) conclusion ($p$, therefore $q$) would state that the shape is a square, therefore it has four sides. A *modus tollens* (MT) conclusion (not $q$, therefore not $p$) would state that the shape does not have four sides, therefore it is not a square. Both conclusions are valid according to traditional formal logic.

However, two common mistakes are made in conditional logic. Denying the antecedent (DA; not $p$, therefore not $q$) would state that the shape is not a square, therefore it does not have four sides. However, many shapes that are not squares have four sides (e.g., rectangle, rhombus), making this conclusion demonstrably false. Similarly, affirming the consequent (AC; $q$, therefore $p$) would state the shape has four sides, therefore it is a square. Because many examples of four-sided non-squares exist, this statement is also verifiably untrue.
Table 2

Possible Conclusions (Both Valid and Invalid) for Conditional Statements

<table>
<thead>
<tr>
<th>Argument Name</th>
<th>Form</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modus Ponens</strong></td>
<td>$p, \text{ therefore } q$</td>
<td>The shape is a square, therefore it has four sides.</td>
</tr>
<tr>
<td><strong>Modus Tollens</strong></td>
<td>not $q$, therefore not $p$</td>
<td>The shape does not have four sides, therefore it is not a square.</td>
</tr>
<tr>
<td><strong>Denying the Antecedent</strong></td>
<td>not $p$, therefore not $q$</td>
<td>The shape is not a square, therefore it does not have four sides.</td>
</tr>
<tr>
<td><strong>Affirming the Consequent</strong></td>
<td>$q$, therefore $p$</td>
<td>The shape has four sides, therefore it is a square.</td>
</tr>
</tbody>
</table>

*Note.* Of the four conclusions, *modus ponens* and *modus tollens* are considered logically valid. Denying the antecedent and affirming the consequent are commonly-made fallacious conclusions for conditional statements.

Participants saw five emotional conditional statements and five neutral conditional statements, each of which had four possible conclusions (MP, MT, DA, and AC). The themes and wording for each emotional statement and its neutral counterpart were kept as similar as possible. After data collection, it was discovered that one conclusion for a neutral if/then statement was a duplicate. This conclusion and its emotional counterpart were removed from both studies, leaving 19 emotional stimuli and 19 neutral stimuli.

**Reading Comprehension.** Participants were screened using a short reading comprehension task freely accessible from the National Assessment of Educational Progress (NAEP). The passage and questions were designed to test eighth grade reading comprehension skills. The task consists of a short passage followed by two multiple-
choice questions that require the reader to refer to and interpret the passage (see Appendix B). The inclusion of this task is intended to ensure that participants are fluent English speakers capable of reading and comprehending the reasoning task. Reading Comprehension was coded as one or both questions answered incorrectly (0) and both questions answered correctly (1). Participants who answered both questions correctly were included in the planned analysis.

**Affect Intolerance Scale (AIS).** The AIS (Stapinski et al., 2014) measures beliefs about emotions on two subscales (see Appendix C). Threat Expectancy measures a tendency to believe that strong negative emotions will be uncontrollable and cause harm. Items include, “My negative feelings could spiral out of control,” and, “My negative feelings stop me from enjoying life.” Avoid/Suppress measures the belief that strong negative emotions should be avoided. Items include, “I try to avoid negative feelings,” and, “I try to distract myself from negative feelings.” The scale and its subscales have good internal reliability (total scale $\alpha = .94$; Threat Expectancy subscale $\alpha = .94$; Avoid/Suppress $\alpha = .88$; Stapinsky et al., 2014). Affect intolerance was calculated by adding the totals from the Likert scale. Higher numbers on the AIS indicate a greater degree of agreement and higher levels of affect intolerance.

**Procedure**

Participants completed all measures and tasks online, beginning with the reasoning task. All participants were given both emotional and neutral conditional statements in a randomized order. Leftover emotion from the previous items may influence performance on the following items (Blanchette et al., 2014). The ten conditional statements were presented in a random order to help prevent ordering effects.
from influencing results. The four possible conclusions were presented one at a time while the conditional statement always remained visible. Participants were told to assume that the premise was absolutely true in order to help prevent a belief bias effect. Belief bias occurs when participants judge the validity of a conclusion based on its believability rather than how well supported it is by the premise (see Oakhill, Johnson-Laird, & Garnham, 1989) and has been shown to be reduced by giving specific instructions (Newstead, Pollard, Evans, & Allen, 1992). Participants were then asked to select from “Yes” or “No” whether each conclusion logically followed from the premise. For each statement, the order of the four possible conclusions was randomized to prevent participants from detecting response patterns. Following the reasoning task, participants completed the reading comprehension task. This served as both a literacy test and time break between the experimental reasoning task and the AIS, preventing any priming effects of the task.

Finally, participants were asked to complete the AIS. The positioning of the AIS at the end of the experiment prevents any priming effects from AIS items from influencing performance on the reasoning task. The order of the AIS items was first randomized and then administered in that order to all participants.

Participants provided demographic information including age, gender, and race at the end of the study. These factors were not expected to influence performance but provided an indication of group diversity and informed generalizability of results.

**Dependent Variables**

The dependent variable was the number of conclusions out of 38 correctly categorized as logically valid or invalid according to normative logic. In other words,
participants should have categorized *modus ponens* and *modus tollens* as valid and denying the antecedent and affrming the consequent as invalid. The Emotional and Neutral Correct variables were calculated by recoding MP and MT questions so that “Yes” equaled 1 and “No” equaled 0. Likewise, AC and AD questions were recoded so that “No” equaled 1 and “Yes” equaled 0. The totals were then added separately for emotional and neutral stimuli. Henceforth, the DV will be referred to as “correctness.”

Analysis

Data were analyzed using linear mixed model (LMM) analysis and IBM SPSS for Windows V.25 LMM module. Like regression analysis, LMMs allow the researcher to examine the effects of both categorical and continuous variables (fixed effects) but also controls for the intercept associated with each participant (random effects). In other words, LMM controls for idiosyncratic relationships in the dependent variable expected by repeated data collection from individual participants. Additionally, LMMs allow the exploration of categorical fixed variables and continuous covariates and their interactions in a repeated measures design. In this study, using LMM allows AIS to remain continuous, avoiding the loss of important data that might occur by artificially dichotomizing it (e.g., Maxwell & Delaney, 1993).

The LMM was carried out in accordance with the guidelines recommended by Molenberghs and Verbeke (2005) and West, Welch, and Galecki (2015). The procedure is as follows: first, a reference model is fit. This model does not test a hypothesis but serves as a saturated model against which specific hypotheses can be tested. A second model is then fit to examine the residual structure of the random effects. Finally, a third model eliminates non-significant fixed effects to examine the relationships demonstrated
by the data. Each of these steps will be further elaborated in the hypothesis testing section of the results. Though it is recommended for some methodologies, this analysis does not examine whether random effect should be retained. Because the procedure is a repeated measures design, it is assumed that the random effect associated with participant performance should be retained.

Results

Descriptives

Other than Duration, variables of interest were normally distributed (see Table 3). Duration was collected by the Qualtrics software and indicates how long (in minutes) participants took to complete the entire study. Duration had large skew (12.67) and kurtosis (164.50). Some participants appear to have begun the study and then completed it several hours later, indicating they may have paused and returned at a later a time. Even with the extreme outliers removed, Duration was not normal and could not be used in the LMM. Duration is examined in the correlation matrices, but all relationships should be interpreted with extreme caution.

Table 3

Means, Standard Deviations, Skew, and Kurtosis for Variables in Study 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>M (SD)</th>
<th>Skew</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration (in Minutes)</td>
<td>61.29 (506.87)</td>
<td>12.67</td>
<td>164.50</td>
</tr>
<tr>
<td>Age</td>
<td>21.74 (4.56)</td>
<td>1.87</td>
<td>3.14</td>
</tr>
<tr>
<td>Emotional Correct</td>
<td>12.61 (3.18)</td>
<td>0.74</td>
<td>-0.13</td>
</tr>
<tr>
<td>Neutral Correct</td>
<td>13.41 (3.36)</td>
<td>0.62</td>
<td>-0.44</td>
</tr>
<tr>
<td>Total Correct</td>
<td>26.02 (6.22)</td>
<td>0.90</td>
<td>-0.12</td>
</tr>
<tr>
<td>Affect Intolerance</td>
<td>103.59 (27.09)</td>
<td>-0.10</td>
<td>-0.44</td>
</tr>
</tbody>
</table>

Note. Mean, standard deviation, skew, and kurtosis for all variables in Study 1 are presented. Skew and kurtosis are close to or within the accepted range of ±2.00 for all variables except for Duration. Duration exhibits high skew and kurtosis and is not included in formal analysis. Age exhibits a kurtosis outside of the generally accepted range. However, age is not used in either planned or exploratory analyses.
Correlations

The correlation matrix for all variables, including duration, age and gender, is presented in Table 4. For these correlations, duration outliers \((N = 3)\), defined as being more than 3 standard deviations above the mean, were removed to more accurately examine its relationship to other variables. Duration continued to exhibit high skew and kurtosis even after removing the outliers, so relationships should continue to be interpreted cautiously. Duration was positively related to correctness for both emotional \((r = .15)\) and neutral \((r = .19)\) stimuli, but to a similar degree. Additionally, gender was significantly positively correlated with correctness for neutral questions \((r = .20)\). Because female is coded as 0, this correlation indicates that male participants were more likely to answer neutral questions correctly than female participants.

Table 4

**Correlation Matrix for Variables in Study 1**

<table>
<thead>
<tr>
<th></th>
<th>Dur.</th>
<th>Age</th>
<th>Gender</th>
<th>EC</th>
<th>NC</th>
<th>AIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration (Min)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>.11</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>.04</td>
<td>.17*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC</td>
<td>.15*</td>
<td>.03</td>
<td>.13</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NC</td>
<td>.19*</td>
<td>.07</td>
<td>.20**</td>
<td>.69***</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>AIS</td>
<td>.00</td>
<td>-.18*</td>
<td>-.10</td>
<td>-.04</td>
<td>-.07</td>
<td>1</td>
</tr>
</tbody>
</table>

*Note.* Duration, age, and gender are included in the correlation matrix though they were not included in planned or exploratory analyses. Duration outliers \((N = 2)\) were removed to examine the relationships more accurately, but Duration continued to have high skew and kurtosis. Therefore, correlations between Duration and other variables are interpreted with extreme caution. EC = Emotional Correct, NC = Neutral Correct, AIS = Affect Intolerance Scale. *\(p < .05\), **\(p < .01\), ***\(p < .001\)

**Hypothesis Testing**

**Reference Model (Model 1).** Model 1 was fit with a loaded mean structure to serve as a reference model for further testing. All variables of interest were included.
Participant was considered a random effect to account for the repeated measures design. Affect intolerance (i.e., scores on the AIS) and emotion (i.e., neutral or emotional question) were included as fixed effects. Additionally, the residual variance structure for Model 1 was assumed to be homogenous. A homogenous residual structure means that the variance of correctness for emotional questions and neutral questions is assumed to be the same. A Restricted Maximum Likelihood (REML) estimation was selected because it provides less biased estimates during analysis (West et al., 2015). Model 1 serves as a reference for hypothesis testing but does not test any hypotheses itself.

**Residual Structure (Model 2).** Model 2 tests the hypotheses:

\[ H_0: \sigma_{\text{emo}} = \sigma_{\text{neu}} \]

\[ H_a: \sigma_{\text{emo}} \neq \sigma_{\text{neu}} \]

Model 2 was fit with the same variables as Model 1 but allows the residual structure for the random effect to be heterogenous. This means the variance for emotional questions can differ from the variance for neutral questions. Participants may, for example, exhibit a greater variation in correctness for emotional questions than for neutral questions. As in Model 1, REML estimation is selected.

The test statistic is acquired by subtracting the -2 Log Likelihood model fit statistic from Model 2 from the -2 Log Likelihood of Model 1. This number is referenced on a chi-square table with a \( df = 1 \). A chi-square test is intended to detect whether two numbers, in this case the -2 Log Likelihood statistics, are different, indicated by a significant result. For this analysis, \( \chi^2(1) = 110.99, p < .001 \). A significant result means the null hypothesis that the residual structure is homogenous is rejected in favor of the
alternative hypothesis that the residual structure is heterogenous. Model 2 is retained. For demonstration, Model 2 is presented in Table 5.

Table 5

*Models 2 and 3 for Linear Mixed Modelling in Study 1*

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 2</th>
<th>95% CI</th>
<th>Model 3</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotion</td>
<td>-1.11 (.66)</td>
<td>[-2.42, -.18]</td>
<td>-0.72 (.17)</td>
<td>[-1.04, -.38]</td>
</tr>
<tr>
<td>AIS</td>
<td>-0.01 (.01)</td>
<td>[-.02, .01]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotion*AIS</td>
<td>0.00 (.01)</td>
<td>[.00, .02]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Model 1 is not presented because Model 2 was preferred when testing for residual structure. Model 2 includes all variables and their interactions with a heterogenous residual structure. Model 3 is the final model after removing interactions and main effects that were not significant. The interaction was removed first, after which the main effect of emotion became significant. Effect sizes are presented in unstandardized format and, therefore, cannot be compared to one another. Standard errors are included in parentheses. Effect sizes for the main effects of Model 2 cannot be interpreted directly because of the presence of the interaction between the two variables. 95% confidence intervals are presented in a [LL, UL] format. The parameter estimate for emotion in both models does not contain 0. AIS = Affect Intolerance Scale

**Fixed Effects (Model 3).** Model 3 was fit with all variables and their interactions and a heterogenous compound symmetry residual structure. Type-III F-Tests were examined to determine whether interactions and main effects should be retained in the final model. Interactions were examined first because the inclusion of interactions between fixed effects can influence the variance explained by main effects. The interaction between emotion and affect intolerance was not significant, $F(1, 175) = 0.405,$
This interaction was removed from the model to examine the main effects of emotion and affect intolerance. Once the interaction was removed, affect intolerance remained non-significant, $F(1, 175) = 0.524, p = .470$, and was also removed from the model. The final model is presented in Table 5.

**Hypothesis 1.** It was predicted emotion would negatively impact performance on the task such that participants would answer emotional items less correctly than neutral items. In the LMM, task emotionality significantly predicted correctness, $F(1, 176) = 18.44, p < .001$, replicating results from Blanchette (2006). As predicted, participants performed better on the neutral questions ($M = 12.67, SD = .22$) than on the emotional questions ($M = 11.96, SD = .20$).

**Hypothesis 2.** Affect intolerance was expected to negatively impact performance on emotional tasks. In the LMM, the interaction between emotion and the AIS was not significant and was removed from the final model. In this study design, individuals who were more intolerant of their emotions did not perform differently on emotional vs. neutral questions. Only emotionality of the question itself was predictive of accuracy.

**Post-Hoc Exploratory Analysis**

Study 1 included a reading comprehension screen taken from a government sponsored eighth grade reading examination. Though all participants in this study were college attendees, only 54.8% correctly responded to both of the screen questions. It is unclear whether this is due to reading comprehension itself or indicates a difference in attention allocated to the reading comprehension task. Other studies examining the relationship between emotion and reasoning rarely if ever examine reading comprehension. Because it is possible reading comprehension and its interactions explain
some of the variance in the data, exploratory analyses including reading comprehension were performed.

Participants in the exploratory analysis included all 323 participants who completed the study without missing data. Participants were mostly female (75.5%) and had a mean age of 21.93 ($SD = 5.00$). 206 (63.8%) identified as European American/White, 49 (15.2%) as Hispanic/Latino, 21 (6.5%) as Asian American/Pacific Islander, 19 (5.9%) as African American, 2 (.6%) as Native American, and 25 (7.7%) as more than one or another race.

**Correlations.** The correlation matrix for all variables with the addition of reading comprehension and the English as a Second Language (ESL) demographic is presented in Table 6. Reading Comprehension was coded as one or both questions incorrect (0) and both questions correct (1). Reading comprehension was positively correlated with correctness for both emotional ($r = .21$) and neutral ($r = .17$) questions to a similar degree. Individuals who responded to both reading comprehension questions correctly were more likely to respond correctly in the reasoning task than individuals who did not. Duration was not related in any way to reading comprehension supporting the suggestion that the relationship between reading comprehension and correctness may not simply be because of lack attention. The ESL demographic was significantly negatively related to correctness for both emotional ($r = -.13$) and neutral ($r = -.11$). However, there was no correlation between reading comprehension and the ESL demographic, $r = -.06$. This suggests the effects of reading comprehension may be due to something other than English fluency. An individual’s ability to comprehend what they are reading, apart from
Table 6

Correlation Matrix for Variables in Study 1 Exploratory Analysis

<table>
<thead>
<tr>
<th></th>
<th>Dur. (Min)</th>
<th>RC</th>
<th>Age</th>
<th>Gender</th>
<th>ESL</th>
<th>EC</th>
<th>NC</th>
<th>AIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dur.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RC</td>
<td>.08</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>.09</td>
<td>-.04</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>.02</td>
<td>.05</td>
<td>.13</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESL</td>
<td>.02</td>
<td>-.06</td>
<td>.11</td>
<td>.10</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC</td>
<td>.15**</td>
<td>.21***</td>
<td>.01</td>
<td>.10</td>
<td>-.13*</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NC</td>
<td>.15**</td>
<td>.17**</td>
<td>.04</td>
<td>.17**</td>
<td>-.11*</td>
<td>.65***</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>AIS</td>
<td>-.02</td>
<td>.03</td>
<td>-.20***</td>
<td>-.18***</td>
<td>-.04</td>
<td>.00</td>
<td>-.02</td>
<td>1</td>
</tr>
</tbody>
</table>

Note. Duration, age, and gender are included in the correlation matrix though they were not included in planned or exploratory analyses. Duration outliers (N = 3) were removed to examine the relationships more accurately, but Duration continued to have high skew and kurtosis. Therefore, correlations between Duration and other variables are interpreted with extreme caution. RC = Reading Comprehension, EC = Emotional Correct, NC = Neutral Correct, AIS = Affect Intolerance Scale. *p < .05, **p < .01, ***p < .001.

their fluency in the language, may predict their performance on reading-based reasoning tasks and may interact with both the question’s emotionality and affect intolerance.

Linear Mixed Modelling. LMM was performed as described in the planned analysis with reading comprehension added as a fixed effect. A reference model was fit with all variables and their interactions. A heterogenous residual selection was preferred over a model with a homogenous residual structure, \( \chi^2(1) = 166.08, p < .001 \). For demonstration, this model is presented in Table 7. Interactions between reading comprehension, AIS, and emotion were all non-significant. These were removed from the model. Additionally, AIS score remained non-significant once interactions were removed, \( F(1, 320) = 0.05, p = .823 \). The effect of emotion persisted in the full sample with reading comprehension included. As in Study 1, participants performed better on the neutral questions (\( M = 12.21, SD = .15 \)) than on the emotional questions (\( M = 11.43, SD = .14 \)), \( F(1, 322) = 42.20, p < .001 \). Additionally, participants who answered both reading comprehension questions correctly (\( M = 12.32, SD = .17 \)) performed better on the
reasoning task than those who did not \((M = 11.32, SD = .19), F(1, 321) = 15.535, p < .001\). The final model is presented in Table 7.

Table 7

Models for Exploratory Analysis in Study 1

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 1</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b (SE)</td>
<td>95% CI</td>
<td>F (p)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>13.45 (.78)</td>
<td>[11.92, 14.98]</td>
<td>613.302 (.000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotion</td>
<td>-1.12 (.64)</td>
<td>[-2.38, .14]</td>
<td>4.087 (.044)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIS</td>
<td>-0.01 (.01)</td>
<td>[-.02, .01]</td>
<td>0.057 (.812)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RC</td>
<td>-2.11 (1.10)</td>
<td>[-4.28, .06]</td>
<td>3.941 (.048)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotion*AIS</td>
<td>0.00 (.01)</td>
<td>[-.01, .02]</td>
<td>0.099 (.754)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotion*RC</td>
<td>0.39 (.91)</td>
<td>[-1.39, 2.19]</td>
<td>0.188 (.665)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIS*RC</td>
<td>0.01 (.01)</td>
<td>[-.01, .03]</td>
<td>1.001 (.318)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotion<em>AIS</em>RC</td>
<td>-0.01 (.01)</td>
<td>[-.02, .01]</td>
<td>0.364 (.546)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>Model 2</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b (SE)</td>
<td>95% CI</td>
<td>F (p)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>12.70 (.18)</td>
<td>[12.34, 13.07]</td>
<td>8663.168 (.000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotion</td>
<td>-0.77 (.12)</td>
<td>[-1.01, -.54]</td>
<td>42.199 (.000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RC</td>
<td>-1.00 (.25)</td>
<td>[-1.49, -.50]</td>
<td>15.535 (.000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Model 1 includes all variables and their interactions with a heterogenous residual structure. Model 2 is the final model after removing interactions and main effects that were not significant. The interaction was removed first, after which the main effect of emotion became significant. Effect sizes are presented in unstandardized format and, therefore, cannot be compared to one another. Standard errors are included in parentheses. Effect sizes for the main effects of Model 1 cannot be interpreted directly because of the presence of the interactions among those variables. 95% confidence intervals are presented in a [LL, UL] format.
CHAPTER III

STUDY 2

Study 2 compared the effects of emotional and cognitive reflection on reasoning tasks. Participants were given the conditional statements from the reasoning task in Study 1. Additionally, they were randomly divided into two groups: those who were prompted to consider how the question makes them feel (i.e., emotional reflection) and those who were asked to consider synonyms of a word within the question (i.e., cognitive reflection). Being aware of and reflecting on one’s emotions may enable individuals to parse the relevance of those emotions to the task (Blanchette et al., 2014). If actively reflecting on one’s emotional responses assists in logical reasoning, those in the emotional reflection group should perform better on the emotional conditional statement than those in the cognitive reflection group. Following this task, participants completed the AIS. It was thought that those who were less tolerant of their emotions may have been be less willing or able to reflect on their emotions before responding to the task than those who were more tolerant of their emotions.

Method

Participants

Participants for Study 2 were recruited from Amazon’s Mechanical Turk (MTurk). In previous studies, MTurk has been demonstrated to provide demographically diverse samples and produce similar results to other sampling strategies (Paolacci, Chandler, & Ipeirotis, 2010). MTurk participants were limited to those in the United
States who are fluent English speakers. Before entering the study, participants were asked if English was their first language. Participants who responded “No” were not permitted to participate. MTurk participants were compensated $1.50 US.

Four-hundred eighty-three participants were recruited. Precautions were included to prevent multiple retakes of the survey. Participants were alerted multiple times that they would only be paid once for completing the study, and MTurk worker numbers were tagged as having completed the study, preventing that worker from accessing it again. Duplicate IPs largely indicate either multiple MTurk accounts or leaving and restarting the survey. In the latter case, participants were sometimes re-assigned to the opposite condition and, therefore, exposed to both the emotional and cognitive reflection groups. For these reasons, all participants with a duplicate IP (N = 27) were removed from the study to prevent gross violation of the assumption of independence. An additional 60 participants were removed for failing to complete the survey or for missing data, leaving a final N = 365.

Participants were majority male (51.8%) with an average age of 34.38 (SD = 15.13). Two-hundred thirty-seven (64.9%) self-identified as European American/White, 27 (7.4%) as Native American, 26 (7.1%) as Asian American/Pacific Islander, 42 (11.5%) as African American, 27 (7.4%) as Hispanic/Latino, and 5 (1.4%) as another or more than one race.

**Materials**

Participants were presented with the conditional statements, the reading comprehension task, and the AIS from Study 1 with significant procedural differences outlined below. In Study 2, reading comprehension was retained as a variable of interest.
Though reading comprehension was originally intended as a screen, Study 1 demonstrated it had valuable predictive power for the DV. It is retained in Study 2 to more fully describe the observed data.

**Procedure**

Participants were first randomly divided into two groups. The “emotional reflection” group received the reasoning task from Study 1 except each premise was followed with the prompt:

Please reflect on how this statement or situation makes you feel. Consider any sensations your emotions are creating in your body. Try to name your emotion. Select from the following which emotion most reflects your experience.

Participants were then given a selection of four emotions (Sadness, Anger, Joy, Disgust) from which to select and an empty text box to fill in their own emotion. These responses were presented in a random order, other than the text box which was always the last option.

The “cognitive reflection” group received the reasoning task with each premise followed by the prompt:

Please reflect on the meaning of the word "WORD" in the above sentence. Think of other words which have the same or similar meanings. Select from the following which word has a meaning most similar to "WORD" as used in the above sentence.

WORD was replaced by a non-emotional noun or verb in the statement. Participants were given four possible options, one of which was a synonym or close approximation, one of which made sense in the sentence but was not a synonym, and two
of which were randomly selected words from an online word generator accessible at http://randomwordgenerator.com. These responses were presented in a random order.

Participants were then given four possible conclusions one at a time and asked to determine whether they were valid by selecting either “Yes” or “No.” The original conditional statement always remained visible. As in Study 1, both the order of the conditional statements and the order of their four conclusions were randomized.

Following the reasoning task, participants were asked to complete the reading comprehension task and the AIS. The AIS was presented at the end of Study 2 to eliminate any possibility that being reminded of their attitudes towards emotions would influence participant performance. The order of the AIS items was first randomized and then administered in that order for each participant.

Finally, demographic information was collected for all participants.

**Dependent Variable**

The dependent variable was the number of conclusions out of 38 correctly categorized as logically valid or invalid using the same procedure as Study 1.

**Results**

**Descriptives**

Random assignment resulted in 186 (51%) participants in the cognitive reflection group and 179 (49%) participants in the emotional reflection group. Two-hundred two (55.3%) participants responded to the reading comprehension question correctly. As in Study 1, Duration in minutes was non-normal (skew = 15.20; kurtosis = 243.54) and excluded from formal analysis, though it is included in the correlation matrix for cautious
examination of relationships. Age was also skewed (-3.07) and exhibited high kurtosis (32.28). Variable means, standard deviations, skew and kurtosis are presented in Table 8.

Table 8

<table>
<thead>
<tr>
<th>Means, Standard Deviations, Skew, and Kurtosis for Variables in Study 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Duration (in Minutes)</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Emotional Correct</td>
</tr>
<tr>
<td>Neutral Correct</td>
</tr>
<tr>
<td>Total Correct</td>
</tr>
<tr>
<td>Affect Intolerance</td>
</tr>
</tbody>
</table>

*Note.* Mean, standard deviation, skew, and kurtosis for all variables in Study 2 are presented. Skew and kurtosis are close to or within the accepted range of ±2.00 for most variables. Duration and age exhibit high skew and kurtosis and are not included in formal analysis.

**Correlations**

A correlation matrix for all variables, including duration, age, and gender, is presented in Table 9. Of interest, reading comprehension was significantly positively corrected with correctness for both emotional ($r = .32$) and neutral ($r = .40$) questions. Participants who answered both reading comprehension questions correctly were more likely to correctly answer the reasoning questions than participants who answered one or both reading comprehension questions incorrectly. Additionally, condition was significantly positively related to correctness for neutral questions ($r = .11$). Finally, AIS was significantly negatively correlated to correctness for both emotional ($r = -.15$) and neutral ($r = -.23$) questions. Because higher scores on the AIS indicate a greater degree of emotional intolerance, the relationship suggests individuals who are more intolerant of their emotions were less likely to correctly answer both emotional and neutral questions.
Table 9

Correlation Matrix for Variables in Study 2

<table>
<thead>
<tr>
<th></th>
<th>Dur.</th>
<th>Cond.</th>
<th>RC</th>
<th>Age</th>
<th>Gender</th>
<th>EC</th>
<th>NC</th>
<th>AIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration (Min)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>.07</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RC</td>
<td>.06</td>
<td>-.04</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>.12*</td>
<td>.05</td>
<td>.06</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>-.03</td>
<td>-.01</td>
<td>-.13*</td>
<td>-.11*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC</td>
<td>.01</td>
<td>.06</td>
<td>.32***</td>
<td>.15*</td>
<td>-.05</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NC</td>
<td>.01</td>
<td>.11*</td>
<td>.40***</td>
<td>.12*</td>
<td>-.04</td>
<td>.76***</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>AIS</td>
<td>-.07</td>
<td>.02</td>
<td>-.11*</td>
<td>-.19**</td>
<td>.05</td>
<td>-.15**</td>
<td>-.23***</td>
<td>1</td>
</tr>
</tbody>
</table>

Note. Duration, age, and gender are included in the correlation matrix though they were not included in planned or exploratory analyses. Duration outliers \((N = 2)\) were removed to examine the relationships more accurately, but Duration continued to have high skew and kurtosis. Therefore, correlations between Duration and other variables are interpreted with extreme caution. Additionally, age was not normally distributed, and its relationships should be interpreted with caution. RC = Reading Comprehension, EC = Emotional Correct, NC = Neutral Correct, AIS = Affect Intolerance Scale. *\(p < .05\), **\(p < .01\), ***\(p < .001\)

Hypothesis Testing

After initial exploration of the data, ANCOVA analysis was determined to be inappropriate for the data in Study 2. As a basic assumption, ANCOVA assumes the covariate is independent of the fixed effect variables. In other words, the covariate is expected to influence the dependent variable across different conditions but not interact with independent variables (see Figure 2). Preliminary analyses indicated that this assumption was violated. Therefore, LMM was also used to analyze the data in Study 2, primarily to address the observed interaction between the condition variable and the covariate AIS.

In Study 2, reading comprehension, emotionality, AIS and condition were treated as fixed effects and participant was treated as a random effect. Reading comprehension was treated as a variable of interest in Study 2 because it was demonstrated in Study 1 to be a significant predictor of performance. Taking reading comprehension into account
Figure 2. Example of Classic ANCOVA Results. ANCOVA examines the difference in a dependent variable (along the Y-axis) in different conditions while holding a covariate (along the X-axis) constant. Differences in the DV across the conditions are compared along the same level of the covariate, such as the value indicated by the strong vertical black line. For an ANCOVA, the spread of values of the Y-axis across the X-axis should be similar in all conditions. Graphically, data points should not demonstrate different slopes or be clustered at different points between the conditions.

more fully describes the data. However, it should be noted that the nature of the relationships and interactions were not altered by including reading comprehension in the model.

Reference Model (Model 1). A reference model with a loaded mean structure and a homogenous residual structure was fit to test further hypothesis. The model included all fixed effects and their interactions. A REML estimation was used to avoid biased estimates.

Residual Structure (Model 2). A homogenous residual structure was tested against a heterogenous residual structure using the difference between the -2 Log
Likelihood fit statistics on a chi-square distribution with a $df = 1$. A model with a heterogenous residual structure was preferred, $\chi^2(1) = 255.79, p < .001$. Therefore, Model 2 was retained.

**Fixed Effects (Model 3).** Model 3 was fit with all variables and their interactions and a heterogenous compound symmetry residual structure. Type-III $F$-Tests were examined to determine whether interactions and main effects should be retained in the final model. Interactions were examined in the model first. Interactions that were not significant were removed. Some interactions that were initially significant became non-significant, and these were also removed. In the final model, only the interaction between condition and emotional intolerance was significant, $F(1, 360) = 6.655, p < .01$. This relationship is described below under Hypothesis 3.

The main effects of AIS score, $F(1, 360) = 8.636, p < .01$, and condition, $F(1, 360) = 9.518, p < .01$, were significant. However, the coefficient estimates for both affect intolerance and condition cannot be interpreted because of the presence of an interaction between these two variables. Finally, reading comprehension was significantly predictive of performance on the task. Individuals who responded to both reading comprehension questions correctly ($M = 12.93, SD = .18$) performed better than those who did not ($M = 10.92, SD = .20$), $F(1, 360) = 55.11, p < .001$. The final model is presented in Table 10.

**Hypothesis 1.** As in Study 1, emotion significantly predicted correctness on the reasoning task, $F(1, 364) = 13.45, p < .001$. Participants were more correct on neutral questions ($M = 12.13, SD = .15$) than they were on emotional questions ($M = 11.71, SD = .14$). This result replicates both the findings in Study 1 and in Blanchette (2006).
Table 10

**Final Model (Model 3) for Linear Mixed Modelling in Study 2**

<table>
<thead>
<tr>
<th>Fixed Effects</th>
<th>b (SE)</th>
<th>95% CI</th>
<th>F (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>16.72 (.70)</td>
<td>[15.35, 13.07]</td>
<td>771.814 (.000)</td>
</tr>
<tr>
<td>Emotion</td>
<td>-0.42 (.11)</td>
<td>[-.64, -.19]</td>
<td>15.752 (.000)</td>
</tr>
<tr>
<td>AIS</td>
<td>-0.02 (.01)</td>
<td>[-.03, -.01]</td>
<td>10.925 (.001)</td>
</tr>
<tr>
<td>RC</td>
<td>-2.01 (.27)</td>
<td>[-1.49, -.50]</td>
<td>55.107 (.000)</td>
</tr>
<tr>
<td>Condition</td>
<td>-2.94 (.95)</td>
<td>[-4.81, 1.07]</td>
<td>9.518 (.002)</td>
</tr>
<tr>
<td>Condition*AIS</td>
<td>0.02 (.01)</td>
<td>[.01, .04]</td>
<td>6.655 (.010)</td>
</tr>
</tbody>
</table>

Note. Model 3 is the final model after removing interactions and main effects that were not significant. The interaction was removed first. Some previously significant interactions then became non-significant and were removed. Effect sizes are presented in unstandardized format and, therefore, cannot be compared to one another. Standard errors are included in parentheses. 95% confidence intervals are presented in a [LL, UL] format.

**Hypothesis 3.** It was predicted that reflecting on one’s emotions, compared to reflecting on a non-emotional aspect of the task, would improve performance on reasoning tasks that have emotional aspects. Instead, emotional reflection appeared to have negatively impacted performance on all aspects of the reasoning task for individuals who were otherwise more tolerant of their emotions, $F(1, 360) = 6.655, p < .01$.

Individuals who were less tolerant of their emotions performed roughly the same in both cognitive and emotional reflection groups (for graphic representation of interaction, see Figure 3).
Figure 3. Interaction Between Condition and Affect Intolerance. Graphical representation of the interaction between condition and affect intolerance. For the purposes of illustrating the nature of the relationship, estimated means of correctness (along the Y-axis) were acquired by dichotomizing AIS. Participants with a high affect intolerance performed similarly in both conditions. Participants with a low affect intolerance performed better in the cognitive reflection group than in the emotional reflection group. This chart represents the combined average of correctness for both emotional and neutral questions. However, the observed relationship is similar for both emotional and neutral questions when considered separately. This was indicated both graphically in Figures 4 and 5, as well as by the lack of an Emotion x Condition x AIS interaction in the final model.
CHAPTER IV
GENERAL DISCUSSION

These studies were designed to examine the relationships between emotion, emotional intolerance, and reasoning. Historically, emotion has been positioned as reason’s antagonist. One must eliminate emotion in order to be reasonable. Previous research has demonstrated that emotional content can interfere with reasoning tasks (Blanchette & Richards, 2004; Blanchette 2006; Jung et al., 2014; Lerner et al., 2015). Although certain types of decision making appear to be facilitated by emotion, especially if the emotion is task-relevant (Blanchette et al., 2014; Damasio, 1994), in both studies presented here emotion interfered with the reasoning task in all respects. Participants were less correct in responding to emotional stimuli than to neutral stimuli, directly replicating Blanchette (2006). Additionally, asking participants to think about their emotional responses, even to neutral stimuli, appeared to interfere with reasoning. Though the effect was small in this paradigm, it appears that to correctly perform a logical reasoning task, it is preferable to remove emotion from the equation.

One proposed mechanism for emotion’s interference is the allocation of cognitive resources towards processing emotional reactions. This mechanism, outlined and tested in De Neys (2006), draws from dual-process theories. It proposes that people with a greater working memory (and therefore more cognitive resources) are better equipped to override automatic Type 1 processes in favor of cognitively demanding Type 2 processes. De Neys demonstrated this effect for the belief bias heuristic, the tendency for individuals to
reject conclusions that are incongruent with their prior beliefs or knowledge (Oakhill et al., 1989). Participants with a higher working memory span were better able to counter the belief bias heuristic and identify logically valid conclusions that seemed unbelievable.

Emotion can be viewed as a fast, automatic Type 1 process, and processing it may consume resources (Evan, 2008). For example, a recent small study by Trémolière, Gagnon, and Blanchette (2016) suggests incidental, or unrelated, emotion may interfere with the processing of difficult tasks more than easy tasks. Their results, though preliminary, support the hypothesis that emotion drains cognitive resources rather than reduces analytical ability generally. Processing emotion may take up cognitive resources needed for processing reasoning tasks. However, emotion’s impact may sometimes be unconscious (Haidt, 2001, 2007; Kahneman & Tversky, 1973, 1983; Mercier & Sperber, 2011). In Study 2’s design, reminding participants of their emotional responses was intended to bring emotion to the forefront (i.e., out of the unconscious), potentially allowing participants to consider whether it was important for the task. It is unclear whether participants used the opportunity to make that consideration because the task did not explicitly instruct participations to do so. In the future, participants could be prompted more directly to consider whether their emotional responses are relevant to the subsequent task and, if not, to try and set those emotional responses aside. Doing so may help free otherwise spent cognitive resources.

The present studies also suggested that certain types of metaemotional factors may be involved in the relationship between reason and emotion. In particular, an individual’s affect intolerance, or how threatening emotions are perceived, was hypothesized to have an effect. Individuals who were intolerant of their emotions were
not expected to acknowledge them, which was hypothesized to enable their emotions to continue to interfere with the reasoning task. The combined results of Studies 1 and 2 offer conflicting evidence. Study 1 demonstrated no effect for affect intolerance on the number of items correct and no interaction between affect intolerance and emotional stimuli. However, Study 2 demonstrated an effect for affect intolerance. Participants with a greater affect intolerance appeared to have performed worse on the reasoning task, though this effect was very small.

The more interesting result of Study 2 was the observed interaction between condition and affect intolerance. Participants in the cognitive reflection group performed better if they were more tolerant of their emotions than if they were less tolerant. However, the participants in the emotional reflection group performed the same regardless of their affect intolerance score (see Figure 3). Similarly, in the cognitive reflection group, people who were more tolerant of their emotions demonstrated an effect of emotion on their performance. These individuals were more correct for neutral questions than emotional questions. People who were less tolerant of their emotions performed very similarly for both neutral and emotional questions in both the cognitive reflection and emotional reflection groups (see Figures 4 and 5). These relationships suggest two things. First, a carryover effect may be present. This effect is especially suggested by the high affect intolerance individuals whose performance was similar across all conditions. Second, emotional tolerance may be somewhat protective of the carryover effect under certain conditions.

Previous research on emotion and cognition has shown incidental emotion can carry over to later tasks. The effect has been observed in consumer behavior (Lerner,
Figure 4. Interaction Between Condition and Affect Intolerance (Emotional Questions). Graphical representation of the interaction between condition and affect intolerance in emotional questions. For the purposes of illustrating the nature of the relationship, estimated means of correctness (along the Y-axis) were acquired by dichotomizing AIS. Participants with a high affect intolerance performed similarly in both conditions. Participants with a low affect intolerance performed better in the cognitive reflection group than in the emotional reflection group.

Small, & Loewenstein, 2004), gambling decisions (Kugler, Connolly, & Ordóñez, 2012), an emotional Stroop task (Bertels, Kolinsky, Pietrons, & Morias, 2011), and memory (Schmidt & Schmidt, 2016). The degree to which carryover effects occur are likely influenced by the specific emotion elicited, the intensity of that emotion, and the length of time between the emotional stimuli and the unrelated task (Schmidt & Schmidt, 2016; Sharma & McKenna, 2001). The present studies suggest emotional carryover effects may also be influenced by characteristics of the participant, such as an individual’s emotional tolerance. In Study 2, participants who were less tolerant of their emotions may have been affected by their emotional reactions from trial to trial, indicated by the similarity of their overall task performance in both the cognitive and emotional reflection groups. However, participants who were more tolerant of their emotions appeared to combat this
Figure 5. Interaction Between Condition and Affect Intolerance (Neutral Questions). Graphical representation of the interaction between condition and affect intolerance in neutral questions. For the purposes of illustrating the nature of the relationship, estimated means of correctness (along the Y-axis) were acquired by dichotomizing AIS. Participants with a high affect intolerance performed similarly in both conditions. Participants with a low affect intolerance performed better in the cognitive reflection group than in the emotional reflection group.

carryover effect to some degree, demonstrated by their superior performance in the cognitive reflection group.

This effect was unexpected, and its mechanisms are not clear. Some researchers have suggested emotional carryover effects are due, in part, to increased attention to emotional stimuli and, simultaneously, an inability to disengage from the emotional reaction (e.g., Compton, 2000). In this case, it may be that individuals who are more tolerant of their emotions are better able to disengage from their emotional responses than individuals who are less tolerant. In the cognitive reflection condition, these participants still performed worse on emotional vs. neutral trials. However, there was time between emotional trials and neutral trials while participants thought about the meaning of a non-
emotional word. The emotional “break” may have reduced the carryover effect for people who are more tolerant of their emotions. In contrast, incidental emotion continued to interfere with performance for participants who were less tolerant of their emotions, despite the emotional “break.” These individuals may require more time to disengage from their emotional responses. Compared to those in the cognitive reflection condition, participants in the emotional reflection condition did not have time to disengage from their emotional responses during the task. They were reminded of their emotion at the beginning of every trial, even neutral ones. In this situation, all participants performed similarly regardless of their emotional intolerance score.

Limitations and Future Study

A significant limitation in the two studies is the combination of neutral and emotional stimuli. All participants were presented with both neutral and emotional versions of the conditional statements. This structure was taken from previous research examining these relationships and is intended, in part, to allow participants to act as their own control for difficult reasoning tasks. However, Study 2 suggests carryover effects of emotion can continue to influence performance on neutral stimuli. A direct test of carryover effects could be conducted by examining the differences in groups receiving only neutral, only emotional, and both neutral and emotional stimuli. Additionally, participant characteristics, such as affect intolerance, may moderate emotional carryover effects. To more accurately examine the effects of emotion, participants could be divided into conditions that receive only emotional or neutral stimuli. Potentially moderating characteristics, such as intelligence, reading ability, or affect intolerance, could then be examined in purely emotional or neutral conditions.
A second limitation is the online nature of both studies. The logic task presented is difficult and tedious. Some participants seem to have found it hard to maintain attention and remain cognitively and emotionally engaged in the task. This potentiality is supported by the wide range of completion times recorded by Qualtrics. Although most participants in both studies completed the tasks between 10 and 25 minutes, many participants completed the study in fewer than five minutes or more than an hour. These participants may have rushed through the material or left the material and returned at a later time. Because these studies are intended to examine the effects of emotion on reasoning tasks, it is important that participants remain engaged with the material for the entire duration. Lack of attention or engagement may contribute to a small effect size for emotion. The true effect may be larger. In future studies, participants could be in a laboratory setting where researchers can ensure uninterrupted participation. Additionally, although the task is tedious in nature, steps could be taken to ensure the material is as engaging as possible.

**Conclusion**

Though emotion is sometimes a critical input for rational decision-making, the present studies suggest emotion can be detrimental to logical reasoning tasks. It may be that emotion takes up processing power necessary to solve such problems, making it harder to perform an already difficult task. It remains to be seen whether the effect of emotion could be mitigated by a prolonged consideration of whether an emotional response is relevant to solving the problem. However, simply bringing the emotional response to the forefront was not sufficient for individuals to make those considerations or to improve their performance on the logical reasoning task. Additionally, idiosyncratic
metaemotional factors, such as affect intolerance, appear to be involved in the way people process emotions, including their susceptibility to phenomena such as carryover effects. Individuals who are more tolerant and accepting of their emotions may have an easier time recovering from momentary emotional responses, preventing unconscious lingering emotions from affecting later, unrelated tasks. Regardless of the mechanism, Study 2 showed that the type of processing employed, emotional vs. cognitive, did affect task performance. Taken as a whole, this research shows that emotion, emotional tolerance, and emotional processing are all relevant factors to consider when engaging in and studying logical reasoning.
REFERENCES


APPENDIX A

Conditional statements modified slightly from Blanchette (2006). Asterisked statements originally read, “If your boyfriend is having an affair, then you will find lipstick on his shirt collar,” and, “If your boyfriend has been playing football, then you find dirt on his clothes.” These were altered with updated, non-gendered language.

<table>
<thead>
<tr>
<th>Emotional Statements</th>
<th>Modus Ponens</th>
<th>Modus Tollens</th>
<th>Denying Antecedent</th>
<th>Affirming Consequent</th>
</tr>
</thead>
<tbody>
<tr>
<td>If a child has been sexually abused, then he has behavioral difficulties.</td>
<td>Joshua has been sexually abused, therefore he has behavioral difficulties.</td>
<td>Joshua does not have behavioral difficulties, therefore he has not been sexually abused.</td>
<td>Joshua has not been sexually abused, therefore he does not have behavioral difficulties.</td>
<td>Joshua has behavioral difficulties, therefore he has been sexually abused.</td>
</tr>
<tr>
<td>If people are stressed, then they have trouble sleeping.</td>
<td>Amy is stressed, therefore she has trouble sleeping</td>
<td>Amy does not have trouble sleeping, therefore she is not stressed.</td>
<td>Amy is not stressed, therefore she does not have trouble sleeping.</td>
<td>Amy is having trouble sleeping, therefore she is stressed.</td>
</tr>
<tr>
<td>If you see a fire, then you run.</td>
<td>Kyle sees a fire, therefore he is running.</td>
<td>Kyle is not running, therefore he did not see a fire.</td>
<td>Kyle did not see a fire, therefore he is not running.</td>
<td>Kyle is running, therefore he saw a fire.</td>
</tr>
<tr>
<td>If you hear a burglar in your house, then you hide.</td>
<td>Michelle hears a burglar in her house, therefore she is hiding.</td>
<td>Michelle is not hiding, therefore she does not hear a burglar in her house.</td>
<td>Michelle does not hear a burglar in her house, therefore she is not hiding.</td>
<td>Michelle is hiding, therefore she hears a burglar in her house.</td>
</tr>
<tr>
<td><em>If your significant other is having an affair, then you find a sext on their cell phone.</em></td>
<td>Jackie’s boyfriend has been having an affair, therefore she found a sext on his cell phone.</td>
<td>Jackie did not find sext on her boyfriend’s cell phone, therefore he is not having an affair.</td>
<td>Jackie’s boyfriend has not been having an affair, therefore she did not find a sext on his cell phone.</td>
<td>Jackie found a sext on her boyfriend’s cell phone, therefore he is having an affair.</td>
</tr>
<tr>
<td>Neutral Statements</td>
<td>Modus Ponens</td>
<td>Modus Tollens</td>
<td>Denying Antecedent</td>
<td>Affirming Consequent</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------------</td>
<td>-----------------------------------</td>
<td>-----------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>If a child eats too much sugar, then he has behavioral difficulties.</td>
<td>Michael ate too much sugar, therefore he has behavioral difficulties.</td>
<td>Michael does not have behavioral difficulties, therefore he has not eaten too much sugar.</td>
<td>Michael has not eaten too much sugar, therefore he does not have behavioral difficulties.</td>
<td>Michael has behavioral difficulties, therefore he has eaten too much sugar.</td>
</tr>
<tr>
<td>If people drink too much coffee, then they have trouble sleeping.</td>
<td>Ashley drank too much coffee, therefore she has trouble sleeping.</td>
<td>Ashley does not have trouble sleeping, therefore she did not drink too much coffee.</td>
<td>Ashley did not drink too much coffee, therefore she does not have trouble sleeping.</td>
<td>Ashley is having trouble sleeping, therefore she drank too much coffee.</td>
</tr>
<tr>
<td>If you want to catch a bus, then you run.</td>
<td>James wants to catch the bus, therefore he is running.</td>
<td>James is not running, therefore he does not want to catch the bus.</td>
<td>James does not want to catch the bus, therefore he is not running.</td>
<td>James is running, therefore he wants to catch the bus.</td>
</tr>
<tr>
<td>If your mother is looking for you, then you hide.</td>
<td>Maria’s mother is looking for her, therefore she is hiding.</td>
<td>Maria is not hiding, therefore her mother is not looking for her.</td>
<td>Maria’s mother is not looking for her, therefore she is not hiding.</td>
<td>Maria is hiding, therefore her mother is looking for her.</td>
</tr>
<tr>
<td>*If your significant other has been playing football, then you find dirt on their clothes.</td>
<td>Jill’s boyfriend has been playing football, therefore she found dirt on his clothes.</td>
<td>Jill did not find dirt on her boyfriend’s clothes, therefore he was not playing football.</td>
<td>Jill’s boyfriend has not been playing football, therefore she did not find dirt on his clothes.</td>
<td>Jill found dirt on her boyfriend’s clothes, therefore he was playing football.</td>
</tr>
</tbody>
</table>
Fun.

By Suzanne Britt Jordan

Fun is hard to have.
Fun is a rare jewel.

Somewhere along the line people got the modern idea that fun was there for the asking, that people deserved fun, that if we didn't have a little fun every day we would turn into (sakes alive!) puritans.

"Was it fun?" became the question that overshadowed all other questions: good questions like: Was it moral? Was it kind? Was it honest? Was it beneficial? Was it generous? Was it necessary? And (my favorite) was it selfless?

When the pleasure got to be the main thing, the fun fetish was sure to follow. Everything was supposed to be fun. If it wasn't fun, then we were going to make it fun, or else.

Think of all the things that got the reputation of being fun. Family outings were supposed to be fun. Education was supposed to be fun. Work was supposed to be fun. Walt Disney was supposed to be fun. Church was supposed to be fun. Staying fit was supposed to be fun.
Just to make sure that everybody knew how much fun we were having, we put happy faces on flunking test papers, dirty bumpers, sticky refrigerator doors, bathroom mirrors.

If a kid, looking at his very happy parents traipsing through that very happy Disney World, said, "This ain't fun, ma," his ma's heart sank. She wondered where she had gone wrong. Everybody told her what fun family outings to Disney World would be. Golly gee, what was the matter?

Fun got to be such a big thing that everybody started to look for more and more thrilling ways to supply it. One way was to step up the level of danger so that you could be sure that, no matter what, you would manage to have a little fun.

Television commercials brought a lot of fun and fun-loving folks into the picture. Everything that people in those commercials did looked like fun: taking Polaroid snapshots, buying insurance, mopping the floor, bowling, taking aspirin. The more commercials people watched, the more they wondered when the fun would start in their own lives. It was pretty depressing.

Big occasions were supposed to be fun. Christmas, Thanksgiving and Easter were obviously supposed to be fun. Your wedding day was supposed to be fun. Your honeymoon was supposed to be the epitome of fundom. And so we ended up going through every Big Event we ever celebrated, waiting for the fun to start.

It occurred to me, while I was sitting around waiting for the fun to start, that not much is, and that I should tell you just in case you're worried about your fun capacity.

I don't mean to put a damper on things. I just mean we ought to treat fun reverently. It is a mystery. It cannot be caught like a virus. It cannot be trapped like an animal. The god of mirth is paying us back for all those years of thinking fun was everywhere by refusing to come to our party. I don't want to blaspheme fun anymore. When fun comes in on little dancing feet, you probably won't be expecting it. In fact, I bet it comes when you're doing your duty, your job, or your work. It may even come on a Tuesday.
I remember one day, long ago, on which I had an especially good time. Pam Davis and I walked to the College Village drug store one Saturday morning to buy some candy. We were about 12 years old. She got her Bit-O-Honey. I got my malted milk balls, chocolate stars, Chunkys, and a small bag of M & M's. We started back to her house. I was going to spend the night. We had the whole day to look forward to. We had plenty of candy. It was a long way to Pam's house but every time we got weary Pam would put her hand over her eyes, scan the horizon like a sailor and say, "Oughta reach home by nightfall," at which point the two of us would laugh until we thought we couldn't stand it another minute. Then after we got calm, she'd say it again. You should have been there. It was the kind of day and friendship and occasion that made me deeply regretful that I had to grow up.

It was fun.


Questions (bolded answers are correct):

1. What is the author's point about big occasions like holidays?
   A. They go by too quickly to be enjoyed.
   B. They are not as much fun as people expect them to be.
   C. They have become too centered around money.
   D. They help us to appreciate the important events in life.

2. When the author tells us to "treat fun reverently," she is encouraging us to:
   A. look forward to having fun
   B. have great respect for fun
   C. teach others how to have fun
   D. have fun less frequently
APPENDIX C

Items from the Affect Intolerance Scale (Stapinski et al, 2014)

**Subscale: Threat Expectancy**

- My negative feelings could spiral out of control.
- I can’t cope with my negative feelings.
- I fear that I will lose control of my negative feelings.
- Negative feelings tend to overwhelm me.
- I fear that my negative feelings won’t go away.
- Negative feelings could make me go mad.
- I experience negative emotions more intensely than others.
- Once I have negative feelings, I worry that they will get worse.
- My negative feelings could cause me to do something I might regret.
- I can’t focus on other things when I have negative feelings.
- Negative feelings stop me from getting things done.
- My negative feelings stop me from enjoying life.
- My negative feelings prevent me from having positive social interactions with others.
- Negative feelings put my body under a lot of stress.
- My negative feelings adversely affect those around me.

**Subscale: Avoid/Suppress**

- Avoiding conflict with others helps me to avoid negative feelings.
- I try to avoid negative feelings.
- I try to avoid anything that might trigger negative feelings.
- Fitting in with others helps me avoid negative feelings.
- Seeking the approval of others helps me to avoid negative feelings.
I try to distract myself from negative feelings.

I try to avoid situations that might cause me to become emotional in front of others.

I try to suppress negative feelings.

Controlling my environment helps to prevent negative feelings.

I am not comfortable expressing negative feelings.

It is important to stop negative feelings from surfacing.

I should avoid negative feelings.

I avoid conversation topics that may trigger my negative feelings.

I try to keep busy to stop negative feelings.

I tend to put off tasks that will cause me to experience negative feelings.
APPENDIX D

Unversity of Colorado
Colorado Springs
Institutional Review Board (IRB) for the Protection of Human Subjects

Date: 3/26/2018

IRB Review

IRB PROTOCOL NO.: 18-144
Protocol Title: Problem Solving Strategies
Principal Investigator: Amanda Harvey
Faculty Advisor if Applicable: Michael Kerley
Application: New Application
Type of Review: Expedited
Risk Level: No more than Minimal Risk
Renewal Review Level (If changed from original approval) if Applicable: N/A No Change
This Protocol Involves a Vulnerable Population: N/A (No Vulnerable Population)
Expires: 25 March 2019

*Note, if exempt: If there are no major changes in the research, protocol does not require review on a continuing basis by
the IRB. In addition, the protocol may match more than one review category not listed.
Externally funded: ☒ No ☐ Yes
OSP #:
Sponsor:

Thank you for submitting your Request for IRB Review. The protocol identified above has been reviewed according to
the policies of this institution and the provisions of applicable federal regulations. The review category is noted above,
along with the expiration date, if applicable.

Once human participant research has been approved, it is the Principal Investigator’s (PI) responsibility to report any
changes in research activity related to the project:
• The PI must submit all protocol, recruitment, advertising, and consent form amendments/versions to the IRB for approval.
• The PI must approve these changes prior to implementation.
• If you are a student, please note that it is required to include the IRB approval letter to the library when you submit the
dissertation/thesis.
• The PI must promptly inform the IRB of all unanticipated serious adverse events within 24 hours. All unanticipated adverse events must be reported to the IRB within 1 week (see 45CFR46.103(e)(5): Failure to comply with these federally mandated responsibilities may result in suspension or termination of the project.
• Notify the IRB when the study is complete.

If you have any questions, please contact Research Compliance Program Director in the Office of Sponsored Programs
and Research Integrity at 719-235-3503 or irb@uccs.edu

Thank you for your concern about human subject protection issues, and good luck with your research.

Sincerely yours,

Melissa J. Benton
Melissa Benton, Ph.D
IRB Committee Member
IRB Review

IRB PROTOCOL NO.: 18-173
Protocol Title: Problem Solving Strategies
Principal Investigator: Amanda Harvey
Faculty Advisor if Applicable: Michael Kisley
Application: New Application
Type of Review: Expedited
Risk Level: No more than Minimal Risk
Renewal Review Level (If changed from original approval) if Applicable: N/A No Change
This Protocol involves a Vulnerable Population: N/A (No Vulnerable Population)
Expires: 30 May 2019

*Note, if exempt: If there are no major changes in the research protocol does not require review on a continuing basis by the IRB. In addition, the protocol may match more than one review category not listed.
Externally funded: ☐ No ☐ Yes

Thank you for submitting your Request for IRB Review. The protocol identified above has been reviewed according to the policies of this institution and the provisions of applicable federal regulations. The review category is noted above, along with the expiration date, if applicable.

Once human participant research has been approved, it is the Principal Investigator's (PI) responsibility to report any changes in research activity related to the project:

- The PI must submit all protocol, recruitment, advertising, and consent form amendments/revocations to the IRB for approval.
- The IRB must approve these changes in a timely manner.
- Changes in funding status must be reported to the IRB as quickly as possible to ensure funding requirements are met.
- If you are a student, please note that it is required to include the IRB approval letter in the library when you submit the dissertation/thesis.
- The PI must promptly inform the IRB of all unanticipated serious adverse (within 24 hours). All unanticipated adverse events must be reported to the IRB within 1 week (see 45CFR46.103(b)(4)). Failure to comply with these federally mandated responsibilities may result in suspension or termination of the project.
- Renew study with the IRB at least 10 business days prior to expiration.
- Notify the IRB when the study is complete.

If you have any questions, please contact Research Compliance Program Director in the Office of Sponsored Programs and Research Integrity at 719-255-3903 or irb@uccs.edu.

Thank you for your concern about human subject protection issues, and good luck with your research.

Sincerely yours,

Michele Olson, Ph.D.
IRB Reviewer