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Is Testing a Laughing Matter? Achievement Effects via Working Memory And Humor Relevance

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IS TESTING A LAUGHING MATTER? ACHIEVEMENT EFFECTS VIA WORKING MEMORY AND HUMOR RELEVANCE

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ABSTRACT

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The relevant literature concerning the relationship between humorous intervention and academic performance features conflicting evidence. Authors present evidence that humor is able to directly benefit student academic performance (Ford et al., 2012), while other authors suggest humorous distraction may actually worsen performance (Bieg et al., 2015). Among the issues contributing to these contradictory findings are two particularly important considerations: the mechanism by which humor may impact performance and the content of humor used in interventions. One mechanism by which humor could impact subsequent academic performance is working memory (Strick et al., 2009). The first study (n = 31) investigated if a humorous intervention was able to temporarily increase participants' working memory capacity more so than a set of nature pictures intended to be relaxing. Considering the content of jokes used in an intervention, some authors suspect humor related to the academic assessment is likely to cultivate better outcomes for anxiety and performance (Wanzer et al., 2010). The second study (n = 35) investigated if math-related humor embedded within a timed and difficult math exam could benefit participant outcomes more than unrelated humor. Despite a limitation of significant findings due to low sample sizes, interesting evidence is presented within the results of each study. Follow-up research is needed to further analyze these same research questions across both studies with larger sample sizes, utilizing an in-person and highly controlled research design. Other discussion of results and implications is included.

ACKNOWLEDGEMENTS

This dissertation is dedicated to all those individuals who need a laugh to get through a tough day, a long week, or a life full of compromise and struggle. I became interested in humor as a formal research topic after considering how interesting and valuable I considered laughter to be. I also want to dedicate this dissertation to everyone who wonders if they deserve their own achievement. Coming from a nowhere town, I am a first-generation college student who often wonders if he deserves what he has achieved. This occurs largely because I never expected to attend college, much less obtain my Ph.D. I dedicate this project to those who need a laugh, and to those who need to be reminded they belong – no matter their identity, origin, or pathway towards today.

I want to acknowledge the people that helped me craft this dissertation. Most of all, I want to thank Dr Molly Jameson. Her countless hours of mentorship, guidance, editing, and camaraderie over the past five years made this all possible. Dr. Jameson gave me direction, priceless advice, and much of her time while I was navigating what it meant to complete a doctorate degree. I want to also acknowledge Dr. Sue Hyeon Paek for her guidance and advice pertaining to measurement, statistical analysis, and for serving on my committee. I also want to thank my committee members Dr. Doug Woody and Dr. Mel Moore for serving on my committee, giving me excellent feedback, and being willing to serve on my committee. Thank you to Janet, my single mother who never lets me forget how much she loves me, no matter what I decided to do with my career. And thank you to my wife, Holly, who never tires of listening, loving me, and supporting me through each next step in this educational journey.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Significance of These Studies

University educators spend a considerable amount of time and energy contemplating how to best serve their students (Bieg et al., 2015; Nelson & Knight, 2010). Instructors attempt a host of strategies to increase student motivation (Guiffrida et al., 2013), reduce boredom (Smith, 2007), and engage students in lessons they will hopefully consider valuable and impactful (Hackathorn et al., 2011). Instructors may positively affect student GPA and student persistence in future semesters by increasing students' sense of intrinsic motivation (Guiffrida et al.). Additionally, increasing a student's self-efficacy and increasing the amount of attention the student devotes to studying may positively impact a student's GPA (Krumrei-Mancuso et al., 2013). One significant method by which instructors attempt to help students is by reducing the severity of students' academic anxiety (Ford et al., 2017).

Many students have test anxiety regardless of academic subject (Jones et al., 2018), and some students experience intense anxiety toward specific subjects such as history or mathematics (Ashcraft, 2002). College students have more anxiety specific to mathematics than other core subjects, and women often report higher levels of math anxiety (Zettle & Raines, 2000). Math anxiety is defined as "… a feeling of tension, apprehension, or fear that interferes with math performance" (Ashcraft, pg. 181), and may affect students in both academic and non-academic settings (Jameson, 2020). Students grappling with math anxiety often report a lowered sense of confidence in their math abilities, altering their math self-efficacy (Jameson). Lower math self-

efficacy and a generalized fear of mathematics negatively impact student achievement on math assessments, possibly due to a compromised working memory (Foley et al., 2017). An individual's working memory capacity is limited, and math computation requires a significant amount of working memory (Ramirez et al., 2016). Math anxiety often includes a range of negative effects, including negative self-talk (e.g., "I am so stupid") (Passolunghi et al., 2016), compromising working memory resources required to maintain attention and correctly solve math problems (Foley et al.). Researchers have previously investigated if instructors may be able to assist students with their math anxiety in attempts to increase levels of achievement (Hackathorn et al., 2011; Javidi & Long, 1989).

Interventions to reduce student anxiety and improve academic outcomes for students, both acutely and across their collegiate endeavors, are important for instructors to employ (Goodboy et al., 2015). Several methods have assisted students with their levels of academic anxiety including mindfulness meditation classes (Bamber & Morpeth, 2019), reflective writing assignments (Nelson & Knight, 2010), and utilizing peer mentors (Sprengel & Job, 2004). When considering how to lower academic anxiety within the classroom and positively affecting student outcomes, one method would be the use of humor (Ford et al., 2017).

Purpose of These Studies

The manner in which humor impacts student anxiety (Garner, 2006), motivation (Pekrun & Linnenbrink-Garcia, 2012), enjoyment of a course (Wanzer et al., 2010), or student perceptions of the instructor (Hackathorn et al., 2011) has been investigated with increasing frequency. The use of humor to impact subsequent performance on an academic assessment has also been examined (Ford et al., 2012), but with mixed results (Bolkan et al., 2018). Humor may impact student performance by increasing a student's liking of the instructor (Wanzer et al.,

2010) and the academic subject (Bell, 2007) or by reducing the recursive worrying related to academic anxieties (Garner, 2006). Many students feel as if they have learned more when humor is used to teach the material (Wanzer et al.). There remains disagreement in the literature (Bolkan et al.), however, and the best methods for making students laugh to increase achievement remain unclear (Foley et al., 2017).

Previous studies have analyzed whether humor could effectively alter student performance by employing humor prior to (Ford et al., 2017) or during (Wayne et al., 2021) an examination. Additionally, the avenue through which humor impacts student performance has not been sufficiently analyzed (Bolkan et al., 2018; Ford et al., 2012). Many investigations have found that when participants experience humor before an exam, this reaction increases positive feelings of self (Garner, 2006), minimizes negative emotions (Strick et al., 2009), or lowers perceived levels of content-related anxiety (Ford et al.). To date, previous literature has not discovered the exact mechanism by which the emotional reaction to humorous manipulations allows for differences in performance on an academic assessment.

The Current Studies

Within this dissertation project, I completed two independent yet complementary studies investigating the manner in which humor affects student performance. Both studies occurred online via synchronous online video sessions and survey software. An individual's working memory and ability to focus on the task may be negatively impacted by academic anxieties (Eysenck & Calvo, 1992; Sweller, 2010) while taking either a math test or solving a working memory task. If humor can reduce the number of negative thoughts that compromise participant's limited working memory capacity (Strick et al., 2009), individuals may be able to perform better on these academic tasks (Ford et al., 2012). These two studies will connect

missing pieces in the divided literature regarding humor's impact on student anxiety and performance. Together, these investigations analyze the possible mechanisms by which humor increases performance on an academic assessment. Getting students to laugh in the classroom can be difficult, and outward student laughter is not an adequate predictor of effects on student achievement (Wanzer et al., 2010). If educators are to reliably use humor in the classroom to ease student anxiety and increase student achievement, instructors should be informed about best practices.

The first study investigated whether an increase in working memory capacity is the mechanism through which humor impacts performance. Utilizing a between-participants design, I analyzed if participants scored differently on a pair of working memory tasks after being subjected to humor prompts versus pictures of nature. Participants' working memory performance after being exposed to either humor or pictures of nature was compared to their baseline score on the same working memory tasks. The order of the two working memory tasks was randomized to offset levels of fatigue or momentary distraction occurring during specific task trials. One task measured numerical working memory, while the other task measured linguistic working memory ability. After the second round of working memory tasks, participants were asked to rate numerically how funny they found each of the humor prompts in the humor condition or how relaxing they found each nature picture in the nature condition. Then, demographic information was collected to finish the study.

The second study also utilized a between-participants design, investigating whether discipline-relevant humor (i.e., humor pertaining to math) is more effective than general humor prompts (i.e., unrelated to math) in altering levels of student math anxiety and subsequent performance on a math exam. Participants' self-reported levels of state math anxiety after

completing a 10-question math assessment served as baseline markers for math anxiety and math performance. Then, participants took a brief break before completing a longer math exam including humor prompts within the pages of the exam; the two groups varied only by the content of the humor prompts imbedded within their longer math exams (i.e., discipline-relevant or general humor). At the end of the session, participants were asked how funny they found each of the humor prompts embedded within the exam, numerically rating each humor prompt. Finally, demographic information was collected.

Research Questions

Study 1:

Q1 Is participants' working memory capacity different when presented with humorous prompts compared to relaxing prompts?

Q2 Does the degree to which participants consider an intervention funny or relaxing predict a change in working memory capacity?

Study 2:

Q1 Does the degree to which participants consider a humorous intervention funny in the presence of their math anxiety predict a change in math performance?

Q2 Does math-related humor embedded in a math exam alter levels of math anxiety and math performance differently than unrelated humor prompts?

Definition of Terms

Anxiety – An emotional response consisting of recursive worrying or fear related to various situations (Nourkova & Vasilenko, 2018).

Cognitive Load – The pressure on an individual’s limited working memory capacity as they attempt to retrieve task-relevant memories and solve a new situation utilizing both stored memory and new information (Sweller, 2011).

Contiguous Humor – An attempt at humor not related to or embedded within a subject, material, or content of a presentation intended to serve as a positive distraction (Bolkan et al., 2018).

Humor – Stimuli that may be considered funny or elicit laughter (Martin et al., 2003).

Information Processing – The processes including focused attention, working memory, and the remembrance of pertinent details when an individual is solving a task (Newell & Simon, 1972).

Integrated Humor – An attempt at humor directly embedded and related to a subject being discussed delivered at the appropriate time to connect with the correlating subject matter (Bolkan et al., 2018).

Math Anxiety – " … a feeling of tension, apprehension, or fear that interferes with math performance" (Ashcraft, 2002, pg. 181).

Processing Efficiency – The quality at which a person performs a task divided by the effort they exert during the task (Eysenck & Calvo, 1992).

Self-Efficacy – The degree to which an individual believes they are capable of learning and performing a task at a specific level (Schunk & DiBenedetto, 2014).

Sense of Humor – Relatively stable personality trait summarizing an individual's propensity to both attempt making others laugh through a variety of means and react to the attempts at humor made by others (Martin et al., 2003).

State Anxiety – Temporarily elevated anxiety provoked by a specific environment and timeframe associated with a specific set of stimuli, either anticipated or experienced (Pekrun, 2006).

Trait Anxiety – Ever-present and recurring negative emotions associated with generalized memories or anticipations of future events (Pekrun, 2006).

Working Memory – The ability to process relevant information (Sweller, 2011) and focus and maintain one's attention on a particular task while ignoring task-irrelevant thoughts (Beilock & Carr, 2005).

Summary of Research

The following chapters include relevant information pertaining to the relationship between humorous interventions, academic anxiety, and academic performance. Several questions remain in the heterogeneous research connecting humorous intervention to academic outcomes. The mechanism by which humor may be able to enhance academic performance has been overlooked. This mechanism may be working memory, and the first study within this dissertation investigated this possibility. The content of jokes used within a humor manipulation is often not included as a variable of importance for analysis. Accordingly, the second study within this dissertation analyzed if math humor is able to more effectively impact math anxiety and math performance than unrelated humor prompts. Chapter 2 presents an overview of relevant literature pertaining to these active gaps in the literature and provides context for both studies in this dissertation. Next, chapter 3 provides a detailed review of the methodology utilized in both studies. Chapters 4 and 5 are independent manuscripts, one for each study. Finally, Chapter 6 is a combined discussion bridging together the two studies within this dissertation.

CHAPTER II

LITERATURE REVIEW

Theoretical Foundation

Information Processing Theory

The foundational theory informing both investigations, as well as other theories employed within this research paradigm, is Newell and Simon’s (1972) Information Processing Theory. This theory represents humans as active information processing systems when attempting to sustain attention and solve a problem. Unlike a machine performing a rote task, the environment and the unique person solving the problem both factor into the outcomes of this information processing system. The Information Processing Theory claims the memory capacity for individuals solving problems and remembering task-relevant information is finite (Newell & Simon, 1972) and relies on several stages of memory to adequately process novel information (Huitt, 2003). Individuals notice different stimuli via their sensory memory, converting these experiences into meaningful data used within their working memory. After information is practiced sufficiently and no longer relevant to the immediate task, the information may be transferred to long-term memory for future retrieval. An individual's working memory capacity is limited as they attempt to balance new information from sensory memory with the retrieval of previously stored memories (Huitt). This limited capacity for considering new information and retaining task-relevant details constrains an individual’s general performance. Some of this capacity fluctuates for the same individual depending on the environment in which this task occurs (Newell & Simon). For students experiencing academic anxieties during an academic

lesson or exam, their working memory capacity may be negatively impacted due to the processing of additional irrelevant information (i.e., anxiety-related thoughts) to the accurate completion of the task.

Cognitive Load Theory

Furthering the theory surrounding an individual's real-time problem-solving capacity is Sweller's Cognitive Load Theory (Sweller, 1994; Sweller, 2011; Sweller & Chandler, 1991). Given the limited capacity of memory stores, Cognitive Load Theory explains that novel or complex tasks require more resources, which can further tax working memory. Accordingly, the individual must then refine their approach to solving the task based on the feedback between their long-term memories and the novel information they receive while completing the task.

Some situations require a higher cognitive load, such as paying attention to more than one task, obtaining information in more than one method, or the unclear presentation of material (De Jong, 2010). In these contexts, an individual's cognitive load may increase via "extraneous" cognitive load; unnecessary mental resources utilized by the situation that do not contribute to learning (De Jong). One factor of interest contributing to extraneous cognitive load includes anxiety related to academics (Jones et al., 2018).

Information Processing Efficiency Theory

Information Processing Efficiency Theory (Eysenck & Calvo, 1992) explains that anxiety may inhibit working memory performance by compromising the speed of working memory processing during anxiety-provoking tasks. This reduced processing speed subsequently reduces the efficiency of working memory, making anxiety-provoking tasks more effortful. This extra effort relates to increased cognitive load, as highly anxious learners are expending more cognitive resources to solve problems, and this lowers the efficiency of their processing. While

this may result in slower reaction times in highly math anxious students, students with high math anxiety often compensate by engaging in a speed for accuracy tradeoff, responding quickly but inaccurately to math questions (Ashcraft & Krause, 2007). To maintain accuracy and preserve academic performance, students with higher levels of math anxiety must input higher levels of effort and concentration.

Processing efficiency may be conceptualized as the quality of a student's academic performance divided by the amount of effort invested in the activity. Within this theoretical framework, the efficiency with which students can complete an academic task is compromised by their anxieties, whether they be general or subject specific. Additionally, the efficiency of processing is impacted via two avenues. The efficiency with which individuals can inhibit attention to task-irrelevant information and switch between tasks within a set of mental processes are compromised by state levels of anxiety (Derakshan & Eysenck, 2009). Within this framework, a student may be able to surmount the negative effects on their performance during an academic assessment only if they commit an increased amount of effort. This increased effort will enable students to inhibit task-irrelevant thoughts and quickly switch between various modes of thinking while solving a task (Derakshan & Eysenck). However, if students are not aware of the negative impacts on their performance due to their anxiety, the student will not be aware of the extra effort required to maintain the same level of academic performance. Eysenck and Calvo further speculated individuals with higher levels of anxiety may experience more radical depletions in their processing efficiency than individuals with lower levels of trait anxiety. This difference is thought to occur because highly anxious individuals will have a higher degree of working memory resources devoted to worry than individuals who are less anxious. Additionally, highly anxious individuals tend to set higher expectations for their own

performance (potentially to an unrealistic standard), increasing the mismatch of expectations and performance for the individual once the processing efficiency has been compromised during the assessment (Eysenck & Calvo). This aspect of the Information Processing Efficiency Theory has been validated in prior studies analyzing the relationship between academic anxiety, an individual's self-confidence, and their performance (Passolunghi et al., 2016).

Literature Review

Cognition and Emotion

Humans process information using limited cognitive resources, but do not compute information without also experiencing some degree of subjective emotionality (Newell & Simon, 1972). The nature of an individual's perceived emotions may subsequently affect their limited memory stores or ability to efficiently process ne information during a cognitive task (Eysenck & Calvo, 1992). These emotions may be positive and could further assist a student with a specific task (e.g., a student who loves reading is likely to enjoy a reading task) or may motivate a student to seek out further opportunities in order to learn more (Wanzer et al., 2010). Conversely, some emotional responses (e.g., frustration or anxiety) may negatively impact a student's memory ability, placing extraneous cognitive load on the student during the task and negatively affecting subsequent performance (Ashcraft, 2002).

The proposed remedy for a limited cognitive load and to increase information processing efficiency is to encourage instructors to design educational systems that avoid cognitive overload (De Jong, 2010) and draw on the relationship between cognition and emotion. Positive distraction, or intentional attempts at easing student anxiety, may be sufficient to reduce the amount of mental load compromised by worrying (Bachman & Bachman, 2011; Bamber & Morpeth, 2019; Sprengel & Job, 2004). One such possible distraction is the use of humor in

teaching and assessment. Humor may be able to serve as a protectant by reducing anxieties (Ford et al., 2012) or increasing student's current positive feelings (Goodboy et al., 2015), reducing the amount of working memory capacity compromised by anxiety. This lowered level of anxiety may additionally improve a student's processing efficiency, increasing their academic achievement. Previous studies have reported greater benefits of humor for highly anxious individuals (Hackathorn et al., 2011) or those less interested in the subject matter (Wanzer et al., 2010), further justifying possible connections between humor and the assumptions within this theoretical design.

Academic Anxiety

Anxiety, an emotional response consisting of recursive worrying or fear related to various situations (Nourkova & Vasilenko, 2018), is common in college students. Generalized Anxiety Disorder is the most treated mental health condition for college students (Bamber & Morpeth, 2019), and academic anxiety is the highest predictor of overall student distress, outweighing financial issues and lack of family support (Bieg et al., 2015; Jones et al., 2018). Anxiety is typically characterized into state and trait anxiety. State anxiety is a temporary situation-specific state of worry related to the current environment, occurring within a specific timeframe, and fluctuating depending on the current environment (Belzer et al., 2000; Pekrun Cassady & Johnson, 2002). Trait anxiety includes ever-present and recurring negative emotions associated with generalized memories or anticipations (Belzer et al.); when this is specific to academic interactions, it is academic trait anxiety (Pekrun, 2006). Trait anxiety is the biggest predictor for how much time a student spends negatively ruminating about their academics, and college students with higher levels of trait anxiety report poor coping strategies including impulsivity and carelessness (Belzer et al., 2002).

Test anxiety is a common generalized academic anxiety pertaining to high-stakes assessments and may impact performance in multiple domains and settings (e.g., history and science and language arts) (Cassady & Johnson, 2002). Anxiety pertaining to academic assessments is directly tied to fears of negative evaluation and is often uncontrollable, further compromising a student's finite cognitive load during the exam (McDonald, 2001). This negative emotion is common and often subject-specific, acutely impacting a student within one or two courses (Pekrun, 2006).

When considering anxiety specific to academic subjects, mathematics is one subject that elicits levels of state anxiety for students disproportionately to other domains (Passolunghi et al., 2016), with some studies finding up to 80% of college-attending students possessing at least a moderate level of math anxiety (Beilock & Willingham, 2014). In Western cultures, educators sometimes lead students to assume math class should be hard, that mathematics is about skill and not effort, and being skilled at math is optional for the general population (Ashcraft, 2002). A subject-specific anxiety impacting most college students is a phenomenon that requires particular attention.

Math Anxiety

Math anxiety is defined as, "… a feeling of tension, apprehension, or fear that interferes with math performance" (Ashcraft, 2002, p. 181) and is a state of unpleasant feeling toward a present or future event involving math that may or may not be appropriate (Hembree, 1990). Math anxiety involves affective (e.g., tension and anxiety), behavioral (e.g., avoiding taking additional math courses), and cognitive (e.g., lowered self-confidence) factors impacting student attitudes and performance on mathematical tasks (Allen & Jameson, 2021; Ashcraft). Like general anxiety, math anxiety also takes the form of both trait (generalized ever-present fear of

future math interactions; Hembree) and state math anxiety (a momentary response to a math-related task such as an exam or being in a math class; Pekrun, 2006).

Math anxiety may include generalized negative obsessions about completing math in the future regardless of context, affecting students in both academic and non-academic environments (Beilock & Maloney, 2015; Choe et al., 2019; Foley et al., 2017). This anxiety may lower student motivation toward courses involving mathematics and may lead to avoidance behaviors (Allen & Jameson, 2021; Ashcraft & Moore, 2009) such as enrolling in fewer elective math courses, avoiding math-related college majors, or refusing to apply for jobs requiring math computations (Beilock & Maloney, Choe et al.; Foley et al.). Some students doubt their own ability to solve math problems in the presence of math anxiety (Passolunghi et al., 2016), negatively affecting their math self-efficacy (Jameson, 2020).

Self-efficacy is the degree to which an individual believes they are capable of learning and performing a task at a specific level (Schunk & DiBenedetto, 2014) and is predictive of college GPA (Krumrei-Mancuso et al., 2013). Students with math anxiety often report lower math self-efficacy, and individuals with low math self-efficacy may lose optimism about their ability to solve math problems, increasing their levels of math anxiety (Cooper & Robinson, 1991; Jameson, 2020; Jameson & Fusco, 2014). Lower self-efficacy often includes a higher degree of negative self-talk (e.g., “I am not good at math”) or avoidance behaviors (e.g., refusing to ask for assistance when learning new math concepts; Wang et al., 2014). An individual experiencing math anxiety alongside a compromised self-efficacy may experience negative impacts on their academic achievement (Passolunghi et al., 2016).

The Effect of Math Anxiety on Performance

Math anxiety negatively impacts student performance both in the short-term (Ashcraft, 2002; Ramirez et al., 2013) and long-term (Beilock & Maloney, 2015; Choe et al., 2019). Math anxiety can negatively impact student performance on exams or homework assignments due to extraneous load and recursive worrying. Repetitive fear pertaining to mathematics may also result in lower levels of motivation, further inhibiting the student's potential long-term achievement (Ashcraft, 2002; Passolunghi et al., 2016). While the exact mechanism behind this anxiety-performance relationship is unknown, several explanations have been put forth. First, individuals with high math anxiety sometimes lack foundational math skills (Passolunghi et al.); therefore, it may be that low skills are the cause of the relationship between anxiety and performance. As previously mentioned, self-efficacy levels are relevant in math anxiety, and low self-efficacy in math has been found to mediate the relationship between math anxiety and math performance (Ashcraft, 2002; Ashcraft & Krause, 2007; Cooper & Robinson, 1991; Palestro & Jameson, 2020). A higher level of state math anxiety also leads to worry and intrusive thoughts while completing math problems (Passolunghi et al.), contributing to extraneous load and further compromising the limited mental resources a student has available to accurately calculate and solve math problems (Ashcraft & Kirk, 2001; Sweller, 2011). The essential aspect of cognitive load being compromised by state math anxiety is an individual's limited working memory capacity (Eysenck et al., 2007).

Working memory is the ability to focus and maintain one's attention on a particular task and remember task-relevant information (Newell & Simon, 1972) while ignoring task-irrelevant thoughts (Beilock & Carr, 2005). Students attempting to solve math computations utilize their limited working memory resources, especially when solving direct number computations

(Ashcraft, 2002; Ashcraft & Krause, 2007). As math problems increase in difficulty, the computations require larger portions of an individual's working memory resources (Ashcraft & Kirk, 2001) and increase the student's cognitive load (Sweller, 2011). The worry, fear, and negative anticipation of future math-related tasks associated with state anxiety reduces an individual's already-limited working memory capacity by distracting the individual from focusing their attention on the task (Ashcraft & Kirk; Beilock & Maloney, 2015; Ramirez, 2013). Available working memory resources are further depleted when an individual's self-efficacy is negatively affected, and they engage in negative self-talk during a task (Ashcraft & Krause, 2007). When considering an individual's limited cognitive load and compromised working memory capacity, math anxiety having a negative impact on manipulating numbers, solving complex math problems, and retrieving relevant math information is not surprising (Passolunghi et al., 2016).

Interventions to reduce math anxiety and increase performance have been researched; expressive writing is one that has shown promise. Across several studies, researchers found that highly math anxious students who were instructed to write before a math exam had equitable performance to students with low math anxiety; furthermore, the more the students write about their anxiety and anticipation, the more the performance gap was diminished (Doherty & Wenderoth, 2017; Jannah et al., 2019; Park et al., 2014). These findings suggest that student math anxiety can be compensated with interventions (Hackathorn et al., 2011).

Positive Interventions

Instructors have attempted a range of interventions to positively impact student performance and students' subjective perceptions of their learning experience (Cassady & Johnson, 2002; Sprengel & Job, 2004; Young, 1991). The efficacy of these interventions may be

affected by factors such as student bias towards academic subjects, classroom relationships, and teacher attitudes (Astin, 1999).

Student boredom has the potential to reduce motivation and resulting achievement, impacting student achievement outcomes more than other affective experiences. (Krumrei-Mancuso et al., 2013; Smith, 2007). To reduce student boredom, instructors have used techniques such as clicker systems, supported student choice for assignment options, and utilized social media components within their course requirements (Cui et al., 2017; Welch & Bonnan-White, 2012). These interventions have generally found positive outcomes on student motivation and levels of perceived class value. Clickers are reported as fun, interesting, and inducing feelings of responsibility for learning (Bachman & Bachman, 2011), while students who feel more autonomy pertaining to course assignments report liking the instructor more finding the class material more valuable (Cui et al., 2017). Beyond increasing engagement in class, many interventions attempt holistic benefits for students that may transcend the classroom environment.

Positive interventions have the potential to benefit students beyond their interest in a course. One noteworthy example is an intervention that utilized positive reflection writing assignments, requiring students to document previous successful personal experiences, both of an academic and non-academic nature. Students experienced more positive affect, less negative affect surrounding their semester experiences, more optimism about future semesters, and less perceived test anxiety in their current courses. Students also perceived large assignments as a challenge to overcome instead of labeling these hurdles as a threat to be managed (Jannah et al., 2019; Park et al., 2014).

Considering repetitive interventions, instructors have also attempted to alter student mindset through mindfulness meditation, utilizing formal sessions that coach students how to be mindful of their breathing, thoughts, and internal states (Bamber & Morpeth, 2019). Adding a social component, another study required senior nursing students to serve as mentors to first-year nursing students. Both the mentor and mentee reported lower levels of anxiety, less stress about the program, and participants reported the increased interactions with other students in their programs were enjoyable (Sprengel & Job, 2004). Another form of social intervention that may improve student outcomes is the intentional use of humor within an academic setting.

Humor and Its General Effects

Humor, a stimulus considered funny or causing laughter (Martin et al., 2003), has recently entered positive psychology literature as a variable of interest. Humor is subjective; individuals do not always agree on what they find funny (Foley et al., 2012). A sense of humor, including both attempts to be funny and an individual's reactions to humor, is often mentioned as a desirable character trait in both a friend and romantic partner (Cann et al., 2016) In fact, researchers have identified four styles of humor: *self-enhancing*, *self-defeating*, *affiliative*, and *aggressive*, distinguished along two axes pertaining to whether the humor is aimed at oneself or others, and if the content of the humor is harmful or benign (Martin et al.; see Figure 2.1).

Figure 2.1

Four Main Humor Styles

Attributes	Aimed at Self	Aimed at Others
Harmless (Benign)	**Self-Enhancing**	**Affiliative**
Harmful	**Self-Defeating**	**Aggressive**

The positive effects of humor include both physical and psychological outcomes. Individual’s pain tolerance can increase for approximately 20 minutes after watching a funny video, despite the subjectivity of humor and its frequent ambiguity (Gironzetti, 2017; Zweyer et al., 2004). Humor is so effective for pain management that humor therapy is a research-based practice for individuals with chronic pain (Tse et al., 2009). Humor can assist patients in therapy to feel less anxious and experience higher levels of appreciation (Richman, 2007), and it is proposed to serve as a protective factor against anxiety and depression (Menendez-Aller et al., 2020)

Humor's Effect on Learning

In addition to altering physical perceptions and mood, humor can also aid the learning process. The presentation of humor increases the number of stimuli that children can remember, possibly by keeping them engaged in the content (Dormann & Biddle, 2007). Humor can aid the acquisition of second language vocabulary and semantic understanding (Bell, 2007; Wanzer et al., 2009). Experienced college educators tend to use humor more often than their novice counterparts, both via informal and intentional methods (Javidi & Long, 1989; Ziv, 1988). An instructor’s use of humor may initiate positive bonding between the student and their instructor (Hackathorn et al., 2011), while using a specific style of humor such as the *self-defeating* humor style, may further increase student perceptions of the instructor (Garner, 2006; Wanzer et al., 2010). Certain curriculums may greatly benefit from the use of humor by utilizing the interpretation of jokes to enhance the comprehension of lesson material, such as in second-language courses (Bell, 2007; Swanson, 2013).

For instructors to effectively benefit their students via the use of humor, they will first need to understand how their students may respond to the same joke in vastly different manners.

The use of humor between group peers while completing a group project may allow the students to bond with each other and experience higher levels of achievement than groups who do not share as much humor. However, too much laughter may signal a group has gone off-task and is no longer progressing due to confusion or lack of engagement (Berge, 2017). If students can bond with their instructor or peers because of humor, perhaps humor can also reduce the amount of academic anxiety for students.

The Effects of Humor on Anxiety

Considering the prevalence of anxiety reported by university students (Bamber & Morpeth, 2019), instructors may be tempted to use humor in the classroom in attempts to ease their students' anxieties. One study employed two different interventions to lower students' sense of math anxiety prior to taking a difficult statistics exam. The researchers encouraged some participants to adopt a *self-enhancing* humor approach to the instructions surrounding the task, and other participants were told to adopt a generally carefree and humorous attitude about the stressful event (Ford et al., 2017). Participants were not ultimately required to take the exam, but the researchers found both humor interventions significantly lowered participants' level of state anxiety prior to beginning the statistics exam. However, attempting to adopt a *self-enhancing* sense of humor resulted in greater benefits than adopting a general carefree and humorous approach to the situation. Participants who were instructed in both humor interventions resulted in the greatest reduction in perceived math anxiety as compared to those who were not instructed in either humorous intervention (Ford et al.,). Something as simple as a humorous outlook, as directed by another individual, is enough to ease student anxiety about an upcoming assessment.

Another study presented funny cartoons to participants before actually requiring them to take an exam (Ford et al., 2012). Researchers compared levels of state anxiety and performance

on the exam from participants in the humor conditions to participants who either were shown dramatic poems (meant to be interesting but not funny) or were not shown anything prior to taking the exam. Participants experiencing the humor prompts prior to taking the exam reported lower levels of state anxiety after the exam was complete compared to those who read poems or did not receive any positive distraction (Ford et al.). The level of state anxiety reported by participants moderated the effect of humor on how well the participants scored on the exam, illustrating the power of lingering state anxieties during the exam (Ford et al.). If humor is able to reduce the amount of anxiety present before or during an academic assessment, reducing the cognitive load imposed on the student, then humor may allow students to also obtain increased academic achievement.

The Effects of Humor on Academic Performance

The use of humor to positively impact student performance is a literature filled with nuance. Several studies present evidence that students experienced increased achievement when their instructor utilized humor in delivering content versus teachers who do not use humor (Hackathorn et al., 2011; Wanzer et al., 2009; Ziv, 1988). Instructors' use of humor within a lesson or academic assessment can be a positive predictor for student perceptions of how much they are learning, increase the amount of effort students are willing to invest in a class, and increase how much students are willing to participate, leading to increased student outcomes (Garner, 2006; Goodboy et al., 2015).

Within second-language English courses, humor aided in acquisition of new vocabulary and semantic meaning by making class examples more memorable and requiring students to deeply process the language involved (Bell, 2007) or by requiring students to process the

meaning of puns (Wanzer et al., 2009). The use of humor with language courses may also benefit student scores on standardized exams, such as the National Spanish Exam (NSE; Swanson, 2013).

One study illustrated the ambiguous relationship between humorous distraction and performance by discovering gender discrepancies in a learning task. The *Iowa Gambling Task* (IGT; Bechara et al., 1994) is an emotionally laden working memory task which tests how quickly participants can discern favorable decks of cards from a set of 4 decks, attempting to maximize their amount of hypothetical money by the end of the task (Bechara et al.). Flores-Torres and colleagues (2019) presented participants with humorous prompts and funny videos before beginning the task and compared their performance to others who did not watch any videos or humorous items before completing the IGT. Women exposed to the humor prior to the IGT outperformed women in the no-humor condition, but men exposed to humor performed worse than men in the no-humor condition. Individuals often do not agree on what is funny, and each individual may be affected differently when their emotional state is altered because of humor (Martin et al., 2003). This combination of variance increases the unpredictable relationship between the use of humor and academic performance.

Audible laughter is not an effective predictor of increased learning because individuals differ in their outward expression of amusement, especially across cultures (Niedenthal et al., 2018; Wanzer et al., 2010). Sometimes students may not be aware that their reactions to humor are impacting their subsequent performance. Comparing student performance across levels of Bloom's Taxonomy, Hackathorn and colleagues (2011) used humor in lessons throughout the semester, finding that students performed better when instructors used intentional humor to introduce material. This effect was limited to knowledge and comprehension level items on

exams, but no significant differences were found on application items (Hackathorn et al.). Perhaps humor may unreliably affect some aspects of student achievement, or only be able to increase academic performance in specific lower-order avenues.

The evidence suggests humor is not always beneficial for student outcomes, some suggesting positive distraction may ultimately inhibit performance (Bolkan et al., 2018; Eisend, 2009; Hollander, 1995) especially for highly anxious students (Ziv, 1976) due to extraneous distraction from the course material. One study added a humorous “E” option on every quiz or test question presented to students in courses over a two-year period and discovered no significant effects on student achievement (Bennett-Levy et al., 2001). Students may laugh at the humor presented and remember the jokes instead of the academic content (Bolkan et al., 2018), possibly becoming less interested in the material, and further limiting the relationship between humor and academic performance (Matarazoo et al., 2010).

A metanalysis investigating the link between the use of humor in instruction and student performance by Martin and colleagues (2006) concluded humor may indeed impact performance, but the degree to which the relationship exists and the method in which humor benefits student achievement is still in question. The clarification between a temporary increase in performance and long-term retention when considering the benefits of humorous instruction is an avenue in need of future research (Martin et al.). Hackathorn and colleagues (2011) suggested many humor studies are not realistically mapped onto actual classroom scenarios and may not reflect dependable results that could readily be applied in the classroom (Bennett-Levy et al., 2001; Matarazoo et al., 2010). If humor is to be utilized in teaching or assessment to benefit student outcomes (both in their levels of anxiety and achievement), researchers should present the

evidence for best practices. The mechanisms by which humor may be able to reliably improve student performance are still in speculation and need further investigation.

The Effects of Humor on Working Memory

Authors studying the pathway through which humor impacts performance tend to speculate about these connections without gathering further evidence to support their claims. Garner (2006) found humorous distraction increased a sense of detachment from the stressful academic event and increased a sense of objectivity for participants. However, the cognitive effect by which this detachment may have impacted performance was not mentioned, nor was the subsequent research completed. Cognitive distraction from a stressful task via humorous manipulations can prevent participants from experiencing as many negative anxiety-related thoughts (Strick et al., 2009). Participants with less negative emotions during the exam than their counterparts who did not receive humor before their exam performed better on the test. Strick and colleagues speculated humor may be affecting performance via an expanded working memory capacity but did not gather any evidence to test this speculative claim.

Another study asserted that exposing participants to humor prior to taking a math test enhanced performance by inhibiting the amount of anxiety felt by participants (Ford et al., 2012), and speculated that working memory capacity increased once participants’ levels of math anxiety had been effectively lowered. Ford and colleagues further speculated the increased working memory capacity afforded by a lowered state anxiety via humorous distraction may explain the increase in performance but did not attempt to explain the causal relationship any further. Claiming working memory is the link between exposure to humorous stimuli and an increase in academic performance without testing these claims is insufficient.

One article argued against the role of working memory in the relationship between humor and academic performance, claiming “emotions consume cognitive resources (i.e., resources of the working memory) by focusing attention on the object of emotion” (Pekrun & Linnenbrink-Garcia, 2012, p. 264). The authors further explain that any kind of distraction, even positive distraction, is going to further limit working memory capacity by effectively increasing the cognitive load for partition. The authors call for more investigation into the complicated nature of emotional effects on student achievement, but do not seek to further explain the ways in which alleviating one’s mood may explain an increase in academic performance (Pekrun & Linnenbrink-Garcia). To present an argument against working memory's role in the relationship between humor and performance without subsequent evidence to explain the culprit is insufficient.

State anxiety during an academic task has been effectively demonstrated to compromise a person’s working memory and working memory capacity is directly tied to academic performance (Ashcraft & Krause, 2007; Foley et al., 2017). Studies presenting the relationship between humorous interventions and lowered state anxiety during an assessment are more prevalent than studies investigating the relationship between humor and performance (Strick et al., 2009). Some speculate the decrease in state anxiety may connect to an increase in student performance via a refreshed working memory capacity without testing these claims or providing evidence for an alternate explanation (Ford et al., 2012; Strick et al.). The first study in this research project attempts to fill this missing gap by assessing whether humorous distraction can increase participants’ working memory capacity. If the results from this study present evidence that working memory capacity increases in the presence of humor, a crucial piece of the relationship between humor and performance may be built into future research designs. Utilizing

the Information Processing Theory and Cognitive Load Theory, I am curious if humor can not only subtract from an individual's working memory load, but also better enable them to perform on a following round of working memory tasks.

The Unclear Relationship Between Humor and Academic Performance

The conclusions remain disputed in the literature investigating the possible relationship between humor and academic performance. Some investigations find humor has no effect on motivation nor performance (Bennett-Levy et al., 2001; Bolkan et al., 2018), while other studies report humor is capable of both improving academic performance and lowering students' state anxiety during the exam (Ford et al., 2012), and a host of other studies fall somewhere in between, presenting mixed results (Bolkan et al., 2018; Hackathorn et al., 2011; Strick et al., 2009). Addressing the contradictory nature of these results, authors tend to ruminate about the lack of consistency without gathering further evidence.

Curiously, only a few studies to date have requested participants rate how funny they consider the humor prompts (Ford et al., 2017), but most of these investigations use these numerical ratings as a manipulation check to ensure participants find the humor prompts funnier than an opposing manipulation (e.g., poems meant to be interesting but not funny; Ford et al., 2012). Having participants rate how funny they find humor prompts may add a valuable factor useful for analyses, acknowledging that not all participants within a humorous manipulation are having the same experience (Wayne et al., 2021).

Another factor preventing homogenous conclusions may be explained by the Incongruity-Resolution and Disposition Theory (Wanzer et al., 2010). There exist several reasons why participants may not react to humor in the same manner, and Wanzer and colleagues present

three events required for any participant to be affected by an attempt at humor. Participants would have to first notice an attempt at humor had occurred. Second, the individual would have to understand the joke or "get it." Finally, the participant would have to interpret this noticeable and understandable joke as funny. If any of these progressions do not occur, the participant cannot be positively affected by any instructor attempts at humor (Wanzer et al., 2010).

Studies investigating the connection between humor and academic performance might consider utilizing replication studies to validate their own claims (Bolkan et al., 2018) and varying humor styles may be causing too much variation in participant responses to humor (Martin et al., 2003). An aspect of humorous interventions that remains undiscussed is the ideal content of a humorous intervention; what jokes are going to work the best for affecting academic performance?

Joke Content Matters for Academic Performance

Most students, (74%), enjoy when their instructor use humor, especially if the jokes tend to be lighthearted and not deemed offensive (Frymier et al., 2008; Torok et al., 2004) or if the jokes are related to the subject material (Wanzer et al., 2010). In a math course, math-related humor can result in higher student elaboration on content both in class and outside of the classroom or increase interest in the subject, while unrelated humor may negatively detract from the math content (Less& Schuman, 2004; Wanzer et al.). The design of the second study within this research investigates this exact issue: how math-related and unrelated humor may differently impact participant performance and anxiety.

Matarazzo and colleagues (2010) used humor within a math learning program and included humor within the math test instructions to investigate if humor could increase participants' interest in learning math. Humorous instructions for the exam generated increased

interest for participants, but only for those who did not experience humor throughout the learning program. Participants may become desensitized to humor if they already experienced previous humor attempts in a lesson. Participants who were not initially interested in math experienced an increase in their math interest when humor was presented throughout the lessons, but individuals who were already interested in learning math did not experience this same effect, illustrating that humor does not impact student interest in a subject matter in the same manner (Matarazzo et al.). Those who became more interested in math tended to score better on the math assessment, but humor was not able to predict math tests core in this sample. The humor used in this study was not related to the math content, instead using puns and off-content humor manipulations (Matarazzo et al.). These results suggest unrelated humor manipulations were not capable of reliably impacting student performance, and this unrelated humor decreased the level of interest in learning math for those who came into the study highly interested in math.

Building on the Incongruity-Resolution and Disposition Theory mentioned earlier (Wanzer et al., 2010), an additional theory has been presented that may explain a content-related link in the relationship between humor and academic performance. The Instructional Humor Processing Theory claims five levels of processing are required for humor to positively impact student achievement (Wanzer et al., 2010), and includes aspects of the Information Processing Theory (Newell & Simon, 1972) in the theoretical assumptions. First, students must notice the humor and cannot miss when the joke is presented. Second, the student must understand the joke and “get it.” Third, the student must interpret the understood attempt at humor as funny. After noticing the humor, understanding the joke, and appraising the stimuli as funny, the student's reaction alters their affect toward the class content (either increasing or reducing motivation and chance of elaboration). Last, this altered affect may positively impact student performance by

increasing the amount of effort a student puts into studying, concentrating on the assessment, etc. If any of these consecutive five steps do not occur for a student, the presented humor may be unable to positively affect their academic achievement (Wanzer et al., 2010). To maximize the potential benefits for participant anxiety and performance with the use of humor, instructors should attempt to keep the humor on topic and make jokes that empower the course content, not distract from it. Using the Instructional Humor Processing Theory, the second study in this project will explore the fourth and fifth steps of this framework by comparing how math-related humor may affect participants differently than non-related humor prompts during a math exam.

Can Math-Related Humor Affect Math Performance?

When considering if humor is on-task or serves as a distraction, a distinction must be made between contiguous and integrated humor. Contiguous humor includes jokes that are not related to the message or academic content and are meant to serve as an irrelevant positive distraction. Contiguous humor does not add nuance to the educational message, instead distracting from a student's negative thoughts or anxiety surrounding an academic task (Bolkan et al.; Lee & Shuman, 1994). Integrated humor is directly embedded in instructional material or an assessment within the appropriate timeframe and is intentionally placed to encourage deeper understanding of the course material (Bolkan et al). These integrated attempts at humor add a factor of enjoyment for students, and integrated humor may benefit both student outcomes and their subjective liking of the course material (Wanzer et al., 2010).

The design of the second study combines the distinction between integrated and contiguous humor with Wanzer's Instructional Humor Processing Theory (Wanzer et al., 2010) and previous findings that students may react more favorably to humor associated with the

current academic task (Bolkan et al., 2018). I am curious whether integrated math-related humor will be able to limit participant math anxiety and increase math performance on a timed math exam differently than contiguous humor manipulations that are not related to math (Bolkan et al.).

CHAPTER III

RESEARCH METHODS

Methodology

Participants and Setting

Participants included students enrolled in either Principles of Psychology (PSY 120) or UNIV 101 in the Spring and Fall 2021 semesters. The studies occurred solely online via live online video call sessions and survey software. Participants were asked to leave their camera on and ensure they would be in a quiet and secluded environment. The entire session took between 30 and 60 minutes to complete.

Participant Recruitment

IRB Approval was individually obtained for each study. Participant recruitment did not begin for either study until final IRB approval for exempt status was granted for both studies. Students enrolled in PSY 120 must complete 3 hours (i.e., 6 credits) of research studies during their course enrollment; they are provided with alternative assignments to avoid coercion. Students registered for studies through an online portal Sona. Via Sona, students were able to view all available studies they may participate in, including both of these studies. Additionally, students enrolled in UNIV 101 were offered a chance to enter a drawing to receive one of four possible $50 gift cards to the UNC Bookstore if they participate in one of these studies. Students who decided to sign up obtained a link to a sign-up calendar. All students selected an available timeslot from a list of options and a custom link was sent to the student. If a student did attend

the study session, PSY 120 students did not receive research participation credit on SONA, and UNIV101 students were not entered into the gift card raffle.

Study 1

Measurements

The Digit Span task used in this study is a modified working memory task based on the Wechsler Memory Scale-Revised (Elwood, 1991; Wechsler, 2014; Wechsler & Kodama, 1949). The researcher stated aloud a series of numbers. Participants were tasked with responding by stating these same numbers aloud. Three different sections of the task altered the order in which these digits would be correctly stated by participants. In the forward condition, participants repeated the numbers in the same order they were presented (e.g., “5-0-2” would necessitate “5-0-2”). In the backward condition, participants attempted to state the numbers in the reverse order they were presented (e.g., “4-7-3 requires “3-7-4”). The sequence condition required participants to reorganize all the digits they heard into ascending order before attempting to verbally recall the numbers (e.g., “6-8-3-1” requires “1-3-6-8”).

Within each condition, the number of digits began at two. As the participant correctly recalled the digits (either in forward, backward, or sequence condition), the researcher progressed to the next row of numbers, each trial adding another digit to be correctly recalled. The task maxed out at eight digits. Each condition ended either when participants failed to correctly recall two consecutive lines of digits, or they reached the end of the trial by completing the longest list of digits. The participant completed two sets of trials within each of the three conditions, totaling six digit span trials within the task.

The Digit Span task correlates well with other working memory tasks such as the Subtract 2 (r = .71), the Syntax Simple Sentences task (r = .61) and the Alphabet Span (r = .51;

Waters & Caplan, 2003). The Digit Span also maintains good split half reliability (*r* = .88; Elwood, 1991) and the sub scores are highly correlated with one another according to the WAIS-IV technical manual (*r* = .91; i.e., .93). Utilizing a higher order model and varying calculations of reliability, one particular study found lower levels of reliability between the various sub scores of the Digit Span (*r* = .74; Gignac et al., 2019). Considering this evidence, the digit span subscales were analyzed separately in appropriate computations.

In the Reading Span Task (Daneman & Carpenter, 1980), participants were required to read aloud sets of unrelated sentences and an accompanying word featured in all capital letters at the end of each sentence (e.g., "Heavy winds scattered leaves around the neighborhood park. BASKET"). Each set contained a range of two to five pairs of sentences and words. After the set was complete, the participant saw a "???" appear on the screen. At this time, the participant attempted to recall the words chronologically that were featured in capital letters in the set. The number of words the participant could verbally recall is their score for that trial. The Reading Span Task was composed of twelve trials, including three iterations each of trials including two, three, four, and five sentences. The original Reading Span Task was delivered to participants on paper, but this study utilized an adapted version for online use employing a computer screen.

The Reading Span task is moderately correlated with other memory span tasks asking participants to recall a set of words in order without reading anything in between (*r* = .55), and correlates well with verbal SAT score (*r* = .59) and tests of reading comprehension (*r* = .72; Daneman & Carpenter, 1980). Another study concluded the Reading Span task was highly correlated with a similar working memory task involving numerical equations instead of sentences prior to a target word (*r* = .68; Daneman & Hannon, 2007. Additionally, Daneman and

Hannon (2007) found the Reading Span task correlated well with a simpler task requiring participants to remember a set of words in order (*r* = .50).

Traditionally, the Reading Span Task is scored as the highest sentence amount at which participants can recall the words correctly most of the time (two out of three trials). Although this scoring method is reliable (Daneman & Carpenter, 1980), authors have speculated if this style of scoring is missing valuable variability within participant scores (Friedman & Miyake, 2005; McNamara & Scott, 2001). One such investigation compared four different scoring methods of the Reading Span Task. More continuous measures of scoring led to more reliable and consistent results (Friedman & Miyake, 2005). Therefore, scoring was calculated by total words correctly recalled across all trials (Range: 1 - 42) by each participant as their Reading Span Score. Using this more continuous measure of scoring led to more normally distributed results, higher rates of test-retest reliability (*r* = .80), higher levels of internal split-half reliability (*r* = .83), and higher correlation with reading comprehension criterion measures such as subtests of the ACT (*r* = .47) and Verbal SAT (*r* = .53; Friedman & Miyake, 2005). Following this evidence presented by Friedman & Miyake (2005), the Reading Span Task was scored in this manner for more accurate analysis.

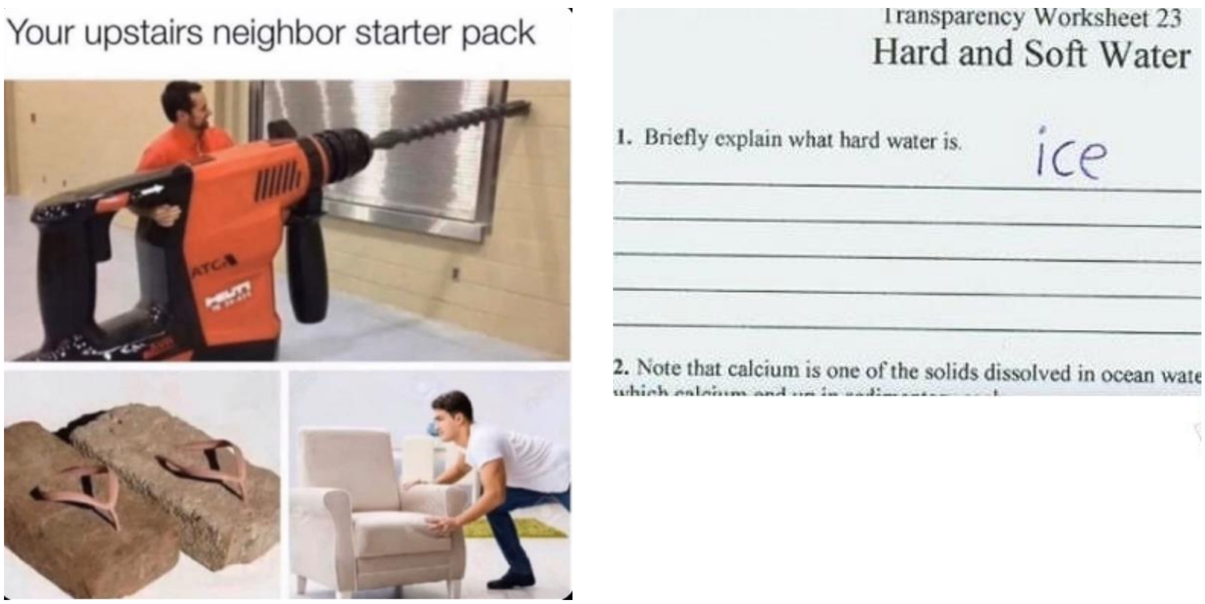
Humor Prompts

The humor prompts were curated and employed in two previous investigations (Wayne et al., 2021). Two independent samples of participants rated these humor prompts for how funny they were on a scale of 1 (*not funny*) – 10 (*very funny*). Across both previous studies, 30 prompts were used. I selected the twelve highest-ranked humor prompts to ensure the humor manipulations used in this study would be considered humorous. The humorous items included one-liner puns, funny test replies, internet-generated memes, and road signs. I asked participants

how funny they consider these prompts at the end of this study, accounting for the degree to which each participant finds the humor prompts funny. Examples of the humor prompts are included in Figure 3.1.

Figure 3.1

Humor Prompt Examples



Nature Prompts

The pictures of nature were curated and selected by the research team according to a number of criteria. Each of the twelve pictures included natural landscapes that a) did not include any human-made or human-influenced aspects b) did not feature any wildlife or humans within the photo c) was taken during the day as to provide clarity of the scenery and d) did not repeat a similar environment (e.g., jungle, desert, beach, prairie). Examples of the nature pictures are included in Figure 3.2.

Figure 3.2

Nature Picture Examples

Procedure

Participants signed up for participation on Sona or through a scheduling calendar link. Participants received an email confirmation about their scheduled session and accompanying timeslot. The researcher first presented the participant with the consent form via Qualtrics, and the session continued if the participant signed the consent form. Participants began by shutting off their cell phone and placing it away. The researcher then explained this session will include tasks that require their complete focus and attention, and then the researcher verbally asked the participant if they are currently in a quiet and stable environment. The researcher ensured the participant appeared to be in a quiet and calm location before beginning the first working memory task. The researcher then informed the participant they will complete two separate cognitive tasks.

The two working memory tasks were presented in a random order for each participant to balance fatigue and distractions. In a randomized order, the digit span and reading span tasks were administered both before and after the intervention (twelve humor or nature pictures). Each task included a series of practice rounds to acquaint participants before the first trial began.

Between each task, participants were shown a screen informing them to notify the researcher when they are ready to proceed to the next task.

After the two working memory tests were completed, participants then viewed the twelve humor or nature prompts. The researcher informed participants they would be shown a series of images, asking participants to observe these images as they appear on the screen. The participant observed each prompt for 10 seconds each. Once participants had experienced all humor or nature prompts, they completed the same working memory tasks as before, but in a different order. Prior to beginning the same working memory tasks in a randomized order, participants saw a screen requesting they inform the researcher when they are ready to proceed. The same screen appeared in between the working memory tasks, similar to the first session that participants completed.

After all working memory tasks were completed again, participants then rated how funny they found each of the humor or nature prompts they saw in between the working memory tasks (1 = *not funny*, 5 = *very funny*). Lastly, participants completed a demographic form. The researcher verbally debriefed the participant while the debrief form was displayed on the screen. Participants were given an opportunity to ask any questions and were thanked for participating in the study.

Analysis

Q1 Does exposure to humorous images increase working memory capacity differently than a set of relaxing images?

I utilized a series of one-way ANOVAs to analyze if the treatment condition (humor vs relaxation) predicted a different change in working memory capacity for each working memory task. To compute the working memory change score for each participant, I subtracted the pre-

intervention score from their post-intervention score. To avoid familywise errors across repetitive analyses, the significance level was adjusted to ($p < .01$).

Q2 Does the degree to which participants consider an intervention funny or relaxing predict a change in working memory capacity?

Considering the subjective participant reactions to the interventions, I used a simple linear regression analysis for both treatment groups. I investigated if the degree to which participants found the humor prompts funny or the nature pictures relaxing predicted their working memory change scores (pre-intervention score subtracted from the post-intervention score) for each working memory task.

Study 2

Measurements

Math Anxiety. The *Abbreviated Math Anxiety Scale* (AMAS; Hopko et al., 2003) measured the amount of state math anxiety participants were experiencing at two intervals. This 9-item measure requests participants to rate how anxious they felt the last time they had to complete math-related tasks such as “take a math test” or “remember information from a math lecture” (Range: 1 “*low anxiety*” – 5 “*high anxiety*”). The AMAS (Range: 9 – 45) has strong correlations with longer math anxiety measures such as the Math Anxiety Rating Scale Revised (MARS-R; $r = .85$), as well as excellent internal consistency ($\alpha = .90$) and two-week stability reliability ($r = .85$; Hopko et al., 2003).

The *Single-Item Math Anxiety* measure (SIMA; Núñez-Peña, Guilera, & Suárez-Pellicioni, 2014) measured the amount of trait math anxiety participants are experiencing at two intervals. The SIMA consisted of one question, asking participants “How anxious do you feel about math right now” (Range: 1 (*low anxiety*) – 10 (*high anxiety*)) and correlates well with longer measures of math anxiety (e.g., $r = .77$ with the sMARS and $r = .41$ with the State and

Trait Anxiety Inventory – State (STAI-S); Núñez-Peña, et al., 2014). This single question was presented after the end of the 9-item AMAS for a total of 10 questions gauging participants' state math anxiety.

Math Performance. Math achievement was measured by using two modified versions of the math computation subtest of the *Wide Range Achievement Test 4th Edition* (WRAT-4) (Wilkinson & Robertson, 2006). This subtest includes 40 items arranged in increasing difficulty and is appropriate for individuals between the ages of 5-85. The WRAT-4 includes two versions identical in difficulty and design, which include different calculations. The first 20 items on each version are elementary-level mathematical computations; therefore, to differentiate participant scores and avoid a ceiling effect on the foundational items, only the final 20 items were used for this study. To avoid participant fatigue across the multiple points of data collection, the baseline math subtest included every other item from the final 20 questions for a total of 10 items. The intervention math performance measure included all 20 difficult items from a separate version of the math computation subtest with humor prompts on every other page.

Humor Prompts. I curated the humor prompts embedded in both versions of the math exam (the math group receiving humor prompts related to math and the unrelated group experiencing humor prompts not related to math). An initial bank of thirty math-related humor prompts were developed, and a pilot study (*N* = 35) asked participants to rate how funny they found each prompt; the twelve prompts with the highest average ratings were used in this study. Examples of the math humor prompts are included in Figure 3.3. The unrelated humor prompts were curated and employed in two previous investigations (Wayne et al., 2021), and the twelve highest rated prompts from these prior studies were used in this study. The humorous prompts included a variety of one-liner puns, funny test responses, internet-generated memes, and road

signs. I asked participants how funny they considered these prompts at the end of this study (Range: 1 "*not funny*" – 5 "*very funny*"), measuring to which degree each participant found the humor prompts funny. The sum of their humor ratings was the Total Humor Rating (THR; Range 12 – 60). Ad-hoc analyses ensured the total humor ratings of both humor categories in this study shared similar distributions and means.

Figure 3.3

Examples of Math Humor Prompts

Procedure

Participants signed up for participation on SONA or via a calendar link. Participants received an email confirmation about their scheduled session and accompanying timeslot. The researcher first presented the participant with the consent form via Qualtrics, and the session continued if the participant signed the consent form. Each participant began their session by shutting off their cell phone and placing it away.

Participants began the study by completing the 10-question baseline math performance measure. They were informed of the 5-minute time limit, and the researcher notified them when 30 seconds was remaining. The researcher notified the participant they may use scratch paper,

but no calculator or internet use was allowed during the test. After completing the baseline math measure, participants then answered a set of questions about their state math anxiety using the AMAS and SIMA.

Next, the researcher informed participants they were about to complete a very difficult math exam. The researcher explained the exam is "very difficult and hard to finish within the allotted time limit." The math exam included twenty questions from the Blue WRAT-4. The exam included two blocks of ten questions each. Four humor prompts were presented to participants prior to the start of both exam blocks and after the exam was over, for a total of three humor blocks including twelve humor prompts overall. Participants in the math group saw humor manipulations related to the style of math problems they are solving (e.g., fractions, decimals, algebra, etc.) in line with requirements of integrated humor (Bolkan et al., 2018). Participants in the unrelated group experienced unrelated, non-math humor prompts. The researcher informed participants they were about to witness a series of images. The researcher then displayed each humor prompt for ten seconds before proceeding to the next prompt. After each humor block, the participant saw a screen asking them to notify the researcher when they were ready to proceed.

Once participants completed the math exam and experienced the final block of humor manipulations, they completed the AMAS and SIMA measures for post-test levels of math anxiety. Then, participants rated how funny they found each of the 12 humor prompts (Range: 1 (*not funny*) – 5 (*very funny*); THR: 12 – 60) during the exam. Last, participants completed a demographic form. The researcher then verbally debriefed the participant while the debrief form was displayed on the screen. Participants were given an opportunity to ask any questions and were thanked for participating in the study.

Analysis

Q1 Does the degree to which participants consider a humorous intervention funny in the presence of their math anxiety predict a change in math performance?

I utilized a stepwise regression to analyze if the Total Humor Rating (THR) may predict the change in participants' math performance. In this stepwise regression, the math anxiety change score (pre-test math anxiety subtracted from post-test math anxiety) was included in the first step and total humor rating was added in the second step. The dependent variable was the math performance change score (Baseline math score subtracted from the intervention test score).

Q2 Does math-related humor embedded in a math exam alter levels of math anxiety and math performance differently than unrelated humor prompts?

After coding the treatment group as a dummy variable, I utilized a multivariate regression to investigate if the treatment group predicted the change in math anxiety. Second, I utilized another multivariate regression to investigate if the treatment group predicted the change in math performance. The total humor rating (THR) served as the covariate in both models and the significance value ($p = .025$) was halved to avoid inflating the likelihood of committing a Type 1 familywise error.

CHAPTER IV

IS MEMORY A LAUGHING MATTER? HUMOR'S CAPACITY TO ALTER WORKING MEMORY

To be submitted to *The International Journal of Humor Research*

Contribution of Authors and Co-Authors

Manuscript in Chapter IV

Author: Ivan Jay Wayne

Contributions: Designed study, developed online study materials, facilitated online portal setup of study, ran participants, entered and synthesized data, wrote drafts of manuscript.

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Contributions: Assisted in study design, provided feedback of online survey formatting, edited and refined drafts of manuscript, mentored throughout the entire process.

Abstract: The literature connecting humorous distraction with a benefit to academic performance features conflicting evidence. Authors present evidence that humor is able to directly benefit student academic performance (Ford et al., 2012), while other authors suggest humorous distraction may actually worsen performance (Bieg et al., 2015). The missing element within the heterogenous results is the mechanism by which humor may impact subsequent performance. Researchers have speculated this mechanism is an increase in working memory without collecting evidence to support their claims (Strick et al., 2009). This study (*n* = 31) investigated if a humorous intervention was able to temporarily increase participants' working memory capacity more so than a set of nature pictures intended to be relaxing. Results indicated that neither the humorous nor relaxing interventions were able to significantly predict a change in working memory scores. Despite requiring follow-up research, one particular piece of evidence suggests participants may benefit from humorous intervention on working memory tasks specifically related to language. Other results and a discussion of implications are included.

Keywords: working memory, performance, humor, relaxation,

Literature Review

Benefitting Student Achievement

Assisting students attain their peak academic performance has been a major focus of recent education initiatives. Student performance, across both long periods of time and in acute situations (e.g., mid-term exam), may be negatively impacted by a host of factors such as enjoyment of the course, anxiety, lack of content knowledge, or the degree to which the student enjoys the instructor (Bamber & Morpeth, 2019; Cui et al., 2017; Jones et al., 2018; Pekrun, 2006). These factors prevent students from performing optimally, and instructors desire to alleviate this extraneous strain on their students. Instructors attempt a host of interventions to affect factors limiting student performance such as mindfulness meditation, writing exercises, community-building, or the intentional usage of humor (Astin, 1999; Sprengel & Job, 2004; Welch & Bonnan-White, 2012). Humor can be utilized as a powerful tool to alleviate student anxiety or to possibly increase student interest in the subject matter (Garner, 2006; Javidi & Long, 1989).

Humor

Humor is defined as a stimulus intended to be funny or comical (Martin et al., 2003) and may be either premeditated or a tactic an instructor does not plan in advance (Ziv, 1988). Many instructors intentionally embed humor in their teaching practices, attempting to use humor during direct instruction, within their prescribed directions for an activity, or in graded assessments (Garner, 2006; Ford et al., 2017; Hackathorn et al., 2011). Evidence suggests that humor may benefit individuals in several avenues including temporarily increasing their pain tolerance, enabling stronger feelings of optimism, or lowering levels of perceived academic anxiety related to completing academic tasks (e.g., studying, listening to a lecture, or taking an exam (Bechara et

al., 1994; Ford et al., 2017; Martin et al., 2003). Alongside a decrease in anxiety, humor may also benefit student performance within a course or during an assessment, especially in second-language courses due to the increased comprehension of language required to “get” the jokes (Bell, 2007; Swanson, 2013).

Humor and Performance

Humor may benefit student performance, even if the student is unaware of these benefits (Wanzer et al., 2010). Humor may increase the student’s liking of their instructor or increase their enjoyment of the course material (Garner, 2006; Goodboy et al., 2015), further motivating the student to put in more effort into their assignments. Students may experience a higher degree of intrinsic motivation toward completing a course in which they can laugh and, as a result, obtain higher levels of academic performance. Additionally, students who laugh more during a course perceive they are learning more and may cause the student to have higher degrees of optimism and confidence (Wanzer et al., 2009), furthering the student’s overall achievement. Group projects can prove difficult or frustrating for some students, but those who are able to laugh together while completing a group project have reported a greater degree of peer bonding (Berge, 2017). Laughing together may impact student motivation or while completing the assignment, but much of a student’s grade depends on particular graded assessments throughout a course. Due to the potentially high-stakes nature of such assessments (e.g., a final exam or large project), it is particularly important to understand if humor can impact student performance during a high-stakes assessment.

Humor presented before or during an academic assessment may result in lower levels of anxiety and an increase in performance (Ford et al., 2012; Hackathorn et al., 2011), suggesting well-timed humor has the potential to directly benefit student outcomes. Additionally, evidence

suggests that participants who rate humor manipulations embedded within an exam as funnier tend to score better on that exam (Wayne et al., 2021). However, other evidence suggests humor may actually increase student anxiety (Eisend, 2009) or may negatively impact subsequent student performance due to unnecessary distraction (Bolkan et al., 2018). One particular study suggested humor before a learning task enabled women to perform better, while men who experienced humor beforehand performed worse than their male counterparts not exposed to humor prior to the learning task (Flores-Torres et al., 2019). Inconsistent evidence pertaining to the relationship between humor and acute academic performance raises questions about the possible mechanisms by which humor may be able to impact academic performance.

Disconnects Between Humor and Performance

Authors tend to speculate why this lack of consistent evidence remains in the literature connecting humor and academic performance without gathering further evidence to test these curiosities. Perhaps humor studies do not accurately map on to what students experience within their enrolled courses, or maybe evidence connecting something as subjective as humor to academic performance is difficult to replicate (Bennett-Levy et al., 2001; Matarazoo et al., 2010). Despite the subjectivity of humor manipulations, a few key components remain absent from the discussion. Almost all previous studies have failed to ask participants how funny they consider the humor manipulations, missing the biggest factor; the participants' subjective interpretation of the humor prompts within the study (Wayne et al., 2021).

In addition to a lack of measurement of participant reactions to humor, the mechanism by which humor may be impacting student performance is missing from the literature. Previous study designs have skipped the link in the relationship between humor and performance, assuming this connecting variable was not necessary or assumed the factor was already

accounted for (Wayne et al., 2021). Some authors propose humor may alleviate levels of academic anxiety, and in turn, allow for better academic performance without providing evidence of these claims. If humor is able to increase positive emotion or limit the amount of negative emotion during an assessment (e.g., anxiety or frustration), authors speculate that working memory is the mechanism enabling humor to benefit student performance without further investigating these claims (Foley et al., 2017; Ford et al., 2012; Strick et al., 2009).

Working Memory

The Cognitive Load theory suggests memory capacity and an individual's ability to utilize task-relevant information is limited (Sweller, 1994; Sweller, 2011; Sweller & Chandler, 1991) and may be compromised by extraneous factors such as worrying, anxiety, or task-irrelevant thoughts (Ashcraft, 2002; Pekrun & Linnenbrink-Garcia, 2012). Working memory is the ability to process relevant information and focus one's attention on a particular task while ignoring task-irrelevant thoughts (Sweller, 1994; Sweller, 2011). When an individual's cognitive load is compromised by negative irrelevant distractions, the resulting academic performance will likely suffer because fewer resources can be devoted to the task (De Jong, 2010). If humor is able to alleviate an individual's mood, increase their feelings of optimism, or limit their academic anxiety, they may experience an increased working memory capacity thereafter due to a decline in the amount of negative extraneous thoughts (Ford et al., 2012).

After finding evidence suggesting humor may benefit academic performance, authors have speculated working memory is the variable enabling humor to benefit academic performance without measuring working memory in any follow-up investigations. Other studies have presented evidence that humor does not impact academic performance without asking the participants if they found the humor manipulations funny (Eisend, 2009; Hollander, 1995). If

participants do not consider a humor manipulation funny, significant effects on performance cannot be expected. Measuring a possible change in working memory without also asking participants how funny they consider the humor manipulations leaves out the subjective response of humor, further limiting the evidence for a relationship between humorous distraction and working memory.

The Current Study

This study addresses two of the missing assumptions within the heterogeneous literature examining the relationship between humor and academic performance on a specific assessment. First, the degree to which participants consider a humor manipulation funny must be recorded to enable further data analysis instead of leaving the efficacy of the humor manipulation in question (Wayne et al., 2021. Second, no prior study has analyzed if a humor manipulation is capable of temporarily increasing an individual’s working memory capacity, instead assuming working memory may be at least partially responsible for a possible increase in academic performance (Ford et al., 2012; Strick et al., 2009).

Utilizing a pre- and post-intervention design, this study required participants to first complete a battery of working memory tasks. Then, participants were exposed to one of two manipulations. The humor manipulation was tested alongside a manipulation intended to be relaxing, investigating if humor may alter working memory differently than relaxation. After viewing the manipulations, participants then completed the same battery of working memory tasks. Finally, participants rated how funny or relaxing they found each of the prompts within the manipulation before completing a demographics form. The following research questions will be investigated in this study:

Q1 Is participants' working memory capacity different when presented with humorous prompts compared to relaxing prompts?

Q2 Does the degree to which participants consider an intervention funny or relaxing predict a change in working memory capacity?

Methods

Participants

Participants for this study were 31 undergraduate students (19 women and 12 men) attending a medium-sized public university in the Mountain West region of the United States. Most participants (*n* = 22) were between 18-21 years of age (*M* age = 21), and most participants reported their ethnic identities as white (58%), with 26% of participants identifying with Hispanic/Latinx, 10% Asian, 10% Black, and 12% of participants identified with other ethnicities. About half of the students were first-generation (*n* = 16) or in their first year at university (*n* = 17). All participants were enrolled in 100-level introductory courses.

Measurements

Working Memory Tasks

The Digit Span task used in this study is a modified working memory task based on the Wechsler Memory Scale-Revised (Elwood, 1991; Wechsler, 1945; Wechsler, 2014). The researcher stated aloud a series of numbers. Participants were tasked with responding by stating these same numbers aloud. Three different sections of the task altered the order in which these digits would be correctly stated by participants. In the forward condition, participants repeated the numbers in the same order they were presented (e.g., “5-0-2” necessitated “5-0-2”), while the backward condition required participants to state the numbers in the reverse order they were presented (e.g., “4-7-3 required “3-7-4”). The sequence condition required participants to reorganize all the digits they heard into ascending order before attempting to verbally recall the numbers (e.g., “6-8-3-1” required “1-3-6-8”).

Within each condition, the number of digits began at two. As the participant correctly recalled the digits (either in forward, backward, or sequence condition), the researcher progressed to the next row of numbers, each trial adding another digit to be correctly recalled. The task maxed out at eight digits. Each condition ended either when participants failed to correctly recall two consecutive lines of digits, or they reached the end of the trial by completing the longest list of digits. The participant completed two sets of trials within each of the three conditions, totaling six digit span trials within the task.

The Digit Span task correlates well with other working memory tasks such as the Subtract 2 (r = .71), the Syntax Simple Sentences task (r = .61) and the Alphabet Span (r = .51; Waters & Caplan, 2003). The Digit Span also maintains good split half reliability (r = .88; Elwood, 1991) and the sub scores are highly correlated with one another according to the WAIS-IV technical manual (r = .91). Utilizing a higher order model and varying calculations of reliability, one particular study found lower levels of reliability between the various sub scores of the Digit Span (r = .74; Gignac et al., 2019). Considering this evidence, the digit span subscales were analyzed separately.

In the Reading Span Task (Daneman & Carpenter, 1980), participants were required to read aloud sets of unrelated sentences and an accompanying word featured in all capital letters at the end of each sentence (e.g., "Heavy winds scattered leaves around the neighborhood park. CHAIR). Each set contained a range of two to five pairs of sentences and words. After the set was complete, the participant saw a "???" appear on the screen. At this time, the participant attempted to recall every word that was featured in capital letters, in the order presented, within the set. The number of words the participant could verbally recall was their score for that trial. The Reading Span Task was composed of twelve trials, including three iterations each of trials

including two, three, four, and five sentences. The original Reading Span Task was delivered to participants on paper, but this study utilized an adapted version for online use employing a computer screen (Daneman & Carpenter, 1980).

The Reading Span task is moderately correlated with other memory span tasks asking participants to recall a set of words in order without reading anything in between (r = .55), and correlates well with verbal SAT score (r = .59) and tests of reading comprehension (r = .72; Daneman & Carpenter, 1980). Another study concluded the Reading Span task was highly correlated with a similar working memory task involving numerical equations instead of sentences prior to a target word (r = .68; Daneman & Hannon, 2007). Additionally, Daneman and Hannon (2007) found the Reading Span task correlated well with a simpler task requiring participants to remember a set of words in order (r = .50).

Traditionally, the Reading Span Task is scored as the highest sentence amount at which participants can recall the words correctly most of the time (two out of three trials). Although this scoring method is reliable (Daneman & Carpenter, 1980), authors have speculated if this style of scoring is missing valuable variability within participant scores (Friedman & Miyake, 2005; McNamara & Scott, 2001). One such investigation compared four different scoring methods of the Reading Span Task. More continuous measures of scoring led to more reliable and consistent results (Friedman & Miyake, 2005). Scoring was calculated by total words correctly recalled across all trials (Range: 1 - 42) by each participant as their Reading Span score. Using this continuous measure of scoring led to more normally distributed results, higher rates of test-retest reliability (r = .80 for total words), higher levels of internal split-half reliability (r = .83), and higher correlation with reading comprehension criterion measures such

as subtests of the ACT (r = .47) and Verbal SAT (r = .53; Friedman & Miyake, 2005). Following this evidence presented by Friedman & Miyake (2005), the Reading Span Task was scored in this manner for more rigorous analysis.

Humor Prompts

The humor prompts were curated and employed in two previous investigations (Wayne et al., 2021). Two independent samples of participants rated these humor prompts for how funny they were on a scale of 1 "*not funny*" – 10 "*very funny*". Of the thirty prompts used in previous studies, the twelve highest-rated jokes were used within this study. The humorous items included one-liner puns, funny test replies, internet-generated memes, and road signs. Participants rated how funny they considered these prompts at the end of this study, accounting for the degree to which each participant found the humor prompts funny.

Nature Prompts

The pictures of nature were curated and selected by the research team according to a number of criteria. Each of the twelve pictures included natural landscapes that *a)* did not include any human-made or human-influenced aspects *b)* did not feature any wildlife or humans within the photo *c)* was taken during the day as to provide clarity of the scenery and *d)* did not repeat a similar environment (e.g., jungle, desert, beach, prairie). An example of the nature and humor prompts is included in Figure 4.1.

Figure 4.1

Examples of Jokes and Nature Pictures

Humor	Nature

Procedure

The researcher first presented the participants with the consent form before ensuring the participant was in a calm and quiet environment before asking participants to place their phone on silent and away from access. Participants then completed the series of working memory tasks. The order of tasks was randomized, and each task included a series of practice rounds to acquaint participants before the first trial began.

After the working memory tests were completed, the researcher informed participants they would be shown a series of images for 12 seconds each. The researcher asked participants to

observe these images as they appeared on the screen and ensured participants that they did not need to remember anything about these pictures. Once participants had witnessed all humor or nature prompts, they completed the same working memory tasks in a randomized order.

After all post-intervention working memory tasks were completed, participants rated how funny they found each of the humor (1 = "*not funny*", 5 = "*very funny"*) or nature (1 = "*not relaxing*", 5 = "*very relaxing"*) prompts they saw in between the working memory tasks. Participants rated the intervention prompts at the end of the study as to not unnecessarily add to their cognitive load (De Jong, 2010; Sweller, 2011) prior to completing more working memory assessments. Lastly, participants completed a demographic form as to avoid any stereotype threat (Primi et al., 2014). The researcher verbally debriefed the participant while the debrief form was displayed on the screen before answering any questions the participant had.

Results

2 participants were removed from this data set due to extremely low working memory scores and 1 participant did not complete data collection due to evidence of cheating, resulting in 31 participants. Before running analyses related to the research questions, preliminary psychometric tests concluded none of the working memory task scores at either point (pre- or post-intervention) were skewed or unevenly distributed. Additionally, the 3 pre-intervention digit span scores were moderately correlated (r = .43 – .62; $p < .05$), as well as the post-intervention digit span scores (r = .47 – .57; $p < .01$). The pre- and post-intervention reading span scores were also highly correlated (r = .72). This evidence suggests the following analyses including working memory scores are robust. Descriptive scores across treatment groups are included in Table 4.1.

Table 4.1

Descriptives Across Intervention Groups

Treatment Group	Humorous Jokes		Nature Pictures		*F*	*p*
	M	*SD*	*M*	*SD*		
Pre Reading Score	29.21	5.37	29.33	4.66	1.83	.95
Pre Digit Forward Score	5.18	1.13	4.71	1.01	.40	.25
Pre Digit Backward Score	4.97	1.18	4.37	1.16	.43	.18
Pre Digit Sequence Score	4.68	.73	4.21	.78	.28	.10
Humor or Relaxation Ratings	**36.37**	**6.20**	**42.08**	**7.01**	**2.41**	**.03**
Post Reading Span Score	32.21	4.87	31.42	5.02	1.83	.67
Post Digit Forward Score	5.05	1.03	4.92	1.06	.39	.73
Post Digit Backward Score	4.92	1.15	4.79	1.27	.44	.77
Post Digit Sequence Score	5.47	1.00	4.75	.92	.36	.06
Reading Change Score	**3**	**4.87**	**2.08**	**2.84**	**.44**	**.51**
Digit Forward Change Score	-.13	.72	.21	.66	1.74	.20
Digit Backward Change Score	-.05	.83	.42	.99	2.01	.17
Digit Sequence Score	**.79**	**.99**	**.54**	**.69**	**.57**	**.46**

Q1 Does exposure to humorous images increase working memory capacity differently than a set of relaxing images?

In order to test the first research question, a working memory change score for each working memory task was computed for each participant (post-intervention score – pre-intervention score), and the treatment group was the independent variable in each one-way ANOVA. None of the analyses were significant, indicating that a set of humorous images did not impact working memory change scores differently than a set of relaxing nature pictures. Table 4.2 features a summary of these ANOVA analyses.

Table 4.2

ANOVAs Including Treatment Group as the Independent Variable

Working Memory Task Change Score	Humor		Relaxation		F (1, 29)	*p*
	M	*SD*	*M*	*SD*		
Reading Span	3	2.84	2.08	4.87	.44	.51
Digit Span Forward	-.13	.72	.21	.66	1.74	.20
Digit Span Backward	-.05	.83	.41	.99	2.01	.17
Digit Span Sequence	.79	.99	.54	.69	.57	.45

Q2 Does the degree to which participants consider an intervention funny or relaxing predict a change in working memory capacity?

Attempting to answer the second research question, I ran a series of simple regressions within each treatment group. Due to incompatible intervention constructs for humor or relaxation (e.g., asking participants to consider how funny a joke was vs how relaxing a picture of nature was), the treatment groups were split before running any analyses. Using a lower significance level to avoid committing a familywise Type 1 error ($p < .01$) across the analyses, none of the simple regressions were significant. To account for the different ranges of possible change within the Reading Span Task (Range: 0 – 42), and the Digit Span Tasks (Range: 0 – 8), I calculated a percentage change score for each task. A summary of correlations, percentage change scores, and p-values is included in Table 4.3.

Table 4.3

Correlations Between Total Intervention Rating and Task Change Score

Total Intervention Rating	Humor (*n* = 16)			Relaxation (*n* = 15)		
Working Memory Tasks	*% Change In Score*	*r*	*p*	*% Change In Score*	*r*	*p*
Reading Span	**11.86**	**.19**	**.06**	8.07	.01	.77
Digit Span Forward	-1.17	.00	.98	5.30	.00	.92
Digit Span Backward	0.62	.01	.73	11.6	.07	.40
Digit Span Sequence	**18.11**	**.00**	**.83**	**14.5**	**.05**	**.50**

The degree to which participants considered the jokes funny nor the degree to which participants considered the nature pictures relaxing was able to predict a change in their working memory scores. However, the correlation between total humor ratings within the humor group and the reading span change score was much closer to significance ($p = .06$), indicating humor may be more strongly associated with verbal and linguistic working memory as compared to numeric working memory. Further research with a larger sample size is necessary to clarify if this evidence signifies a potential relationship between humor and linguistic working memory. Although both the Reading Span Score ($t(31) = -3.97$, $p < .001$) and Digit Span Sequence scores ($t(31) = -4.38$, $p < .001$) were significantly different between pre- and post-intervention, neither of these differences were accounted for by the treatment group nor the participant ratings of the humor or nature pictures.

Discussion

The results of this study present evidence that a humor intervention may not be different than a set of relaxing images for increasing participants' working memory capacity. In addition, this study suggests a humorous or relaxing intervention was unable to temporarily benefit working memory capacity as measured in this sample. A lack of evidence for a relationship between an intervention targeting positive emotion and an increase in working memory may not be entirely surprising considering that each participant may react very differently to the intervention (Martin et al., 2003; Matarazzo et al., 2010). However, the overall degree to which participants enjoyed the funny pictures or relaxing pictures of nature also did not predict a change in their working memory scores. This finding was more surprising given the literature speculating the reasons amusement or relaxation leads to an increase in academic performance is via changes in working memory (Bamber & Morpeth, 2019; Nelson & Knight, 2010; Strick et al., 2009).

In theory, participants who considered the intervention funnier or more relaxing should experience a larger increase in subsequent working memory capacity (Strick et al., 2009). This lack of evidence was potentially impacted by the limited sample size or the use of an online video conference to run the study. Despite the limited sample size, a particularly interesting finding within this study is the relationship between the Total Humor Rating in the humor group and the increase in Reading Span scores. This correlation approached significance and indicated humor may be able to benefit a linguistic working memory score more so than a change in numerical working memory. This would make sense, given the previous literature connecting humor intervention and improvements in acquiring secondary languages (Bell, 2007; Swanson, 2013). Understanding humor is often based in the processing of language and may target a

student’s linguistic working memory capacity more effectively, lending further evidence to the distinction of integrated vs contiguous humor (Bolkan et al., 2018). Integrated humor consists of jokes related to the academic content and is intended to enhance comprehension of the material without entirely distracting students away from the current task (Bolkan et al.). Perhaps attempts at linguistic humor (e.g., puns or jokes using some form of word play) are able to impact working memory pertaining to language or verbal skills because the humor is more closely related to the current focus of working memory resources. Further research including a larger sample size should analyze this possible relationship.

Descriptive statistics revealed that participant scores increased after the intervention for two of the four working memory tasks (Reading Span and Digit Span Sequence). Statistical analyses suggested treatment group, nor the total enjoyment rating, were able to predict this increase. Previous evidence suggest participants may not be aware of how much humor is impacting them, some authors suggesting “sleeper” effects may benefit students despite the individual not perceiving any benefit (Wanzer et al., 2010). In this study, perhaps participants benefitted from the humorous or relaxing interventions regardless of how they rated the interventions. Participants may have also been unwilling to admit the degree to which they enjoyed the intervention (Gironzetti, 2017; Zweyer et al., 2004) or did not accurately recall how much they enjoyed the intervention when they were rating the prompts at the end of the study (Martin et al., 2003).

Limitations and Future Research

Several limitations impacted the methodology and results of this study. Due to the COVID-19 pandemic, this study transitioned away from an in-person design to a completely online format. Despite more than 400 possible students signing up for this study to fulfill

research participation credits or to win a gift card, this study failed to recruit more than 40 participants. I suspect some degree of fatigue now exists for students pertaining to live video calls, further limiting participation numbers for a study requiring a live video call. This general fatigue may also possibly decrease the level of effort that participants are willing to commit to cognitive tasks hosted online.

Although the number of students enrolling in online collegiate courses is increasing, the online video call and one-on-one context of this study does not map onto the typical student experience when completing an academic assessment (Bennett-Levy et al., 2001). Additionally, the methodological design of most humor intervention studies do not accurately construct the typical testing environment for participants (Matarazoo et al., 2010), limiting the generalizability of results pertaining to humorous interventions within assessments (Bolkan et al., 2018). The setting of this study is quite different than the typical student experience during a high-stake assessment. For example, participants who joined the video call were often not prepared for the requirements of the study and needed additional opportunities to set up in a quiet and calm environment without significant distraction.

A measurement limitation of this design pertains to the subjective ratings collected in this study (Total Humor Rating or Total Relaxation Rating). Due to the incompatibility of participants rating the prompts as either funny in the humor condition or relaxing in the nature condition, multiple linear regressions utilizing these ratings were not possible. Instead, I was only able to use simple regressions and a series of one-way ANOVAS, settling for correlational comparisons. All participants should have been asked how funny and how relaxing the prompts were in both groups allowing for a continuous variable across all participants to be utilized for both humor (Total Humor Rating) and relaxation (Total Relaxation Rating). This measurement

consideration should be included in future research designs comparing different interventions meant to either be humorous or relaxing. This would also allow for humorous inventions to be considered via two perspectives: how funny the prompts are and how relaxing the jokes were. If relaxation from humor or laughing at jokes affect participants differently in subsequent performance, this dual consideration of a singular humorous intervention could be of particular significance in future analyses (Martin et al., 2003; Wayne et al., 2021).

The first direction for future research is to replicate this exact pair of studies with a much larger sample size, testing if working memory can be impacted by a humorous intervention differently than a relaxing intervention. The ideal sample size of this between-group design is at least 65 participants in each treatment condition (130 participants in each study). Considering the context of taking an online timed difficult math exam during a live video call, these research questions should be revisited in a couple of manners. First, there is still inherent value in analyzing how humor may impact participants during an online video call because of the increasing number of students enrolling in online post-secondary programs (James et al., 2016). Second, the working memory tasks employed in this study are intended to be administered in person. This same methodological design should be replicated, except occurring in person. The in-person facilitation of the working memory tasks and in-person participant observations of the interventions may present different results.

Another future avenue of research is investigating if humor is able to alter linguistic measures of working memory, such as the Reading Span Task, more effectively than numerical forms of working memory (Bell, 2007; Swanson, 2013). The correlations between Total Humor Rating and the change in Reading Span scores approached significance, and this relationship may be significant given a larger sample size. Meanwhile, the correlations between Total Humor

Rating and the change scores for all 3 numerical working memory tasks did not near significance. Understanding jokes often relies on some degree of linguistic processing (e.g., getting the punchline of a pun or written joke; Swanson, 2013). Follow-up studies including larger sample sizes should use a humorous intervention and compare changes in different forms of pre- and post-intervention working memory tasks to investigate if differences occur, especially for linguistic working memory tasks.

CHAPTER V

DO THESE JOKES ADD UP? ASSESSING JOKE CONTENT WITHIN A MATH EXAM

This chapter will be submitted to *Educational Psychology: An International Research Journal*.

Contribution of Authors and Co-Authors

Manuscript in Chapter V

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Contributions: Designed the study, developed online study materials, facilitated online portal setup of study, ran participants, entered and synthesized data, wrote drafts of manuscript, submitted all final documentation.

Co-Author: Dr. Molly M. Jameson

Contributions: Assisted in study design, provided feedback of online survey formatting, edited and refined drafts of manuscript, mentored throughout the process.

Abstract: The literature examining the relationship between math anxiety, math performance, and humorous intervention is rife with contrasting evidence. A question remaining in the existing evidence pertains to the kinds of jokes that researchers employ in humorous interventions, potentially impacting participants differently across studies. Some authors suspect humor related to the academic assessment is likely to cultivate better outcomes for anxiety and performance (Wanzer et al., 2010). This study (*n* = 35) investigated if math-related humor embedded within a timed and difficult math exam could benefit participant outcomes more than unrelated humor. Due to the COVID-19 pandemic, the sample size was much smaller than intended, limiting the statistical analyses. Results presented some evidence that the degree to which participants considered the humor prompts funny was able to make them feel less math anxious after the math exam without actually affecting their math performance. More follow-up research is needed to further analyze these same research questions with a larger sample size, utilizing an in-person and highly controlled research design. Other discussion of results and implications is included.

Keywords: Math anxiety, humor, assessment, math performance

Literature Review

Math Anxiety

Many factors contribute to overall student success, including both academic achievement (e.g., time spent studying) and interpersonal factors such as anxiety and optimism (Bieg et al., 2015; Cassady & Johnson, 2002). Unfortunately, there exists a well-documented relationship between levels of academic anxiety and subsequent academic performance (Ramirez et al., 2013), affecting students across longer periods of time (Choe et al., 2019), altering their confidence, motivation, and career choice (Beilock & Maloney, 2015; Passolunghi et al., 2016). Students often experience anxiety in specific contexts (e.g., during a high-stakes exam) or toward specific subjects (e.g., writing, history, science), particularly mathematics (Ashcraft, 2002; Ramirez et al., 2013).

Specific student anxiety pertaining to mathematics is common (Maloney & Beilock, 2012; Passolunghi et al., 2016), affecting up to 75% of students attending college (Bamber & Morpeth, 2016), and is typically referred to as "math anxiety" (Ashcraft, 2002). Math anxiety is defined as, "… a feeling of tension, apprehension, or fear that interferes with math performance," (Ashcraft, 2002, p. 82). This math anxiety involves affective (e.g., anxiety and rumination), behavioral (e.g., avoiding math classes or careers), and cognitive (e.g., decreased processing speed) factors that negatively influence students' attitudes toward math and their performance (Allen & Jameson, 2021; Ashcraft, 2002). Highly math anxious individuals are likely to avoid challenges relating to mathematics, avoid enrolling in additional math courses, switch their academic major, and avoid applying for jobs relating to mathematics (Choe et al., 2019; Foley et al., 2017). Individuals with high math anxiety are likely to have low math self-efficacy; confidence in their ability to successfully complete math (Cooper & Robinson, 1991; Jameson,

2020; Jameson & Fusco, 2014). Low self-efficacy may include negative self-talk (e.g., “I’m not smart”) and avoidance behaviors, such as refusing help (Wang et al., 2017). Women tend to experience more severe math anxiety than men in both self-report and implicit measures (Else-Quest et al., 2010; Goetz et al., 2013; Rubinsten et al., 2012), but this anxiety difference does not necessarily translate to a gender performance difference (Hyde, 2016).

Math anxiety may exist in two forms, both affecting individuals in a different manner: state and trait math anxiety (Belzer et al., 2000). Trait math anxiety is an enduring aspect of personality likely to remain stable across time and environment, while state math anxiety fluctuates dependent on context (Cassady & Johnson, 2002). State math anxiety tends to be of higher consequence for students since situations involving math (e.g., hearing a math lecture or taking a math test) provoke higher levels of state math anxiety independent of an individual’s level of trait math anxiety (Pekrun, 2006).

Math anxiety is incredibly common amongst college students, most of whom are required to enroll in a minimum of one college math course within their degree (Choe et al., 2019). Due to the unfortunate pervasiveness of math anxiety, educators have employed many interventions in attempts to lower their students’ levels of anxiety (Sprengel & Job, 2004), increase their enjoyment of a course (Wanzer et al., 2009), or perform better on academic assessments (Ford et al., 2012). The explicit goals of said interventions include increasing the accessibility of content (Bell, 2007) or creating a welcoming classroom environment (Bamber & Morpeth, 2019) by supplying positive distractions (Ford et al., 2017). The use of humor within a lesson or assessment can decrease levels of student state anxiety (Hackathorn et al., 2011),

increase positive feelings of self (Strick et al., 2009), alleviate the student's current mood, or impact subsequent student performance (Ford et al., 2012; Martin et al., 2006; Strick et al., 2009).

Humor and Performance

The use of humor to positively impact student performance is a literature filled with nuance. Students may experience increased achievement when their instructor utilizes humor in delivering content versus teachers who do not use humor (Hackathorn et al., 2011; Wanzer et al., 2009; Ziv, 1988). Instructors' use of humor within a lesson can be a positive predictor for student perceptions of how much they are learning, increase the amount of effort students are willing to invest in a class, and increase how much students are willing to participate, leading to better student outcomes (Bell, 2007; Garner, 2006; Goodboy et al., 2015; Wanzer et al., 2009).

Laughter is not an effective predictor of increased learning because individuals differ in their outward expression of amusement, especially across cultures (Niedenthal et al., 2018; Wanzer et al., 2010). Students may not be aware that their reactions to humor are impacting their subsequent performance. Comparing student performance across differing levels of application questions, Hackathorn and colleagues (2011) presented evidence suggesting humor was able to improve performance on only knowledge and comprehension items on exams, not for application items. Perhaps humor may unreliably affect some aspects of student achievement or only be able to increase academic performance in specific lower-order avenues.

Humor may not always benefit student outcomes, some suggesting positive distraction may ultimately inhibit performance, especially for highly anxious students (Ziv, 1976) due to extraneous distraction from the course material (Bolkan et al., 2018; Eisend, 2009; Hollander,

1995). One study added a humorous “E” option on every quiz or test question presented to students in courses over a two-year period and discovered no significant effects on student achievement (Bennett-Levy et al., 2001). Students may laugh at the humor presented and remember the jokes instead of the academic content (Bolkan et al., 2018), students becoming less interested in the material and further limiting the relationship between humor and academic performance (Matarazoo et al., 2010). Despite the incredibly subjective nature of humor, the literature is absent of studies measuring how funny the participants considered the humor manipulations (Wayne et al., 2021).

Measuring Humor

Authors have presented humorous prompts either before (Ford et al., 2012) or during (Wayne & Jameson, 2020) a math assessment attempting to lower state math anxiety of affect student performance (Ford et al., 2012). One study suggested humorous distraction prior to taking a math exam lowered levels of participant state math anxiety and was partially responsible for an increase in participant exam scores (Hackathorn et al., 2011). Other studies draw a conflicting conclusion, claiming attempts at humorous distraction before or during an academic assessment decreases student motivation on the subsequent task (Garner, 2006) or may increase levels of state anxiety due to extraneous distraction (Pekrun & Linnenbrink-Garcia, 2012). Due to the subjective experience of humor, presenting mixed results without collecting evidence that suggests participants found the humor prompts very funny does not allow for valid across-group comparisons (Wanzer et al., 2010; Wayne et al., 2021).

Considering the subjective experience of humor, a participant’s reaction to attempts at humor is a confounding variable that cannot be ignored (Wanzer et al., 2010). Subjective participant ratings of humor interventions are required to accurately analyze the relationships

between humor, anxiety, performance in order to discern possible variations both between treatments and within intervention groups (Bell, 2007). One such investigation utilized a continuous humor rating scale assessing whether the degree to which participants considered humorous jokes funny during a math exam may predict their post-test math anxiety and level of math performance (Wayne et al., 2021). Participants who found the jokes funnier were not less anxious after completing the math exam but did score better on the math exam (Wayne et al., 2021). The results of this investigation included a lack of group differences, further suggesting between-group comparisons (e.g., a group experiencing humor and a group not experiencing any humor) may not be sufficient considering each participant will respond to the humor intervention differently.

Another consideration that directly impacts how funny participants may consider a humor intervention, and almost entirely missing from the relevant literature, is the content of the jokes. The content of a joke within the relevant environment affects how participants will consider and react to these attempts at humor, further entangling the relationship between humor, anxiety, and performance (Wanzer et al., 2010).

Context Matters

Bolkan and colleagues (2018) suggest that the academic content of a joke may affect participants differently depending on circumstance, indicating that not all attempts at humor can be equated. Humor that is related to the relevant academic subject and is meant to elicit further contemplation of the subject is referred to as integrated humor (e.g., a joke about fractions while learning or testing content knowledge of fractions; Bolkan et al., 2018), while humor serving as a distraction, irrelevant to the current academic material, is known as contiguous humor (e.g., a joke about cars during a biology lecture; Bolkan et al., 2018). Contiguous humor may distract

participants away from learning or remembering material, possibly resulting in confusion, scattered attention, or a lack of interest in the subject (Pekrun & Linnenbrink-Garcia, 2012). Utilizing humor to distract students may imply the relevant academic material is a burden to escape or an unenjoyable task to endure, possibly damaging a student's perception of the academic subject (Bolkan et al., 2018; Matarazoo et al., 2010). Integrated humor may be superior for impacting performance because embedding jokes within the academic context enhances the academic content, promotes further comprehension, and allows for more nuanced connections with the material instead of simply trying to distract students (Bolkan et al., 2018; Wanzer et al., 2010).

The Instructional Humor Processing Theory claims five levels of processing are required for content-related humor to positively impact student achievement (Wanzer et al., 2010). First, students must notice the humor and cannot miss the intended stimuli. Second, the student must understand the joke and "get it." Third, the student must interpret the humor as funny (e.g., the participant's subjective rating). After noticing humor, understanding the joke, and appraising the stimuli as funny, the last two steps of this theory are the main concern of the current study.

In the fourth step, the student's reaction to this humor may briefly alter their affect toward the class content (either increasing or reducing motivation). Integrated humor pertaining to the current subject may improve student affect with this stage as opposed to contiguous, unrelated humor (Bolkan et al., 2018). Last, this altered affect toward the academic subject could positively impact student performance by increasing the amount of effort a student puts into studying or concentrating on the assessment (Wanzer et al., 2010). If any of these five steps do not occur, the presented humor may not alter subsequent academic achievement. Accordingly,

this study investigated whether math humor presented during a math exam may decrease levels of participant math anxiety and increase math performance more effectively than unrelated humor.

The Present Study

The literature remains divided about the nature of humor's impact on academic anxiety and subsequent academic achievement. This study investigated the active literature gap concerning the content of humor manipulations used in refining the relationship between humor, math anxiety, and math performance (Wayne et al., 2021). Nearly every previous investigation has presented relevant evidence without assessing the degree to which participants rated the humor prompts as funny (Wayne et al., 2021) or providing guidance as to what types of humor manipulation are most effective. Measuring participants' subjective humor response is necessary to analyze the effectiveness of attempted humor and to analyze the connection between higher levels of amusement, anxiety, and performance (Wanzer et al., 2010). Additionally, comparing math humor prompts and unrelated humor prompts during a math test may provide further evidence for the Instructional Humor Processing Theory (Wanzer et al., 2009), testing if integrated humor is superior to contiguous humor manipulations for lowering participant state anxiety and increasing their math performance (Bolkan et al., 2018). The following research questions were investigated in this study:

Q1 Does the degree to which participants consider a humorous intervention funny in the presence of their math anxiety predict a change in math performance?

Q2 Does math-related humor embedded in a math exam alter levels of math anxiety and math performance differently than unrelated humor prompts?

Methods

Participants

Participants for this study were 35 undergraduate students (27 women and 8 men attending a medium-sized public university in the Mountain West region of the United States. Most participants (*n* = 27) were between 18-22 years of age (*M* age = 21), and most participants reported their ethnic identities including white (71%), with 31% of participants identifying with Hispanic/Latinx, 8% Asian, 1% Black, and 9% of participants identified as other ethnicities. About one-third of students were first-generation (*n* = 12) and nearly half of the participants were in their first year at university (*n* = 16). All participants were enrolled in 100-level introductory courses.

Measures

Two measures of math anxiety were used in this study; the Abbreviated Math Anxiety Scale (AMAS; Hopko et al., 2003) and the Single-Item Math Anxiety scale (SIMA; Núñez-Peña, et al., 2014). The AMAS (Hopko et al.), is a nine-item Likert-type scale requiring participants to rate their anxiety on a 1 – 5 scale (*1 = "low," 5 = "high"*) when they complete various math tasks (e.g., listening to a math lecture, taking a quiz). The AMAS is strongly correlated with longer math anxiety measures such as the Math Anxiety Rating Scale Revised (MARS-R; r = .85) and possesses internal consistency (α = .90) and two-week stability reliability (r = .85; Hopko et al.). The Single-Item Math Anxiety (SIMA) (Núñez-Peña et al., 2014) measures a self-reported level of state math anxiety. The SIMA consists of one question, "How anxious do you feel about math right now?" This assessment, although only a single item (range: 1-10),

correlates well with the 25-item sMARS (Spanish Math Anxiety Rating Scale) (r = .77) and the 40-item STAI-S (State and Trait Anxiety Inventory – State) for mathematics (r = .41) (Núñez-Peña, et al., 2014).

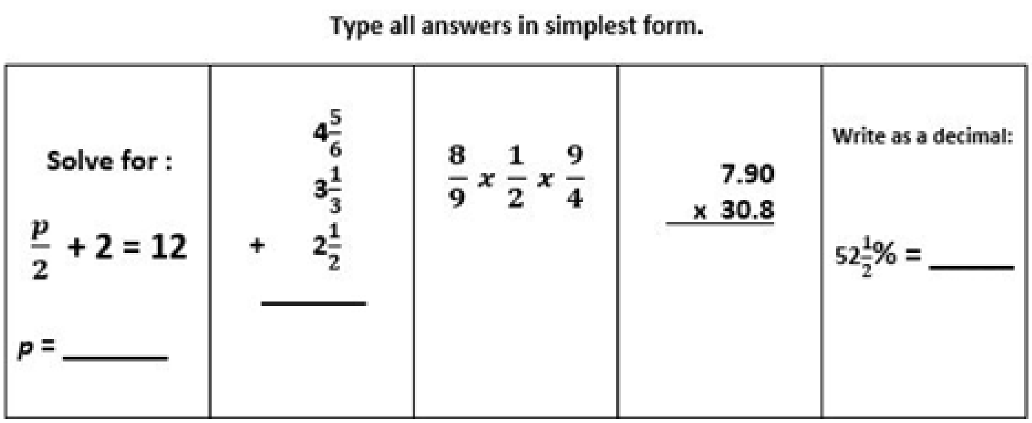
The Wide Range Achievement Test 4th Edition (WRAT-4) Math Subtest (Wilkinson & Robertson, 2006) was used to measure both baseline and intervention math performance. The WRAT-4 Math Subtest correlates well with other general intelligence assessments that include math measures (r = .57 – .72; Dell et al., 2008) and predicts collegiate math course success (r = .37; Zagar et al., 2013). The WRAT-4 Math test-retest reliability for post-secondary students is .87 (Zagar et al., 2013). The questions on the WRAT-4 Math Subtest are open-ended math computation problems ranging from long-form subtraction to solving complex algebraic expressions including fractions (Wilkinson & Robertson, 2006).

Parallel forms of the WRAT-4 Math Subtest were used for both the baseline and intervention math performance measures. For baseline math performance, the WRAT-4 Math Subtest Green version was reduced from 40 to 10 questions (*Range of score: 0 - 10*) and the time limit was appropriately reduced. The first half of the WRAT-4 Math Subtest is less rigorous and would not create as much variance in scores for post-secondary students (Wilkinson & Robertson, 2006), so the last twenty questions from both the Green and Blue versions of the exam were used. Accordingly, the WRAT-4 Math Subtest is designed to get progressively more difficult, so the 10-question baseline measure included every other question from the last twenty items of the WRAT-4 to preserve question difficulty. The intervention math performance measure including humor prompts was the WRAT-4 Math Subtest Blue Version (Wilkinson & Robertson, 2006). The 20 questions were divided into two blocks including 10 questions each and a five-minute time limit. To enhance reliability of exam scores across the two sections of

the measure, odd-numbered questions were placed in the first block and even-numbered questions were placed in the second block to counterbalance difficulty. Both math performance measures were calculated as the number of correct answers out of the total possible. The participant scores for the 20-questions math assessment including the intervention were halved (Range: 0-10), matching the range of scores for the baseline math performance measure (Range: 0-10). This computation allowed for a more accurate comparison between the two math assessments, without inflating the variance in scores for the 10-question baseline measure. Sample items from the WRAT-4 Math Subtest Blue version (Wilkinson & Robertson, 2006) are included in Figure 5.1.

Figure 5.1

Examples from the Wide-Range Achievement Test (WRAT-4) Math Subtest



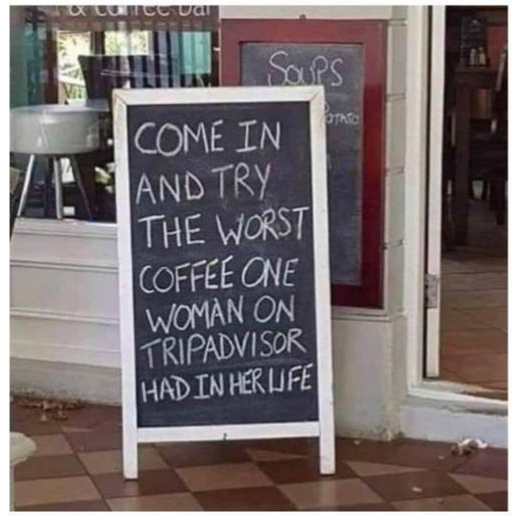
Type all answers in simplest form.

Solve for : $\frac{p}{2} + 2 = 12$ $p =$ ____	$4\frac{5}{6}$ $3\frac{1}{3}$ $+ \; 2\frac{1}{2}$ ____	$\frac{8}{9} x \frac{1}{2} x \frac{9}{4}$	7.90 x 30.8 ____	Write as a decimal: $52\frac{1}{2}\% =$ ____

A total of twelve humor prompts were used in each treatment group. The twelve unrelated humor prompts were jokes rated as the most humorous of twenty-four different humor prompts used in a previous investigation (Wayne et al., 2021). The math-related humor prompts were curated via a small pilot study. Participants (N = 35) rated how funny they found each of twenty math jokes. The twelve highest-rated math humor prompts from these twenty options were used in this study. Samples of the humor prompts are included in Figure 5.2.

Figure 5.2

Humor Prompt Examples

Math	Unrelated
	

Near the end of the study, all participants were asked to rate how funny they considered each of the twelve humor prompts they experienced on a scale of 1 "*not funny*" – 5 "*very funny*." The summed humor rating for each participant is the Total Humor Rating (THR; *Range 12 – 60*), indicating the degree to which participants found the humor intervention funny.

Procedure

Participants were randomly assigned to the unrelated humor or math humor condition prior to data collection. Data were collected via a synchronous video call and survey software in which the participant was required to keep their camera on. After providing informed consent, the researcher informed the participant about the structure of the study before allowing the participant to work at their own pace. The researcher remained on the video chat to answer any questions and provide the participant with any needed guidance through the procedure.

First, participants completed the baseline math performance measure including ten questions

from the WRAT-4 Math Subtest Green Version. Next, participants completed the AMAS and SIMA to report their levels of pre-intervention state math anxiety. Participants were then informed they would take a difficult and timed math exam split into two sections of ten questions. The exam instructions also included information about humor prompts participants should expect to see before the first section, in between sections, and after the final section of math computations. After completing the math exam and experiencing all twelve humor prompts, participants then completed another round of the AMAS and SIMA, reporting their level of post-intervention state math anxiety. Then, participants rated how funny they found each of the humor prompts from before from 1 "*not funny*" – 5 "*very funny*." Participants completed a demographics form at the end of the study to avoid any possible stereotype threat (Bieg et al., 2015), and participants were then debriefed. The study took approximately thirty minutes to complete.

Results

Due to extremely low participant math exam scores (< 10%) or incomplete data, 6 participants were removed from this dataset, resulting in 35 participants. Descriptives across both treatment groups are included in Table 5.1.

Table 5.1

Descriptives Across Humor Conditions

Treatment Group	Math Humor		Unrelated Humor		*F*	*p*
	M	*SD*	*M*	*SD*		
Math Pre-Test Score	4.31	1.66	4.89	1.99	.18	.67
Baseline AMAS	27.94	4.57	25.21	6.09	1.97	.17
Baseline SIMA	5.75	1.81	4.58	2.22	2.24	.14
Math Exam Score	10.75	3.62	11.32	3.83	.12	.73
Halved Exam Score	5.38	1.81	5.66	1.92	.12	.73
Total Humor Rating	36.88	8.02	36.16	8.42	.01	.98
Post-Test AMAS	26.50	5.66	24.32	7.25	2.90	.10
Post-Test SIMA	5.31	1.82	4.05	2.17	.76	.38
Math Change Score	**1.06**	**1.05**	**.76**	**1.65**	**3.05**	**.09**

Prior to conducting inferential analyses, psychometric data was collected for both math anxiety measures. The two SIMA scores were strongly correlated (r = .79), as well as the two AMAS scores (r = .88). Additionally, the AMAS had high internal consistency (pre: α = 82; post: α = .88) in this sample, with no alpha increase from omitted items in either instance. These two math anxiety measures were combined to compute the total math anxiety score in both the pre and post-test measures. These foundational analyses indicate the use of these math anxiety measures in the subsequent analyses are robust.

Q1 Does the degree to which participants consider a humorous intervention funny in the presence of their math anxiety predict a change in math performance?

Testing the first research question, I used a multiple linear regression. In an attempt to predict the change in participants' math performance, the total humor rating (THR) across all participants (both math jokes and unrelated jokes) was the independent variable and the change

in math anxiety was a covariate. The overall model was not significant (r^2 = .09, F(2, 32) = 1.70, p = .20). Attempting to isolate the two different math anxiety constructs, I ran two additional models utilizing each of the math anxiety measures. Though neither model was significant, the regression including the AMAS as the measure of math anxiety was closer to significance (r^2 = .10, F(2, 32) = 1.79, p = .18) than the SIMA (r^2 = .01, F(2, 32) = .23, p = .80). Despite using the total humor rating as a continuous variable (Wayne et al., 2021), the subjective rating of the humor prompts was unable to predict the resulting changes in math performance in the presence of math anxiety changes. An ad-hoc comparison revealed the math score did increase, t(34) = 14.81, p < .001, between the baseline math score (M = 4.63, SD = 1.85) and the math exam (M = 5.52, SD = 1.85), but this difference was not explained by any of the included variables.

Q2 Does math-related humor embedded in a math exam alter levels of math anxiety and math performance differently than unrelated humor prompts?

Testing the second research question, I used three different multiple linear regressions after dummy-coding the group variable (math humor vs unrelated humor). The p-value for significance was halved (p = .025) to adjust for the familywise error rate and avoid committing a Type 1 error.

The first regression included three independent variables: treatment group, THR, and the change in participant math anxiety. Attempting to predict the change in math performance, this model was not significant (r^2 = .11, F(3, 31) = 1.22, p = .32), indicating the treatment group, THR, and the change in math anxiety was unable to predict a change in math performance.

The second multiple linear regression utilized three independent variables including the treatment group, THR, and the change in math performance. This model was not significant in predicting the amount of change in AMAS scores (r^2 = .17, F(3, 31) = 2.08, p = .12). However,

the third regression using treatment group, THR, and math performance change as independent variables to predict a change in SIMA scores approached significance (r^2 = .24, $F(3, 31) = 3.17$, *p* = .04).

To isolate the significant prediction, I performed a series of post-hoc analyses and found the THR predicted a change in SIMA scores (r^2 = .22, $F(1, 33) = 9.42$, *p* = .004), but not the treatment group nor the change in math test score. This result indicates the more participants considered the humor prompts funny across both treatment groups, the less math anxiety they felt after the math test was complete, as measured by the SIMA. Post-test SIMA scores (*M* = 4.63, *SD* = 2.09) were 10% lower than the baseline SIMA scores (*M* = 5.11, *SD* = 2.10) across all participants, *t*(34) = 14.43, *p* < .001. This relationship was not existent between THR and math performance change, indicating the degree to which participants laughed at the jokes was unable to predict their subsequent exam score. Similar to previous evidence, the humor manipulations (including both math and unrelated jokes) were able to impact levels of state math anxiety, but not math achievement (Martin et al., 2006; Matarazoo et al., 2010; Strick et al., 2009), further complicating the relationship between humor, anxiety, and performance (Bolkan et al., 2018; Ford et al., 2012). A summary of all relevant regression analyses is included in Table 5.2.

Table 5.2

Regression Table

Independent Variable(s)	Dependent Variable(s)	F (1, 33)	R	r^2	p
THR AMAS Change	Math Score Change	1.79	.32	.10	.18
THR SIMA Change	Math Score Change	.23	.12	.01	.79
THR Math Anxiety Change	Math Score Change	1.70	.31	.09	.20
Treatment THR Math Anxiety Change	Math Score Change	1.22	.33	.11	.32
Treatment THR Math Score Change	AMAS Change	2.08	.41	.17	.12
Treatment **THR** **Math Score Change**	**SIMA Change**	**3.17**	**.48**	**.24**	**.04***
THR	**SIMA Change**	**9.42**	**.48**	**.22**	**.004****

* = $p < .05$
** = $p < .01$

Discussion

Although the majority of analyses did not present significant findings, these results add relevant information and directions for future research to the heterogeneous literature connecting humor, math anxiety, and math performance (Bolkan et al., 2018; Hackathorn et al., 2011; Strick et al., 2009). This study failed to confirm the previous speculation that embedded humor pertaining to the academic material of an assessment might be able to benefit academic outcomes more than unrelated humor interventions (Wanzer et al., 2010). Although the treatment group

was unable to predict a change in participant math performance, the multiple linear regression predicting a change in SIMA score including group, THR, and a change in math score as independent variables neared significance. However, post-hoc analyses revealed this relationship was only significant between THR and the change in SIMA scores (but not the AMAS), indicating humor may only be able to benefit certain subjective aspects of math anxiety (Matarazoo et al., 2010).

The between-groups design of this study speculated that math jokes embedded within a math exam might lead to greater benefits for participants than unrelated jokes, predicting lower levels of math anxiety and larger increases in math exam score. Neither of these effects were observed, raising questions about the superiority of using integrated humor (related to the subject and relevant to the content) over contiguous (unrelated and random) humor within assessments (Bolkan et al., 2018). However, the total humor rating across groups was almost identical, indicating participants did not find either form of humor less funny. If participants in either condition did not consider the humor prompts funnier, the lack of differential effects makes theoretical sense (Martin et al., 2018). Integrated humor is supposed to benefit student performance because the jokes stay within the same academic context and do not unnecessarily distract the student with random and unrelated thoughts (Bolkan et al., 2018). However, the integrated humor in this study were unable to predict better outcomes for math performance or math anxiety. If the total humor rating is more important for predicting a difference in math anxiety or performance, perhaps the jokes in a humor manipulation do not necessarily need to be on-task (Bolkan et al., 2018; Wanzer et al., 2010).

Although none of the included variables were able to predict an increase in average math performance, the descriptive statistics indicated that participants scores increased between the

baseline and intervention math performance measures. Interestingly, the decrease in participant levels of math anxiety, as measured by both the AMAS and SIMA, was unable to account for the increase in math score. This result is contrary to the very well-established relationship between math anxiety and math performance (Ashcraft, 2002; Ashcraft & Krause, 2007; Pekrun, 2006), raising questions about the methodology of this study design. Perhaps the online component of this study design complicated the relationship between math anxiety and math performance because participants were able to test alone in an environment of their choice (Fast et al., 2010). Additionally, participants may have benefited from practice within the baseline math measure and were able to better manage their time during the intervention performance measure.

The degree to which participants rated the jokes as funny did predict a decrease in their math anxiety as measured by the SIMA, but not the AMAS. The SIMA included only one question, "*How anxious do you feel about math right now?*" as opposed to the 9-item AMAS asking participants how anxious they felt the last time they completed various mathematic tasks, such as listening to a math lecture (Hopko et al., 2003). This result adds to previous evidence that a total humor rating can be an accurate predictor of a change in participant state math anxiety (Wayne et al., 2021).

Considering the relationship mentioned above, the inherent difference in the constructs of the SIMA and AMAS raises a few questions. This evidence may suggest humor is able to benefit state math anxiety – how anxious participants are in the moment – more so than trait math anxiety, which tends to be more stable over time (Ashcraft, 2002; Cassady & Johnson, 2002; Fast et al., 2010). The SIMA targets participant state math anxiety by asking participants how anxious they feel "*right now*", whereas the AMAS arguably relates to a more enduring form of math anxiety by asking participants how they felt in previous instances (Hopko et al., 2003).

Perhaps a humorous intervention is also able to impact a more holistic and subjective interpretation of math anxiety (e.g., the SIMA asking a single question about how math anxious a participant is in the moment) better than a longer, targeted, concrete measure of math anxiety reflecting on specific behaviors (e.g., "*watching a teacher write a math equation on the board*" or "*walking into a math classroom*") as featured in the AMAS. In either case, the desired end result in attempting to lower students' levels of math anxiety is to benefit their math performance (Ford et al., 2012; Strick et al., 2009). The overall connection between total humor rating and math performance was not found in this study, showcasing a need for further research to investigate if and how humor interventions before (Ford et al.) or during (Hackathorn et al., 2011; Wayne et al., 2021) an assessment can reliably improve student academic performance (Bechara et al., 1994; Garner, 2006).

Limitations and Future Research

Several limitations impacted the methodology and results of this study. Due to the COVID-19 pandemic, this study transitioned away from an in-person design to a completely online format. Simultaneously, students were also required to take much of their coursework online for the two semesters prior to data collection and during the two semesters in which data collection occurred. Despite more than 400 possible students signing up for this study to fulfill research participation credits or to win a gift card, this study failed to recruit more than 40 participants. Many other online psychological studies do not contain a requirement to participate in a live Zoom session. I suspect some degree of fatigue now exists for students pertaining to live video calls, further limiting participation numbers, and possibly decreasing the level of effort that participants are willing to commit to online cognitive tasks.

The online video call and one-on-one context of this online study does not map onto the typical student experience when completing an academic assessment. Additionally, the methodological designs of most studies do not accurately construct the typical testing environment for participants (Bennett-Levy et al., 2001; Matarazoo et al., 2010), limiting the generalizability of results pertaining to humorous interventions within assessments (Bolkan et al., 2018). I utilized many of the same measures in a previous study with an in-person and small-group design. Participants in this previous study completed the WRAT-4 with groups of 4-7 other people and their exam included 16 humor prompts. Evidence from this study suggested the humor intervention was associated with lower levels of post-test math anxiety, as measured by the AMAS, and an increase in their math performance (but only for participants who rated the jokes as funny; Wayne et al., 2021). The in-person and small-group components of this previous study more closely mirrored the typical student experience while taking a high-stakes assessment. Perhaps the online video call does not accurately model what students experience while taking a high-stakes assessment, and the environment they choose to inhabit during the study session does not adequately provoke typical levels of anxiety (Fast et al., 2010). That being said, the online format for high-stakes exams should remain a consideration in future studies because many students are transitioning to online classes and will continue to take exams from home or their location of choice (James et al., 2016). If humorous interventions aim to benefit student performance, best practices should be investigated for all testing environments in which students will be expected to excel.

Considering future research, other authors should replicate this exact set of research questions and design with a much larger sample size, testing if math jokes are better than unrelated jokes at impacting math performance and math anxiety. The ideal sample size for this

between-group designs is at least 65 participants in each treatment condition. Considering the context of taking an online timed difficult math exam during a live video call, these research questions should be revisited in a couple of manners. First, there remains value in analyzing how humor may impact participants during an online video call because of the increasing number of students enrolling in online post-secondary programs (James et al., 2016). Second, the same research designs should be facilitated in small groups occurring in-person to accurately model the authentic environment in which students typically complete exams. Previous studies have presented significant evidence utilizing small groups, and these same research questions may discover significant results in a more socially intense context (Ford et al., 2012; Wayne et al., 2021). Humor, anxiety, and a participants' subjective mood all occur within a social context (Dormann & Biddle, 2007; Martin et al., 2003). Perhaps humorous reactions and the fluctuations in perceived math anxiety will be different when participants are in the midst of others experiencing the same stimuli (Berge, 2017).

The Total Humor Rating within both treatment groups (math jokes and unrelated jokes) was able to predict the change in math anxiety as measured by the Single Item Math Anxiety (SIMA) scale, but not the Abbreviated Math Anxiety Scale (AMAS). Future research should compare how humor may be able to alter levels of math anxiety across these two measures. Both scales are intended to measure math anxiety and are capable of fluctuation after an intervention, despite the AMAS more closely measuring trait math anxiety (Hopko et al., 2003; Núñez-Peña et al., 2014). Despite the AMAS items requesting participants to consider previous behaviors, state math anxiety may inflate participant reflections about their previous experiences (Primi et al., 2014). Future research should compare various measures of math anxiety in a pre- and post-

intervention humor manipulation to analyze if and how the measures differ from one another in the presence of humorous interventions.

One result was significant in this study and several other analyses approached significance. Considering these limitations and the possible relationships between humor an academic performance, the research questions within this study should be revisited. If instructors are going to continue using humor within their instruction and assessment materials, they should follow best practices. The literature is still in need of more evidence of those best practices pertaining to the use of humor to benefit student performance.

CHAPTER VI

COMBINED DISCUSSION

The literature investigating a possible relationship between humorous interventions, anxiety, and academic performance features inconsistent evidence that includes several active gaps. This dissertation research project analyzed two of these gaps in an attempt to resolve a pair of missing components within the literature. Due to a low sample size and a few methodological considerations pertaining to running both studies with online video calls, neither study presented significant evidence that could fill any portion of the active gaps. However, the results included in these two investigations suggest a few directions for future research that may be able to further clarify the research questions investigated in these studies.

Working Memory

The first study investigated if a humor intervention was able to temporarily alter working memory capacity better than an intervention intended to increase participant feelings of relaxation. The group condition did not predict a significant change in working memory capacity. Additionally, the degree to which participants enjoyed the humorous or relaxing intervention did not predict any significant changes in working memory scores. Many studies have indicated a humor intervention presented before or during an academic assessment is capable of increasing student performance on an assessment (Ford et al., 2012; Hackathorn et al., 2011; Martin et al., 2018). Authors speculate working memory could be the mechanism by which humorous interventions may benefit subsequent student academic performance without gathering further data to validate these claims (Ford et al., 2012; Strick et al., 2009) The evidence

included in this study suggests the humorous intervention was unable to predict an increase in working memory scores across four different measures, failing to confirm previous speculations.

Additionally, previous studies suggest that relaxing interventions are capable of resulting in lower levels of participant anxiety or increasing the number of positive feelings participants feel before taking an academic assessment (Ford et al., 2012; Strick et al., 2009). Evidence suggests these changes in mood after a relaxing intervention may also lead to better academic outcomes (Hackathorn et al., 2011). This study was unable to replicate these previous findings, suggesting a set of relaxing nature pictures may not be a sufficient intervention to temporarily increase participant working memory.

One result approaching significance was the correlation between the Total Humor Rating for participants in the humor condition and the increase in their Reading Span score. This suggests, with a larger sample size, future research may be able to find evidence that humor is able to benefit linguistic working memory more effectively than numerical forms of working memory. Further research is needed to directly compare how humor may alter performance on linguistic working memory assessments vs numerical assessments of working memory.

The Digit Span Sequence scores increased significantly across both treatment groups (14% in the relaxing treatment and 18% in the humor treatment) despite the treatment group nor the total participant rating of the interventions predicting this change. Further research should investigate if and how an intervention intending to increase participant mood may alter performance on the Digit Span Sequence task as compared to the other forms of the Digit Span. Additionally, another study should utilize similar methods with a much larger sample size to investigate if a significant relationship emerges between a humor intervention and the Digit Span Sequence score.

Math vs Unrelated Humor

The second study analyzed if the different joke content within a humorous intervention would impact subsequent levels of participant math anxiety and math performance. Based on theoretical assumptions of the Instructional Humor Processing Theory (Wanzer et al., 2010), this study investigated if math jokes embedded in a timed math exam could benefit participant levels of anxiety and performance more than a series of unrelated jokes. In order for a humor intervention to possibly benefit participant outcomes, the individual must notice a joke, understand the humor, and consider the joke funny. If all of these responses occur, the joke may alter the participant's subjective attitude of the academic material, possibly increasing the participant's enjoyment of the academic material and increasing the amount of effort they are willing to input into the assessment (Garner, 2006; Goodboy et al., 2015). Despite the possible additional benefits of math-related humor embedded within a timed math exam, this study did not present any significant evidence that math humor was able to benefit math performance more than unrelated humor.

Math performance did increase in both treatment groups by about 11%, but this change was not explained by the Total Humor Rating nor the treatment group. This evidence suggests neither type of humor intervention was able to significantly impact a change in math performance. Alternatively, this may highlight a discrepancy between participants' subjective rating of the humor prompts and the benefits that participants are not able to perceive. Previous studies present evidence that students are often not aware of how their performance is benefitted by humorous interventions, suggesting these "sleeper effects" may be significantly impacting performance (Wanzer et al., 2010). Future research should analyze this possible disconnect between the THR and changes in math performance using a much larger sample size.

The degree to which participants rated the jokes as funny did predict a decrease in their math anxiety during the study, as measured by the Single Item Math Anxiety scale. This result replicates previous literature connecting humorous intervention and a reduction in either general academic anxiety (Wanzer et al., 2009) or math anxiety (Ford et al., 2012). Combined with a lack of relationship between humor and performance, this result replicated previous evidence suggesting that humor may only be able to affect levels of anxiety without altering subsequent academic performance (Matarazoo et al., 2010; Strick et al., 2009). However, this is only the second study to connect a continuous rating of humor appraisal with a decrease in math anxiety, suggesting the more participants appraise the humorous intervention as funny, the more they experience a decrease in math anxiety (Wayne et al., 2021). Due to the subjective nature of humor, the Total Humor Rating is an essential variable that should be utilized in future studies employing a humor intervention.

Of additional interest is the lack of any significant relationship between the Total Humor Rating and changes in participant levels of math anxiety as measured by the Abbreviated Math Anxiety Scale (Hopko et al., 2003). Perhaps the wording of the items on the AMAS leads to a less variable interpretation of math anxiety, preventing a significant relationship between the fluctuations in participant AMAS scores and a humorous intervention. Items are phrased to specifically target behavior that occurred in the past (e.g., “How much math anxiety did you feel the last time you took a math quiz?”). Perhaps humor and the temporary adjustment in mood do not alter these specific considerations of previous behaviors for participants, suggesting the AMAS may be more of a measure of trait math anxiety than state anxiety in the presence of a humorous intervention (Hopko et al., 2003).

Limitations

Several limitations impacted the results of both studies. Due to the COVID-19 pandemic, both studies transitioned to a completely online format. Simultaneously, students were also required to take much of their coursework online for the semesters prior to data collection and during the two semesters in which data collection occurred. Despite hundreds of possible students signing up for this study to fulfill research participation credits, the low recruitment for these two studies suggested students were not selecting these studies to participate in. Additionally, almost none of the hundreds of students who were offered a chance to win 1 of 4 different gift cards to the campus bookstore decided to participate, suggesting a lack of willingness. Many other online psychological studies do not contain a requirement to participate in a live Zoom session. Students have been required to sit in live video calls for three semesters due to the COVID-19 pandemic and may have been discouraged to sign up for these studies due to the live video call component. Those participants who did sign up for participation in these studies were often not ready for the requirements of the study and needed additional opportunities to set up in a quiet and calm environment, to have their phone placed away from access, and to have paper and a writing utensil available (for study 2). I suspect some degree of fatigue now exists within students for live video calls since COVID-19 began, further limiting participation numbers for both studies and possibly decreasing the degree to which participants put in effort into the cognitive tasks included in these study designs. Additionally, a couple participants attempted to cheat during the study, and an unknown number of participants were able to use a calculator without the researcher noticing during the study. The online video call component of this this methodology enables cheating to a higher degree than an in-person design.

The online video call and one-on-one context of this online study does not map onto the typical student experience when completing an academic assessment. Additionally, the methodological designs of most studies do not accurately construct the typical testing environment for participants (Bennett-Levy et al., 2001; Matarazoo et al., 2010), limiting the generalizability of results pertaining to humorous interventions within assessments (Bolkan et al., 2018). I utilized many of the same measures in a previous study using an in-person and small-group design. Participants in this previous study completed the WRAT-4 with groups of 4-7 other people and their exam included 16 humor prompts. Evidence from this study suggested the humor intervention was associated with lower levels of math anxiety, as measured by the AMAS, and an increase in their math performance (only for participants who rated the jokes as funny; Wayne et al., 2021). The in-person and small-group components of this previous study more closely mirror was students experience while taking high-stakes assessments, such as a midterm exam. Perhaps the online video call does not accurately model what students experience while taking a high-stakes assessment, and the environment they choose to inhabit during the study session does not adequately provoke typical levels of anxiety (Fast et al., 2010). That being said, the online format for high-stakes exams should remain a consideration in future studies because many students are transitioning to online classes and will continue to take exams from home or their location of choice (James et al., 2016). If humorous interventions aim to benefit student performance, best practices should be investigated for all testing environments in which students will be expected to excel.

A particular limitation pertains to the measurement of subjective ratings (Total Humor Rating or Total Relaxation Rating) within the working memory study. Due to the incompatibility of participants rating the prompts as either funny in the humor condition or relaxing in the nature

condition, multiple linear regressions utilizing these ratings were not possible. Instead, I was only able to use simple regressions and had to settle with correlational comparisons. All participants should have been asked how funny and how relaxing the prompts were in both groups allowing for a continuous variable across all participants to be utilized for both humor (Total Humor Rating) and relaxation (Total Relaxation Rating). This measurement consideration should be included in future research designs utilizing a contrast between interventions meant to either be humorous or relaxing. This would also allow for humorous inventions to be considered via two perspectives: how funny the prompts are and how relaxing the jokes were. If relaxation from humor or laughing at jokes affect participants differently in subsequent performance, this dual consideration of a singular humorous intervention could be of particular significance in future analyses.

Future Directions

The evidence across these studies illuminates several areas of interest for future research in an attempt to clarify important aspects of humorous interventions. The first consideration is to replicate this exact pair of studies with a much larger sample size, testing if working memory can be impacted by a humorous intervention and if math jokes are better than unrelated jokes at impacting math performance. The ideal sample size of both between-group designs is at least 65 participants in each treatment condition (130 participants in each study). Considering the context of taking an online timed difficult math exam during a live video call, these research questions should be revisited in a couple of manners. First, there remains inherent value in analyzing how humor may impact participants during an online video call because of the increasing number of students enrolling in online post-secondary programs (James et al., 2016). Second, the same research designs should be facilitated in small groups that occur in-person to accurately model

the types of authentic environment in which students take exams. Previous studies have presented significant evidence utilizing small groups, and these same research questions may discover significant results in a more socially intense context (Ford et al., 2012; Wayne et al., 2021). Humor, anxiety, and a participants' subjective mood all occur within a social context (Dormann & Biddle, 2007; Martin et al., 2003). Perhaps humorous reactions and the fluctuations in perceived anxiety and math performance will be significantly different when participants are in the midst of others experiencing the same stimuli (Berge, 2017).

Another future avenue of research is investigating if humor is able to alter linguistic measures of working memory, such as the Reading Span Task, more effectively than numerical forms of working memory (Bell, 2007; Swanson, 2013). The correlations between Total Humor Rating and the change in Reading Span scores approached significance, and this relationship may be significant given a larger sample size. Meanwhile, the correlations between Total Humor Rating and the change scores for all 3 numerical working memory tasks did not near significance. Understanding jokes often relies on some degree of linguistic processing (e.g., getting the punchline of a pun or written joke; Swanson, 2013). Follow-up studies including larger sample sizes should use a humorous intervention and compare changes in different forms of pre- and post-intervention working memory tasks to investigate if differences occur, especially for linguistic working memory tasks.

Considering the content of jokes within a humor intervention, future research should revisit if math jokes (versus unrelated jokes) can lead to lower levels of math anxiety and higher levels of math performance. Utilizing larger sample sizes, future studies could also pivot to other subjects, investigating if other academic subjects could benefit from jokes pertaining to that specific academic subject (e.g., history jokes during a history quiz). Of additional benefit,

researcher should consider asking participants how much they enjoyed the humor prompts or how relaxing the humor prompts were. In addition to having participants rate how funny the jokes were, asking them how much they enjoyed or were relaxed by the attempts at humor may lend additional relevant information (Wanzer et al., 2010). There may be a significant difference between how much a participant considers the attempt at humor and the degree to which they thought the jokes were funny. Previous literature suggests humor pertaining to the academic subject can lead to greater liking of the instructor and course material (Hackathorn et al., 2011). Therefore, measuring the enjoyment of the jokes in the intervention could be utilized in analyses to answer other relevant research questions.

The Total Humor rating within both treatment groups (math jokes and unrelated jokes) was able to predict the change in math anxiety as measured by the Single Item Math Anxiety (SIMA) scale, but not the Abbreviated Math Anxiety Scale (AMAS). Future research should compare how humor may be able to alter levels of math anxiety across these two measures. Both scales are intended to measure state anxiety and are capable of fluctuation in the midst of an intervention altering participant mood (Hopko et al., 2003; Núñez-Peña et al., 2014). Despite the AMAS items requesting participants to consider previous behaviors, state math anxiety may inflate participant reflections about their previous experiences (Primi et al., 2014). Future research should compare various measure of math anxiety in a pre- and post-intervention humor manipulation to analyze if and how these measures differ from one another in this manner.

In summary, neither of these studies resulted in significant analyses. However, the descriptive information within the results indicates potential relationships between humor, working memory, math anxiety, and math performance. Given a larger sample size and a refined

methodology, these same research questions may yield significant results. The manner in which humor may impact student performance remains an important consideration and deserves future investigation.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL LETTERS

UNIVERSITY OF
NORTHERN COLORADO

Institutional Review Board

Date:	02/05/2021
Principal Investigator:	Ivan Wayne
Committee Action:	**IRB EXEMPT DETERMINATION – New Protocol**
Action Date:	02/05/2021
Protocol Number:	2101020103
Protocol Title:	Do These Jokes Add Up?
Expiration Date:	

The University of Northern Colorado Institutional Review Board has reviewed your protocol and determined your project to be exempt under 45 CFR 46.104(d)(701) (703) for research involving

Category 1 (2018): RESEARCH CONDUCTED IN EDUCATIONAL SETTINGS. Research, conducted in established or commonly accepted educational settings, that specifically involves normal educational practices that are not likely to adversely impact students' opportunity to learn required educational content or the assessment of educators who provide instruction. This includes most research on regular and special education instructional strategies, and research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

Category 3 (2018): BENIGN BEHAVIORAL INTERVENTIONS IN CONJUNCTION WITH THE COLLECTION OF INFORMATION FROM ADULT SUBJECTS through verbal or written responses (including data entry) or audiovisual recording if the subject prospectively agrees to the intervention and information collection and at least one of the following criteria is met: (A) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects; (B) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or (C) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by 45 CFR 46.111(a)(7). For the purpose of this provision, benign behavioral interventions are brief in duration, harmless, painless, not physically invasive, not likely to have a significant adverse lasting impact on the subjects, and the investigator has no reason to think the subjects will find the interventions offensive or embarrassing. Provided all such criteria are met, examples of such benign behavioral interventions

UNIVERSITY OF
NORTHERN COLORADO

Institutional Review Board

would include having the subjects play an online game, having them solve puzzles under various noise conditions, or having them decide how to allocate a nominal amount of received cash between themselves and someone else. If the research involves deceiving the subjects regarding the nature or purposes of the research, this exemption is not applicable unless the subject authorizes the deception through a prospective agreement to participate in such research.

You may begin conducting your research as outlined in your protocol. Your study does not require further review from the IRB, unless changes need to be made to your approved protocol.

As the Principal Investigator (PI), you are still responsible for contacting the UNC IRB office if and when:

- You wish to deviate from the described protocol and would like to formally submit a modification request. Prior IRB approval must be obtained before any changes can be implemented (except to eliminate an immediate hazard to research participants).
- You make changes to the research personnel working on this study (add or drop research staff on this protocol).
- At the end of the study or before you leave The University of Northern Colorado and are no longer a student or employee, to request your protocol be closed. *You cannot continue to reference UNC on any documents (including the informed consent form) or conduct the study under the auspices of UNC if you are no longer a student/employee of this university.
- You have received or have been made aware of any complaints, problems, or adverse events that are related or possibly related to participation in the research.

If you have any questions, please contact the Research Compliance Manager, Nicole Morse, at 970-351-1910 or via e-mail at nicole.morse@unco.edu. Additional information concerning the requirements for the protection of human subjects may be found at the Office of Human Research Protection website - http://hhs.gov/ohrp/ and https://www.unco.edu/research/research-integrity-and-compliance/institutional-review-board/.

Sincerely,

Nicole Morse
Research Compliance Manager

Carter Hall 3002 | Campus Box 143 | Greeley, CO 80639 | Office 970-351-1910 | Fax 970-351-1934

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University of Northern Colorado: FWA00000784

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Date:	01/07/2021
Principal Investigator:	Ivan Wayne
Committee Action:	**IRB EXEMPT DETERMINATION – New Protocol**
Action Date:	01/07/2021
Protocol Number:	2011016619
Protocol Title:	Is Testing a Laughter Matter? Achievement Effects via Working Memory
Expiration Date:	

The University of Northern Colorado Institutional Review Board has reviewed your protocol and determined your project to be exempt under 45 CFR 46.104(d)(702) (703) for research involving

Category 2 (2018): EDUCATIONAL TESTS, SURVEYS, INTERVIEWS, OR OBSERVATIONS OF PUBLIC BEHAVIOR. Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met: (i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects; (ii) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or (iii) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by 45 CFR 46.111(a)(7).

Category 3 (2018): BENIGN BEHAVIORAL INTERVENTIONS IN CONJUNCTION WITH THE COLLECTION OF INFORMATION FROM ADULT SUBJECTS through verbal or written responses (including data entry) or audiovisual recording if the subject prospectively agrees to the intervention and information collection and at least one of the following criteria is met: (A) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects; (B) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or (C) The information obtained is recorded by the investigator in such a manner that

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the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by 45 CFR 46.111(a)(7). For the purpose of this provision, benign behavioral interventions are brief in duration, harmless, painless, not physically invasive, not likely to have a significant adverse lasting impact on the subjects, and the investigator has no reason to think the subjects will find the interventions offensive or embarrassing. Provided all such criteria are met, examples of such benign behavioral interventions would include having the subjects play an online game, having them solve puzzles under various noise conditions, or having them decide how to allocate a nominal amount of received cash between themselves and someone else. If the research involves deceiving the subjects regarding the nature or purposes of the research, this exemption is not applicable unless the subject authorizes the deception through a prospective agreement to participate in such research.

You may begin conducting your research as outlined in your protocol. Your study does not require further review from the IRB, unless changes need to be made to your approved protocol.

As the Principal Investigator (PI), you are still responsible for contacting the UNC IRB office if and when:

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- You make changes to the research personnel working on this study (add or drop research staff on this protocol).
- At the end of the study or before you leave The University of Northern Colorado and are no longer a student or employee, to request your protocol be closed. *You cannot continue to reference UNC on any documents (including the informed consent form) or conduct the study under the auspices of UNC if you are no longer a student/employee of this university.
- You have received or have been made aware of any complaints, problems, or adverse events that are related or possibly related to participation in the research.

If you have any questions, please contact the Research Compliance Manager, Nicole Morse, at 970-351-1910 or via e-mail at nicole.morse@unco.edu. Additional information concerning the requirements for the protection of human subjects may be found at the Office of Human Research Protection website - http://hhs.gov/ohrp/ and https://www.unco.edu/research/research-integrity-and-compliance/institutional-review-board/.

Sincerely,

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Institutional Review Board

Nicole Morse
Research Compliance Manager

University of Northern Colorado: FWA00000784

APPENDIX B

CONSENT FORMS

UNIVERSITY OF
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CONSENT FORM FOR HUMAN PARTICIPANTS IN RESEARCH

Project Title:
Is There Something Funny About Memory?

Researchers:
Ivan Wayne, Dr. Molly Jameson, & Andrea White,
School of Psychological Sciences (UNC McKee 14)

Phone: 720-284-1626 **E-mail**: ivan.wayne@unco.edu
Phone: 970-351-4669 **E-mail:** molly.jameson@unco.edu

Purpose and Description: The primary purpose of the present study is to understand how the presence of working memory tasks may influence attitudes toward humorous or relaxing items. To help us better understand these factors, you will be asked to complete a set of working memory tasks.

All survey responses will be kept confidential, and no individually-identifiable information (your bear number nor your name) will be collected. Only the researchers will have access to your survey responses and test performance via one set of shared online Qualtrics login credentials.

The indirect benefit of this study is gaining further understanding of how humor and relaxation responses and working memory function may be related. This is of particular importance because if relationships exist, students and educators alike should be made aware of these relationships.

The risks inherent in this study are no greater than those that would occur on a basis when discussing humor preferences or working on a cognitive task. Should you feel distress during this study or desire to talk to someone about your feelings, contact UNC's counseling services by phone at 970-351-2496 or on the second floor of Cassidy Hall, or the Office of Academic Support and Advising at 970-351-1391 or in Michener L149.

Participation is voluntary. You may decide not to participate in this study and if you begin participation you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Please take your time to read and thoroughly review this document and decide whether you would like to participate in this research study. If you decide to participate, your completion of the research procedures indicates your consent. Please keep or print this form for your records. If you have any concerns about your selection or treatment as a research participant, please contact Nicole

Morse, Office of Research & Sponsored Programs, Carter Hall, University of Northern Colorado Greeley, CO 80639; 970-351-1910.

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CONSENT FORM FOR HUMAN PARTICIPANTS IN RESEARCH

Project Title:
Do These Jokes Add Up?

Researchers:
Ivan Wayne, Dr. Molly Jameson, & Andrea White,
School of Psychological Sciences (UNC McKee 14)

Phone: 720-284-1626 **E-mail**: ivan.wayne@unco.edu
Phone: 970-351-4669 **E-mail:** molly.jameson@unco.edu

Purpose and Description: The primary purpose of the present study is to understand how considering mathematics may alter participants' view of humor. In order to study this relationship, you will take a few surveys and answer a few assessment questions.

All survey responses will be kept confidential, and no individually-identifiable information (your bear number nor your name) will be collected. Only the researchers will have access to your survey responses and test performance via one set of shared online Qualtrics login credentials.

The indirect benefit of this study is gaining further understanding of how academic considerations and humor styles may be related. This is of particular importance because if relationships exist, students and educators alike should be made aware of these relationships.

The risks inherent in this study are no greater than those that would occur on a basis when discussing humor preferences or working on a cognitive task. Should you feel distress during this study or desire to talk to someone about your feelings, contact UNC's counseling services by phone at 970-351-2496 or on the second floor of Cassidy Hall, or the Office of Academic Support and Advising at 970-351-1391 or in Michener L149.

Participation is voluntary. You may decide not to participate in this study and if you begin participation you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Please take your time to read and thoroughly review this document and decide whether you would like to participate in this research study. If you decide to participate, your completion of the research procedures indicates your consent. Please keep or print this form for your records. If you have any concerns about your selection or treatment as a research participant, please contact Nicole

Morse, Office of Research & Sponsored Programs, Carter Hall, University of Northern Colorado Greeley, CO 80639; 970-351-1910.