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Hypomania and the Effects of Working Memory Load on Risk-Taking

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by

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(Under the Direction of Jeff Klibert)

ABSTRACT

Hypomania is an episodic mood state that closely resembles mania, and it is characterized by irritability, euphoria, racing thoughts, and impulsivity. The present study focuses on risk-taking, a behavioral manifestation of impulsivity, and the potential working memory mechanisms responsible for eliciting this behavior in people affected by hypomanic symptoms. Specifically, research suggests that taxing working memory accelerates the process by which individuals with high levels of hypomanic symptoms engage in risk-taking. The purpose of the current study was to examine the effects on hypomanic traits and working memory taxation on a behavioral measure of risk-taking. One hundred and forty-five participants with varying levels of hypomanic functioning were asked to complete the Balloon Analog Risk Task (BART), a computerized behavioral risk-taking measure, while experiencing various levels of working memory taxation. Number of balloon pumps and reaction time were recorded by the BART and used as measures of risk-taking. An analysis of the data revealed no significant effects of working memory on balloon pumps or reaction time. However, there were hypomania group differences on reaction time such that high-hypomania participants had faster reaction times compared to those in the low-hypomania group. Practical implications for future research are considered.

Keywords: hypomania, risk-taking, impulsivity, Balloon Analog Risk Task

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CHAPTER 1: INTRODUCTION

Description of Hypomania

The *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association [APA], 2013) defines hypomania as an episodic mood state that resembles mania, though it is less severe in intensity and duration. Specifically, a person experiencing a hypomanic episode may exhibit an irritable or euphoric mood, racing thoughts, inflated self-esteem, and impulsivity. Hypomania may also include a decreased need for sleep, pressured speech, psychomotor agitation, and diminished attention. During hypomanic episodes, people often report an increase in productivity and creativity (Jamison, Gerner, Hammen, & Padesky, 1980). Moreover, hypomanic episodes may occur independently of any other psychopathological condition or with comorbid disorders (e.g., depression). Where alternating periods of hypomania and depression occur, a diagnosis of cyclothymic disorder is appropriate (APA, 2013). While cyclothymic disorder is a mood disorder with symptoms similar to that of bipolar disorder, it is not as severe.

The term *hypomania* describes a set of dispositional characteristics that reflect subsyndromal symptoms of bipolar disorder (Slater & Roth, 1969). People with hypomanic personalities are often described as energetic, positive, and highly social. Additionally, people with hypomanic personality styles tend to be able to work long hours with little sleep, while also being able to effectively multitask between multiple projects and social engagements (see Eckblad & Chapman, 1984). It has been observed that hypomanic personality characteristics are present in more people who are at higher risk to be diagnosed with a bipolar spectrum disorder (Stone, 1980).

It is hypothesized that the Behavioral Activation System (Johnson, Camilo, Ruggero, & Carver, 2005) regulates mood and behavior as observed in hypomania. Specifically, there may be dysregulation of the Behavioral Activation System among people with hypomanic characteristics such that these individuals may be especially sensitive to goal and pleasure-related pursuits (Meyer & Hoffman, 2005). In keeping with this position, research has shown that measures developed to assess dysregulation of the BAS are associated with hypomania (Meyer, Johnson, & Carver, 1999). Research conducted by Nusslock, Abramson, Harmon-Jones, Alloy, and Hogan (2007) found that a goal-striving event, operationalized as preparing for final exams, was significantly associated with the onset of hypomanic episodes in college students with bipolar spectrum diagnoses. With respect to hypomanic symptoms, Nusslock et al. (2007) found that the final exam period was associated with a greater likelihood of inflated self-esteem, decreased need for sleep, distractibility, and goal-directed activity or psychomotor agitation.

Emerging lines of inquiry also suggest that hypomanic traits contribute to impulsivity and impulsive components including inordinate risk-taking. Examining hypomanic traits in the context of risk-taking and impulsivity may provide significant insights into how adolescents, emerging adults, and young adults become attracted to a number of public health problems including alcohol, risky sexual activity, and gambling.

Risk-taking

Risk-taking is considered to be a subset of behaviors belonging to the overarching construct of impulsivity (Doob, 1990) and has been defined by Ben-Zur and Zeidner (2009) as "one's purposive participation in some form of behavior that involves potential negative consequences or losses (social, monetary, or interpersonal) as well as perceived positive consequences or gains" (p. 110). Given this definition, specific risky behaviors that are attractive, yet are associated with some degree of negative consequences, could be subsumed by the construct of impulsivity. For example, gambling carries the potential to win large sums of money while requiring the individual to accept the risk of losing money. Risky sexual practices may bring about physical pleasure, yet there is a risk of acquiring infections or transmitting infections to partners. Similarly, abuse of addictive substances provides enjoyable neurochemical alterations while carrying substantial social, personal, physical, and economic risks. Individuals who engage in risky behavior often do not take time to weigh the consequences of their behavior against the pleasurable components of the stimuli; thus decisions to engage in risk-taking are based on impulsive principles such as a lack of premeditation.

Risk-taking has been broadly conceptualized as a set of behaviors that contribute to substantial losses associated with one's identity, significant others, and unfamiliar individuals involved in situations created by the risk taker (Ben-Zur & Zeidner, 2009). For instance, risk-taking may consist of behaviors such as substance abuse, unprotected sex, reckless driving, gambling, dangerous sports, excessive drinking, and unlawful activities (Ben-Zur & Zeidner, 2009). With respect to development, these behaviors tend to appear during early adolescence, peak during late adolescents, and then decline through middle adulthood (Boyer, 2006).

The detrimental outcomes associated with these behaviors have been extensively examined. Specifically, the World Health Organization (WHO) found that alcohol consumption contributed greatly to the global burden of disease or injury. In particular, the report stated that the negative impact of alcohol on global health was surpassed only by unsafe sex and childhood malnutrition. Other major risk factors such as tobacco use, high cholesterol, hypertension, and unsanitary water and living conditions were found to have negative effects less than those attributed to alcohol (WHO, 2009). It should be noted that this study accounts for the effects of all levels of alcohol consumption, even those that are considered beneficial.

Data reported by Rehm (2011) indicates that excessive drinking significantly contributes to the alcohol-imposed burden on global health. Specifically, it was found that excessive alcohol consumption is linked to infectious disease progression via pathways that decrease immune system function. Excessive drinking was also found to contribute to oral and gastrointestinal cancers. Concerning diabetes, the article reported that lower levels of alcohol consumption exhibit a protective effect while higher levels are associated with an increased risk for the disease. The article also indicates that alcohol contributes to the risk of cardiovascular disease and neurological disorders such as epilepsy.

Risk-taking in the context of sexual behavior is also of great concern. Specifically, research suggests that risky sexual practices are strongly associated with sexual victimization among women (Clum et al., 2011). This is particularly important to consider because it indicates that risky sexual behavior can be detrimental to the well-being of not only the person engaging in the behavior, but to others who come in contact with those individuals. It has also been found that risky sexual practices are linked to the risk of contracting HIV and syphilis (Charnigo et al., 2013; Zheng, Wu, Poundstone, Pang, & Rou, 2012). Research indicates that adolescents who score high on measures of impulsivity and risk-taking are more likely to report having multiple sexual partners, using alcohol and cannabis before sex, and never refusing unsafe sex (Donohew et al., 2000).

Additionally, gambling has been shown to be associated with risk-taking (Lejuez et al., 2002). While gambling does not necessarily have significant, long-term detrimental effects on many of the people who engage in the activity, gambling addictions negatively impact the well-being of many individuals. In a study conducted by Barry, Steinberg, Wu, and Potenza (2009), it was found that adults who utilized a gambling helpline commonly reported anxiety, familial problems, financial problems, and tobacco use. Additionally, the study's participants often reported suicide attempts.

Risk-taking behaviors, which are an expression of the broader concept of impulsivity, have consistently been shown to negatively impact an individual's physical and mental health. For instance, research has shown that these behaviors introduce, or significantly increase the risk of, anxiety, suicidality, interpersonal difficulties, poor cardiovascular health, and sexually transmitted diseases. It is important that research continues to identify processes that explain how older adolescents, emerging adults, and young adults come to engage in risk-taking.

Hypomanic Traits and Risk-Taking

Given that individuals with hypomanic personalities are sensitive to the pursuit of pleasurable activities, it is not surprising that people who experience hypomania are more likely to engage in risk-taking behaviors, such as drugs and alcohol (Fletcher, Parker, Paterson, & Synnott, 2013). Empirical investigations have revealed support for this position. One study conducted by Meyer, Rahman, and Shepherd (2007) found that people with elevated scores on a measure of hypomania were more likely to suffer from an addiction problem. Specifically, it was found that participants with high hypomania scores were more addicted to drugs, exercise, internet usage, work, and music compared to participants who reported low hypomania scores. Other research has also highlighted the association between hypomania and addiction. Lemere and Smith (1990) found a significant relationship between hypomanic personality traits and cocaine use. Moreover, in a national sample of 32,316 adults, hypomania was shown to be associated with gambling problem severity (Barry, Stefanovics, Desai, & Potenza, 2010).

Using the Hypomanic Personality Scale to assess levels of hypomania, Kwapil et al. (2000) found that 44% of participants with high hypomania scores met DSM criteria for a substance abuse disorder compared to 13% of people in the control group with low to moderate hypomania scores. There was also a significant difference in marijuana use and abuse such that 19% of individuals in the high hypomania group reported use or abuse compared to 3% of controls. Additionally, it was found that the 39% of people with elevated hypomanic personality scores engaged in alcohol use or abuse compared to 10% of controls. Overall, research suggests that addiction and substance abuse features are often associated with hypomanic traits.

In addition to substance abuse, impulsivity, or acting on the spur of the moment with little or no consideration for planning and future consequences (Patton, Stanford, & Barratt, 1995), is a defining feature of hypomania (APA, 2013). Of note, impulsive traits underlying hypomania have been consistently associated with psychopathological features including depression, suicidality, risky sexual behavior, and drug abuse (Bender, Gordon, Bresin, & Joiner, 2011; Corruble, Benyamina, Bayle, Falissard, & Hardy, 2003; Winters, Botzet, Fahnhorst, Baumel, & Lee, 2009). Impulsivity has also been shown to be predictive of risky driving behaviors (Dahlen, Martin, Ragan, & Kuhlman, 2005). Overall, these findings suggest that even sub-threshold levels of hypomanic symptoms can be detrimental to an individual's emotional and behavioral health. These findings further validate the need to identify mechanisms that explain the causal pathways between hypomanic symptoms and negative outcomes (e.g., risk-taking). One potential mechanism that may be important in explicating the pathways between hypomanic symptoms and risk-taking is working memory.

Working Memory

Working memory can be conceptualized as a system that temporarily stores, and subsequently integrates and processes, verbal, acoustic, and spatial information for higher-level cognitive processes such as decision-making (Baddeley, 2007). Numerous studies have supported the idea that people with bipolar I disorder, a condition that elicits high levels of hypomanic features (Johnson, Edge, Holmes, & Carver, 2012), exhibit deficits in working memory (Glahn et al., 2006; McGrath, Chapple, & Wright, 2001).

Numerous empirical studies support this position. For instance, Glahn et al. (2006) conducted a study in which 15 participants diagnosed with bipolar disorder without a history of psychosis and 15 people diagnosed with bipolar disorder with a history of psychosis were compared to 32 normal controls (i.e., high functioning participants) on measures of working memory. To assess verbal working memory, participants were asked to engage in the digit span subtest of the Wechsler Adult Intelligence Scale III. Specifically, the researchers randomly assigned participants from each of the three groups to forward and backward digit span conditions. The backward condition required participants to reorder a digit string held in memory. Conversely, in the forward condition, participants were required to recall digits from digit strings that increased in length. The results revealed that participants suffering from bipolar symptoms without a history of psychosis exhibited backward digit span deficits compared to participants in the control group. However, there was no evidence of forward digit span impairment. Similarly, when compared to controls, individuals suffering from a bipolar condition with a history of psychosis did not show forward digit span impairments but did exhibit decrements in backward digit span (Glahn et al., 2006). Overall, these results indicate that people with a history of hypomanic symptoms exhibit working memory deficits.

The findings by Glahn et al. (2006) provided very useful data regarding the verbal working memory deficits present among individuals reporting hypomanic traits in the form of bipolar disordered symptoms. However, measures of other aspects of working memory, such as visual working memory, were not tested. McGrath, Chappel, and Wright (2001) examined visual working memory among individuals reporting high levels of hypomanic features (via diagnoses of schizophrenia and bipolar disorder in the manic phase) was compared to normal controls. Specifically, 19 participants with schizophrenia, 12 people with bipolar I disorder in a manic episode, and 19 normal controls engaged in a task used to measure visual working memory. Comparisons revealed not only that the participants with bipolar disorder in a manic episode performed more poorly compared to normal controls, they performed equally as poorly as the participants who reported high levels of schizophrenic symptoms. These findings, taken together with those of Glahn et al. (2007), have shown that not only is verbal working memory diminished in those who report high levels of hypomanic features, but that visual working memory is also diminished, particularly in participants experiencing a manic episode.

A specific function of the working memory system involves the executive control component, which allocates resources so that information in working memory can be held for processing or inhibited if it is no longer relevant (Hinson, Jameson, & Whitney, 2003). Given that people diagnosed with bipolar disorder and who experience manic episodes exhibit working memory deficits, it is logical to speculate that the information processing abilities of people high on hypomanic personality traits may be impaired as well. In terms of risk-taking and impulsivity, if there is a decreased ability to process information related to the rewards and consequences of engaging in risky behaviors, it also follows that taxation of the working memory system, such that the ability to attend to, and process, relevant risk and reward information is impinged upon, could lead to increased impulsivity and risk-taking (Hinson et al., 2003).

Hinson et al. (2003) tested whether increasing working memory load leads to increased impulsivity. Specifically, the delay discounting paradigm, which requires participants to indicate their preference for a smaller monetary reward to be delivered immediately versus a larger monetary reward to be delivered at a particular point in the future, was used to measure impulsivity. Hinson, Jameson, and Whitney (2003) argued that participants reporting more impulsivity difficulties would prefer the immediate reward compared to a larger reward to be delivered at a specified future time.

In the first experiment, participants rehearsed a five-digit string in one block of trials and then indicated their preference between a small amount of money to be delivered immediately or a larger amount delivered at a future time. After indicating their preference, participants were asked to recall the number one position to the right of the 5 in the previously presented string. In another block of trials, participants were asked to imagine a barrel with 9 ping pong balls from which they would pick a ball numbered 1 through 9, and then indicate their monetary preference. After the preference indication, they were asked to report the number of the chosen ball. In a third block of trials, a number was displayed on the computer screen after the participants indicated their monetary reward preference, and the participants were asked to report the number displayed by using the computer's keypad. The study's results suggest that participants preferred the more immediate reward during high and moderate working memory taxation blocks.

The second study built upon the first by increasing working memory taxation as a function of monetary reward options. Instead of employing a secondary task to tax the working memory system, 50 participants were given two reward choices in the first block of trials, three choices in the second block, and four choices in the third block of trials. It was hypothesized that as working memory load increased as a function of reward options, participants would again prefer smaller immediate rewards compared to larger delayed rewards, which would indicate that impulsivity increased as working memory load increased (Hinson et al., 2003).

The results of the two experiments suggest that taxing working memory increases impulsivity. In the first experiment, participants preferred the more impulsive reward choice in the trial blocks that taxed working memory the most (i.e., the digit string task), followed by the moderately taxing blocks (i.e., the ping pong task), and then the least taxing blocks (i.e., reporting the displayed digit task). With respect to the second experiment, the smaller immediate monetary reward was preferred as a function of working memory load, such that participants chose the more impulsive reward in blocks that presented the greatest amount of options. Overall, these results suggest an increasing number of options taxes working memory, thereby increasing impulsivity. Additionally, these results also indicate that this effect may be ecologically valid given that there are generally many options in an individual's environment.

One limitation of the previous literature is a lack of specificity with respect to risk-taking. Impulsivity may not necessarily mean that a person will engage in behaviors that could be potentially harmful. Therefore, focusing future research on the effects of working memory load on behavioral measures of risk-taking must be conducted to build our understanding of the clinical relevance of working memory and its relationship with engaging in risky behaviors.

In addition, studies have yet to consider how individuals with high levels of hypomanic traits cope with high levels of working memory load. It is possible that taxing working memory may play an important role in explaining why individuals with high levels of hypomanic traits engage in high-risk behaviors. Examining the interaction between hypomanic functioning and working memory load may generate greater insight into how cognitive processes mitigate or exacerbate risk-taking tendencies.

Current Study

Hypomania features have been consistently linked to increased impulsivity and risk-taking behaviors (Swann, Steinberg, Lijffijt, & Moeller, 2008). Additionally, deficits in working memory appear salient in how the literature conceptualizes both chronic mental health conditions (e.g., Bipolar Disorder) that activate high levels of hypomanic features and inordinate risk-taking. Considering these findings, the primary purpose of the current study was to examine the interaction between hypomanic functioning and working memory on risk-taking behavior. More specifically, we sought to determine the extent to which taxing working memory in participants high on hypomanic traits will affect risk-taking. We expected that the findings from a complex evaluation of these relationships could potentially reveal one of the mechanisms by which people high on hypomanic traits become more impulsive and engage in risk-taking behaviors. On the basis of existing theory and available empirical evidence, we hypothesized that taxing working memory would lead to (a) increases on a behavioral measure of risk-taking among all participants; and (b) a greater increase on a behavioral measure of risk-taking among participants with high hypomania scores compared to participants with lower hypomania scores.

CHAPTER 2: METHODOLOGY

Participants

The sample consisted of 145 undergraduate students, 97 women (66.9%) and 48 men (33.1%). The mean age was 20.45 (*SD* = 13.47) years. With respect to ethnicity, the sample self-reported as mostly European American (*n* = 56, 38.6%), African American (*n* = 42, 29%), and Other (*n* = 32, 22.1%).

To ensure the validity of the BART measures, cases were dropped in which a participant had a mean number of balloon pumps less than 10 on any one of the three trial blocks. This data reduction strategy decreased the sample size for the primary analyses from 145 to 134.

Measures

Hypomanic Personality Scale (HYP; Eckblad & Chapman, 1986). This scale is a 48-item self-report measure that assesses hypomanic personality traits. Each item is a statement that describes the way in which a person might have felt over a long period of time rather than current symptomatology. An example of an item would be "I am so frequently 'hyper' that my friends kiddingly ask me what drug I'm taking." Participants respond by indicating whether the statement is true or false. Total scores can range from 0-48, with higher scores indicating greater levels of reported hypomanic functioning. The HYP was found to have good concurrent validity with the interview-based SADS-L measure of hypomania (Eckblad & Chapman, 1986). Additionally, the HYP had good internal consistency in both the literature (α = .87; Eckblad & Chapman, 1986) and the current analyzed sample (α = .90).

Balloon Analog Risk Task (BART; Lejuez et al., 2002). This is a computerized, behavioral measure of risk-taking. When participants engage in the BART, they pump a balloon by pressing a key on the keyboard. With each pump, 10 points are added to their bank for a specific trial. At any point during a trial, the participant may press another key to end the trial and add that trial's total amount of points into their permanent bank. However, the probability of the balloon popping and the amount of points in the bank being lost increases with each pump. The probability of the balloon popping after a given number of pumps is varied across trials. Continuing to pump the balloon in order to accumulate more points despite the growing probability of the balloon popping is indicative of increased risk-taking. The BART has multiple measures of risk-taking. Specifically, risk-taking can be measured by the number of times the participant pumps the balloon and via the reaction times of balloon pumps. The BART has been significantly correlated with self-report measures of risk-taking, impulsivity, and sensation-seeking (Lejuez et al., 2002).

Research Design

A 2 x 3 mixed-subjects design with hypomania levels the between-subjects variable and working memory conditions as the within-subjects variable was utilized for this study. This particular design affords the researcher greater statistical power while also reducing the necessary sample size (Mitchell & Jolley, 2012). Given a mixed-subjects design's greater statistical power, along with the need to collect data efficiently, it is the preferred design for the present study. Therefore, all participants in the low and high hypomanic groups experienced the high, moderate, and control working memory taxation conditions.

Taxing working memory has been shown to increase impulsivity (Hinson et al., 2003). Impulsivity was expected to result from working memory's inability to store and process relevant risk and reward information because it is being used to store and process irrelevant information. Given that risk-taking is a behavioral manifestation of impulsivity, it was hypothesized that taxing working memory would also produce increases in risk-taking.

In the current experiment, working memory was taxed by asking participants to silently rehearse digit strings while completing the BART. To determine the extent to which working memory taxation increases risk-taking, there were high-, moderate-, and no-taxation conditions. The high-taxation condition involved rehearsing a 5-digit string, while the moderate- and no-taxation conditions involved the rehearsal of a 3-digit string and focusing on a fixation cross, respectively. It was expected that risk-taking would increase as a function of the degree to which working memory was taxed.

Procedure

Participants were recruited via the Psychology Department's SONA research participant management system. Specifically, students in psychology courses who wished to earn research participation credits signed up for the studies that interested them through the department's SONA web site. Once participants signed up for the study's data collection session that best fit their schedule, they came to the Psychology Department's computer lab to complete the study. Before each participant began the tasks involved in this research, they were given an informed consent document approved by the institution's internal review board. Once the documents were signed, participants were seated in front of a computer, asked to wear headphones, and instructed to read the prompts displayed on the monitor. They first read instructions on how to navigate the BART task. The instructions included a warning that clearly outlined the risk associated with popping the balloon. There were 3 blocks of 30 trials that heavily taxed, moderately taxed, or did not tax working memory (the control condition) and were presented in an order counterbalanced across participants.

In the high taxation block, participants were presented with a 5-digit string on the screen and asked to silently rehearse it during the BART trial. The moderate taxation block involved the same procedure but with a 3-digit string. In the control block, participants were asked to focus on a fixation cross before the BART trial began. At the end of each BART trial, participants were asked to type the digit string that appeared before each trial. During the control manipulation, participants completed the BART trials. To encourage rehearsal, at the beginning of each block, participants were informed that the points won on that trial would not be added to the permanent bank if the response to the digit string probe was incorrect.

To measure hypomanic personality traits, participants completed a computerized version of the HYP. Items were presented individually on the screen, and participants pressed the T key to indicate a True response or the F key for a False response. Additionally, the HYP was presented after a demographics questionnaire to minimize potential priming effects resulting from the BART.

Each measure was programmed in, and executed by, ePrime software (Psychology Software Tools, 2012). Each measure was programmed in ePrime such that the number of balloon pumps and reaction times for each balloon pump were recorded for each block of BART trials along with the total HYP score.

Data Analytic Plan. A percentile split was employed to group participants in terms of high and low HYP conditions. Then, two 2 x 3 (HYP x Working Memory) mixed-subjects factorial ANOVAs were performed to compare the number of balloon pumps and reaction times between the high and low HYP groups working under conditions of high, moderate, or no working memory taxation. When excluding participants with a mean number of balloon pumps below 10 on any of the three trial blocks and whose HYP scores were in the middle third of the distribution, the sample size for the primary analyses was reduced from 145 to 85.

CHAPTER 3: RESULTS

Preliminary Analyses

Gender Differences. A multivariate analysis of variance (MANOVA) was used to compare mean differences by gender on overall balloon pumps, overall reaction times, and total HYP scores. A non-significant overall effect was revealed (λ (3, 130) = 2.09, $p > .05$, $\eta^2 = .05$). See Table 1.

Correlations. Bivariate correlations were examined to determine whether relationships existed among total HYP score, overall reaction time, and overall balloon pumps. Contrary to expectations, HYP scores were non-significantly related to overall balloon pumps. However, total HYP score was significantly correlated with overall reaction time. As expected, a moderately small significant relationship was found between overall balloon pumps and overall reaction times. Correlations are displayed in Table 2.

Primary Analyses

To create high and low HYP groups, a percentile split was employed to remove the middle third of HYP scores while keeping the lower and upper thirds. Using a percentile split over a median split was decided upon post-hoc to maximize the potential for group differences. The lower third of HYP scores were comprised of individuals who self-reported lower scores on the Hypomanic Personality Scale, whereas the higher third of the HYP scores were comprised of individuals who self-reported the highest scores on the Hypomanic Personality Scale. A histogram of the total HYP scores is presented in Figure 1.

A 2 x 3 (HYP x Working Memory) mixed-subjects factorial ANOVA was conducted to compare the mean number of balloon pumps between participants in the high and low HYP groups under conditions of high, moderate, or no working memory taxation. Non-significant main effects of Working Memory ($F(2, 166) = 0.64$, $p > 0.05$, $\eta_p^2 = .01$) and HYP ($F(1, 83) = 0.64$, $p > 0.05$, $\eta_p^2 = .00$) were revealed. A non-significant interaction effect also was revealed, $F(2, 166) = 0.20$, $p > 0.05$, $\eta_p^2 = .00$. These findings are inconsistent with the current study's hypotheses. Importantly, individuals in the low HYP group performed comparably to the individuals in the high HYP group in the balloon pumping task. In addition, results suggest that working memory taxation does not increase the mean number of balloon pumps. Mean and standard deviation scores are presented in Table 3.

A second 2 x 3 (HYP x Working Memory) mixed-subjects factorial ANOVA was conducted to compare the mean reaction times between participants in the high and low HYP groups under conditions of high, moderate, or no working memory taxation. Results revealed a non-significant main effect of Working Memory ($F(1.716, 166) = 2.70$, $p > 0.05$, $\eta_p^2 = .03$) and a significant main effect of HYP ($F(1, 83) = 4.72$, $p < 0.05$, $\eta_p^2 = .05$). The interaction effect was non-significant ($F(1.716, 166) = 1.99$, $p > 0.05$, $\eta_p^2 = .00$). Results indicate that individuals in the high HYP group reacted faster to the stimuli on the BART compared to individuals in the low HYP group. Mean and standard deviation scores are presented in Table 4.

CHAPTER 4: DISCUSSION

The current study attempted to examine the pathways by which working memory could influence risk-taking among a college population with varying hypomanic features. Specifically, a risk-taking paradigm was employed while participants were under conditions of high, moderate, or no working memory taxation to assess the extent to which working memory taxation affects the performance of various degrees of hypomania functioning during a risk-taking task. It was hypothesized that taxing working memory would lead to (a) increases on a behavioral measure of risk-taking among all participants; and (b) a greater increase on a behavioral measure of risk-taking among participants with high hypomania scores compared to participants with lower hypomania scores.

Hypomania and Risk-Taking (Balloon Pumps)

Between subject results assessed the extent to which different HYP groups differed with regard to the mean number of BART balloon pumps. Contrary to expectation, results revealed non-significant between subject effects. Specifically, participants in the high HYP group did not engage in greater levels of balloon pumping compared to participants in the low HYP group. This finding is inconsistent with literature providing support for the position that people with hypomanic traits engage in more risk-taking behaviors compared to normal controls (e.g., Fletcher, Parker, Paterson, & Synnott, 2013).

One possible explanation for these incongruent findings is the ecological validity of the BART. The studies cited in the literature review (e.g., Lemere & Smith, 1990) of this paper clearly show a link between hypomania and increased risky behaviors that provide some degree of pleasure or reward. However, completing the BART as it was set up in this experiment only allows participants to see an increasing amount of points in their bank. The results may have been different had points been labeled as money with the potential to win a prize of some small value at the end of the task. Therefore, future research should offer tangible rewards on risk-taking tasks to when evaluating differences between high and low hypomania groups.

Hypomania and Risk-Taking (Reaction Time)

The between-subjects analyses associated with reaction time did produce significant group differences. Results indicated that individuals in the high HYP group displayed faster reaction times compared to individuals in the low HYP groups. Overall, these results are consistent with the expectations of the current study. However, this finding stands in contrast to the lack of between-subject differences in other behavioral measures of risk-taking (i.e., balloon pumps).

Deconstructing the affiliation between reaction time and impulsivity/risk-taking may be important in clarifying the results of the current study. Commonly, reaction time is seen as a measure of impulsivity (Conners, 2004). Faster reaction time is specifically linked to greater levels of impulsivity, which in turn also appear salient in describing high levels of hypomanic functioning. Considering HYP group differences on estimates of reaction times, our results support the position that reaction time on behavioral tasks may be a solid representation of impulsivity and risk-taking. However, balloon pumping on the BART task has also been considered a measure of impulsivity and risk-taking (Lejuez et al., 2002), yet our findings did not yield significant differences between high and low hypomanic group status with regard to balloon pumping. As noted above, power and other methodological issues associated with the implementation of the BART task may explain the lack of significant differences between high and low hypomanic groups. However, our results also call into question the appropriateness of balloon pumping to serve as behavioral measure of impulsivity and risk-taking. Specifically, a laboratory task using risks associated with intangible losses may lack the ecological validity necessary to measure the construct. This position is also supported by the relatively small correlation between balloon pumps and reaction time. Future work should focus on exploring the utility and appropriateness of using the balloon pumping component of the BART task as a behavioral measure of impulsivity and risk-taking.

Working Memory Taxation and Risk-taking

Both within-subjects analyses assessing the extent to which working memory taxation conditions affected mean the number of balloon pumps and reaction times failed to yield significant results. It was hypothesized that as working memory taxation increased, participants would engage in greater levels of risk-taking, as measured by great balloon pumping and faster reaction times. However, these effects were not detected, which is quite surprising in light of the prevailing evidence suggesting that working memory taxation does influence activation of impulsive and risk-taking traits during delayed discounting tasks (Hinson et al., 2003).

The failure to replicate these results may be due to the nature and procedures associated with the BART risk-taking task. While a delayed discounting task requires participants to rehearse digit strings while rapidly making immediate versus long-term decisions, the BART requires participants to rehearse digit strings during balloon-pumping trials that can range between a few seconds to one minute. There is no time limit on completing a balloon-pumping trial nor are there instructions to do so as quickly as possible. Thus, depending on the speed with which participants pump the balloon, trails have the potential to be quite lengthy in comparison to delayed discounting judgments. This relative increase in trial length may cause rehearsed digit strings to be transferred into long term memory, which would no longer tax the working memory system during later portions of a trial. Transitioning information from working memory to long-term memory may deactivate impulsive and risk-taking tendencies. Considering this possibility, future research should reanalyze the questions of the current study using delayed discounting tasks that are more likely to tax working memory. Such investigations may offer clarity with regard to if and how working memory taxation activates impulsive and risk-taking tendencies.

Gender Differences

An analysis of gender effects on mean overall balloon pumps revealed non-significant differences between men and women. These findings are inconsistent with one meta-analysis of gender differences on measures of risk-taking that included studies using the BART, which found that men engaged in greater levels of risk-taking on the BART compared to women (Cross, Copping, & Campbell, 2011). To measure the extent to which gender differences occur in measures of risk- taking, future research should reanalyze these questions using a balanced sample with respect to an equal number of men and women gender.

Alternatively, the analysis did reveal a significant effect of gender on mean overall reaction time such that men had faster reaction times compared to women. This is consistent with recent research showing that males exhibit slightly faster reaction times on cognitive tasks compared to females (van Deurzen et al., 2012). It is important that future research be directed to understanding these differences further. Specifically, it may be important for researchers to understand how social (e.g., gender role expectations), physiological (e.g., the ratio between pre-frontal cortex and amygdala development), and cognitive (e.g., advancement into formal operations) factors explain gender differences in reaction time.

Practical Implications

Considering that the results of this study conflict with current theory regarding the effects of working memory taxation on impulsivity, researchers should begin to develop methods that tax working memory while still accounting for the lengthy nature of risk-taking tasks. Once these methodological limitations are addressed, it is possible that the hypotheses in this study will be supported. From there, clinical scientists will then be able to develop therapeutic techniques that would teach clients to mitigate environmental factors that tax working memory when making decisions regarding risky behaviors.

Limitations

Given that the majority of the study's findings were non-significant, it is particularly important to note several key limitations. The first potential limitation is measurement with respect to hypomania. While the exploratory correlations presented in the results section show that the BART's measures of reaction time and balloon pumps correlated well with each other in the expected direction, the HYP only significantly correlated with the BART's measure of reaction time. There is a non-significant relationship between HYP scores and number of balloon pumps, which is surprising. Given that impulsivity is a core feature of hypomania (American Psychiatric Association, 2013), a moderately high relationship between the two measures was expected. While the literature suggests that the HYP is a valid and robust measure of hypomania, our results do raise concerns regarding the utility of the HYP in the type of study. Future studies should consider thoroughly testing the HYP for social desirability bias effects before using with a college student population. Additionally, the Hypomanic Personality Scale employs a true/false response key. Such a key may minimize variation in participant scores. As a result, researchers may want to re-analyze the questions of the current study using other scales that employ a likert scale response key.

The second limitation to the current study is confounds associated with time. In the original study by Hinson et al. (2003), the results suggested that taxing working memory does lead to increased impulsivity. Though it is logical that this working memory taxation effect should extend into the more specific construct of risk-taking, the inability of this study's findings to support that hypothesis is troubling. However, the very different natures of the tasks employed in each study could be source of these conflicting findings. Delayed discounting tasks require participants to make one very quick choice during a trial in which their working memory is being taxed. Using a risk-taking task such as the BART requires that participants complete a trial that could last many seconds while rehearsing digit strings to tax working memory. Given that the BART trials have the potential to be relatively lengthy, rehearsal of the digit strings may not have taxed working memory throughout the longer trials because those digit strings had been encoded into long-term memory. Future studies should attempt to design a more robust way of taxing working memory during risk-taking tasks to establish more accurate ways of investigating the causal pathways between working memory and risk-taking.

External validity is the third limitation that should be discussed. The sample was composed of non-clinical participants who were predominantly undergraduate women. The participant characteristics restrict generalizability to clinical populations. Moreover, because the sample was composed of primarily women and exclusively undergraduates, the study's findings may not be generalized outside of those demographic features. Therefore, future studies should sample a more diverse group of students.

General Conclusions

The findings of this study could have contributed to a new understanding of the working memory mechanisms that affect risk-taking among people who exhibit hypomanic features. Unfortunately, the hypothesized relationships were not found when the data were analyzed. However, the limitations proposed in the discussion of this study's findings do offer valuable considerations for future research. Once these limitations are addressed, it is possible that the hypothesized relationships will be found and that new clinical methods will be developed to help clients make beneficial decisions regarding risky behaviors when environmental factors may be taxing working memory.

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Table 1

Means, and Standard Deviations for Total HYP Score, Overall Balloon Pumps, and Overall Reaction Time based on Gender

Variables	Mean (*SD*)
Female (*N* = 57)	
HYP Total	20.89 (9.53)
Overall Balloon Pumps	33.19 (11.95)
Overall Reaction Time (ms)	263.17 (91.86)
Male (*N*= 28)	
HYP Total	20.86 (9.90)
Overall Balloon Pumps	35.58 (12.00)
Overall Reaction Time (ms)	223.14 (55.83)

Table 2

Inter-correlations among Measures of Hypomania, Overall Balloon Pumps, and Overall Reaction Times

Variables	1	2	3
1. HYP Total	---		
2. Overall Balloon Pumps	-.08	---	
3. Overall Reaction Time	-.24*	-.25*	---

Note: * $p < .05$; ** $p < .01$

Table 3

Means, and Standard Deviations for Overall Balloon Pumps and Overall Reaction Time Based on HYP Group

Variables	Mean (*SD*)
Low HYP (*N* = 46)	
Overall Balloon Pumps	34.30 (11.10)
Overall Reaction Time	280.52 (134.85)
High HYP (*N* = 39)	
Overall Balloon Pumps	33.60 (13.01)
Overall Reaction Time	240.76 (76.94)

Table 4

Means and Standard Errors for Overall Balloon Pumps and Overall Reaction Time Based on Working Memory Taxation

Variables	Mean (*SE*)
No Taxation (*N* = 46)	
Overall Balloon Pumps	34.82 (1.57)
Overall Reaction Time	238.56 (9.23)
Moderate Taxation (*N* = 39)	
Overall Balloon Pumps	34.70 (1.42)
Overall Reaction Time	263.88 (13.66)
High Taxation (*N* = 39)	
Overall Balloon Pumps	33.47 (1.63)
Overall Reaction Time	260.63 (12.20)

Figure 1

Histogram of HYP Total Scores