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Posttraumatic stress disorder (PTSD) is often characterized by difficulty experiencing positive emotion and hyperarousal of negative emotion. Theory suggests that positive emotion is dampened due to frequent re-experiencing of trauma-related stimuli. Although prior research has extended positive emotion experiencing to reward processing research, research has not yet examined how reward processing and decision-making are affected in individuals with PTSD under a trauma prime. The proposed study compared the performance of individuals with PTSD (n = 22) to trauma-exposed controls (n = 24) (between-subjects design) in a passive wheel-of-fortune task and again in a decision-making version of the task, under both neutral and trauma primes (within-subjects). It was hypothesized that, compared to controls, the PTSD group would report a lower expectation of and lower satisfaction with reward in both passive and decision-making tasks. It was further predicted that the PTSD group would make more disadvantageous decisions than the control group in the decision-making task. These effects were expected to be predicted by the type of prime (in the PTSD group, lower following the trauma prime). Results showed that expectation of reward was predicted by the possible outcomes that were presented. Satisfaction of reward was predicted by the type of outcome, as well as the interaction of the group and the type of prime, such that individuals with PTSD rated lower satisfaction following the trauma prime compared to the neutral prime. In addition, those with PTSD made less advantageous decisions compared to controls. These findings suggest that in PTSD treatment, intrusion

symptoms may need to be addressed before positive affect can be increased. In addition, individuals with PTSD may make less advantageous decisions (e.g., to engage in social interactions) when the potential gain is not obvious.

REWARD PROCESSING AND DECISION-MAKING

IN POSTTRAUMATIC STRESS DISORDER

by

Casey May

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_____
Committee Chair

APPROVAL PAGE

This thesis written by CASEY MAY has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

Committee Chair Dr. Blair E. Wisco

Committee Members Dr. Paul J. Silvia

Dr. Kari Eddington

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CHAPTER I

INTRODUCTION

A common symptom of posttraumatic stress disorder (PTSD) is the difficulty or inability to experience positive emotions, such as love or happiness (Criterion D7; American Psychological Association, 2013, p. 272). This difficulty with positive emotions is often described vaguely in the literature as "emotional numbing." Emotional numbing was previously described as a "restricted range of affect" in the revised 3rd edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-III-R; American Psychological Association, 1987). This phrase seemed to imply a limited range of all emotional experience, regardless of whether the emotion was positive or negative. In previous research, the definition of emotional numbing also typically included a markedly diminished interest in activities and feelings of being distant or cut off from others (Litz & Gray, 2002). However, the present study focuses on the aspect of emotional numbing involving positive affect because research on this particular facet of emotional numbing is lacking in the field of PTSD research.

Although the definition of emotional numbing has been inconsistent within the literature, some researchers have argued that positive emotion, specifically, is inhibited with individuals diagnosed with PTSD. For example, the most current edition of the DSM, DSM-5 (American Psychological Association, 2013), distinguishes *reduced*

positive affect (i.e., "persistent inability to experience positive emotions" such as love or happiness in Criterion D7) from *increased* negative emotion (i.e., "persistent negative emotional state" such as fear, horror, anger, guilt, or shame in Criterion D4). This suggests that individuals with PTSD do not necessarily experience a general "numbing" of all emotions or an overall "restricted range of affect," as previously thought. Litz (1992) hypothesized that PTSD is characterized by a restricted range of positive affect and a heightened experience of negative affect, consistent with the DSM-5 operationalization. Research has found empirical support for dampened positive affect and heightened negative affect in individuals with PTSD (Amdur, Larsen, & Liberzon, 2000; Orsillo, Batten, Plumb, Luterek, & Roessner, 2004; Jatzko et al., 2006; Saar-Ashkenazy et al., 2015).

Although positive affect may be generally dampened in individuals with PTSD, the experience of positive emotion may be further dampened when competing with strong negative affect (Litz, 1992). Litz suggested that positive emotion is not as accessible post-trauma because of "the activation of trauma-related cognitive processes that are antagonistic to the expression of non-trauma-related emotions" (1992, p. 429). In other words, the experience of positive emotion may be even less available under particular circumstances, specifically following trauma reminders.

The effect of trauma cues on the experience of positive emotion has not yet been directly tested in the PTSD literature. However, past studies have addressed general difficulty with positive emotion by examining how individuals with PTSD respond to reward. For example, in fMRI studies, individuals with PTSD show diminished brain

activity in structures that have been linked to reward pathways (compared to healthy individuals; Sailer et al., 2008; Elman et al., 2009). Elman et al. (2005) asked male heterosexual veterans with or without PTSD to press a key to extend the viewing time of average or beautiful female or male facial images and found that PTSD patients spent less effort to extend the viewing time of beautiful female faces than veterans without PTSD, suggesting a reward deficit in PTSD. In addition, Nawijn et al. (2015) completed a systematic review of 29 studies reporting that, in comparison to control participants, individuals diagnosed with PTSD expressed decreased reward anticipation and approach ("wanting" or what Klein [1984] referred to as "anticipatory pleasure") and reduced hedonic response ("liking" or "consummatory pleasure" [Klein, 1984]).

Hopper et al. (2008) also conducted a study in which individuals with PTSD and trauma-exposed controls (individuals who had previously experienced a trauma but did not meet diagnostic criteria for PTSD) each completed a wheel-of-fortune task. In this task, the participants were presented with a spinner and were asked how positive or negative they expected the reward to be, based on the possible options displayed by the spinner (also known as anticipatory pleasure). Three types of spinners were used: "Good," "Bad," and "Intermediate" (see Figure 1 for possible outcomes of the spinners used by Hopper and colleagues). After the spinner spun and the outcome was shown, participants were asked how happy they were with the outcome (a measure of consummatory pleasure; see Figure 2 for task procedure). Participants diagnosed with PTSD reported both lower expectation of being rewarded and lower satisfaction when the reward was received, compared to trauma-exposed controls. In a prior study, Mellers,

Schwartz, Ho, & Ritov (1997) found an inverse relationship between expectation and satisfaction in healthy individuals, such that the lower the expectation of reward, the greater consummatory pleasure when the reward occurred. Hopper et al. (2008) replicated this relationship in trauma-exposed controls but did not find a relationship between expectation and emotional response in those with PTSD. Interestingly, those with PTSD still reported low satisfaction with a rewarding outcome, even if they previously expressed low expectation of a reward being received.

Research in reward processing has been extended to find that individuals with PTSD may also have a unique decision-making pattern (Dretsch, Thiel, Athy, Born, & Prue-Owens, 2012). Prior research has found evidence of decision-making impairments in other types of anxiety disorders (e.g., obsessive compulsive disorder; de Rocha, Alvarenga, Malloy-Diniz, & Corrêa, 2011), as well as major depressive disorder (Han et al., 2012). However, decision-making research seems to be limited in the field of PTSD. One exception is a study that used standard and variant versions of the Iowa Gambling Task (IGT), a task in which U.S. active-duty soldiers were asked to select cards that incur monetary gains or losses (Dretsch et al., 2012). The standard IGT presents four decks of cards, two of which incur high immediate rewards but eventually incur larger losses as the task progresses (disadvantageous decks that lead to a net loss) and two of which yield smaller immediate rewards but also smaller losses (advantageous decks that lead to a net gain). The standard IGT represents immediate gains and delayed losses. The variant IGT (vIGT), on the other hand, presents losses first and gains later. Two advantageous decks yield high immediate losses but also higher delayed earning (net gain), and two

disadvantageous decks present smaller immediate losses but also smaller gains (net loss). Dretsch et al. (2012) found that individuals with PTSD performed similar to non-diagnosed controls on the standard IGT but performed worse than controls on the vIGT. Their results suggest that the PTSD group did not present a decision-making impairment when presented with monetary gains but did when presented with monetary losses. This study provides evidence of impaired decision-making characterized by PTSD. However, this is the only study that has researched monetary decision-making of this type in individuals with PTSD to my knowledge. The literature on decision-making in PTSD would benefit if research was extended to other types of monetary gambling tasks and a more diverse group of participants.

The altered processing of emotions that typically accompanies PTSD is important to research within the context of decision-making. It is important to know how decision-making may be unique in individuals with PTSD as they make decisions about everyday situations. Because positive affect is often a target in PTSD treatment, it is important to know why individuals with PTSD have difficulty experiencing positive affect and how these difficulties affect their decisions. The present study compared reward processing and decision-making in individuals with PTSD under both a neutral prime and an idiographic trauma prime (specific to a past traumatic event they have personally experienced).

The Present Study

This study examined how PTSD alters the processing of reward, with two overarching goals. The first goal of the proposed study was to examine anticipatory and

consummatory pleasure under neutral and trauma prime. Although it was suggested that their findings may relate to Litz and Gray's (2002) theory, Hopper et al. (2008) did not implement a manipulation to test that individuals with PTSD have difficulty experiencing positive emotion due to the presence of trauma reminders. Consistent with the findings of Hopper et al. (2008), it was predicted that individuals with PTSD would report overall lower anticipatory pleasure of being rewarded (Hypothesis 1a) and overall lower consummatory pleasure (Hypothesis 1b) with the reward compared to trauma-exposed controls. It was also hypothesized that this effect of PTSD on anticipatory and consummatory pleasure would be moderated by the presence of a trauma prime, such that the PTSD group would report lower expectancy and outcome satisfaction in the trauma-primed condition in comparison to the neutral-primed condition, and trauma-exposed controls would demonstrate no effect of prime. Anticipatory pleasure would be additionally predicted by spinner type, such that Good spinners would be rated the highest, Bad spinners the lowest, and Intermediate spinners in the middle. Consummatory pleasure would also be predicted by the type of outcome (gain of money, $0, or loss of money), such that positive outcomes would be rated the highest, negative outcomes the lowest, and outcomes of $0 in the middle.

The second goal of the proposed study was to examine decision-making of PTSD-diagnosed individuals following neutral and trauma primes. To accomplish this goal, I developed a decision-making version of the wheel-of-fortune task, in which participants viewed the spinner, rated their anticipatory pleasure for that particular spinner, and then were given the option to either play the current trial or pass onto the next trial. Playing

the Good spinner is an advantageous decision, as there is a two-thirds chance of gaining money and a one-third chance of neither gaining nor losing money. Passing on the Bad spinner is also an advantageous decision, as there is a two-thirds chance of losing money and only a one-third chance of neither gaining nor losing money. Group differences in performance on the Good and Bad spinners were not expected. The decision to pass or play these spinners was included as a manipulation check.

The advantageous decision to play the Intermediate spinner, however, is less obvious. As mentioned previously, the Intermediate spinner involves possible outcomes of a gain of $1.25, a loss of $0.75, and an outcome of $0. The expected value of this spinner is positive (approximately +$0.50, as the possible gain is higher than the possible loss), making the Intermediate spinner a rational bet. An individual who has a low expectation for reward may see that reward (+$1.25) is only possible in one-third of the possible outcomes and may view the reward as an unlikely possibility. The decision to play or pass affected participants' overall winnings, such that the outcomes of played spinners will affect total amount of money won but passed spinners will not.

It was predicted that individuals with PTSD will continue to report lower anticipatory pleasure than the trauma-exposed controls, similar to the passive portion of the study, and that this effect would be moderated by the type of prime (Hypothesis 2a). In addition, we predicted that individuals with PTSD would report lower decision satisfaction on the Intermediate spinners, compared to controls, and that this effect would be moderated by the type of prime (Hypothesis 2b). Additionally, it was hypothesized that the PTSD group would earn less money than the control group (Hypothesis 2c).

Finally, individuals with PTSD would be more likely than trauma-exposed controls to pass on the Intermediate spinners (i.e., less advantageous decisions) and that this effect would be moderated by type of prime (Hypothesis 2d). In other words, individuals with PTSD would pass more often on the Intermediate spinners in the trauma-primed condition compared to their performance in the neutral-primed conditions, whereas the control group will make similar decisions on the Intermediate spinners regardless of the type of prime.

CHAPTER II

METHOD

Participants

Participants of the present study were recruited though a larger study (IRB #15-0373, commonly known as the "Trauma-Focused Rumination" or "TFR" study) conducted by the CoPE Lab at the University of North Carolina at Greensboro (UNCG) for two reasons. The rationale for this is that a clinical sample of PTSD is generally difficult to recruit, and the CoPE Lab has shown success with the TFR study by recruiting individuals with PTSD and trauma-exposed controls from the community of Greensboro via recruitment methods such as flyers and Craigslist ads. Second, the TFR study provides interview-verified diagnoses and other information that is necessary for the present study (see Materials).

Forty-eight participants consented to participate in the study. Inclusion criteria for this study were based on the criteria set by the larger TFR study. All participants reported exposure to at least one event on the Life Events Checklist (LEC-5; see Materials) that met Criterion A of DSM-5 (APA, 2013), occurred at least one month ago, and that no other traumatic events have occurred within the past month.

Exclusion criteria for this study were based on the current criteria set by the TFR study, which collects physiological data. Participants were excluded if they endorsed any of the following: under age 18, pregnant (if female), take any medication to treat a heart

or cardiovascular condition, ever had a heart attack or stroke, ever had any surgery (including as a child) for their heart, have a pacemaker or internal defibrillator, have hypertension or high blood pressure, have been to the doctor for any other heart issues, have diabetes, take "preventative" medication for asthma, take any heart medications, or have taken any antidepressants in the past 8 weeks.

Materials & Measures

Life Events Checklist for DSM-5 (LEC-5; Weathers, Litz, et al., 2013b). The LEC-5 prompted participants with 17 types of traumatic events that may potentially meet Criterion A of the DSM-5 (APA, 2013; e.g., fire or explosion, life-threatening illness or injury, sexual assault). For each event type, participants were asked to indicate: if they have experienced that type of event directly, if they have witnessed the event occur to others, if they have learned of the event occurring to a close friend or family member, if they have been exposed to the event as a part of their profession, if they are not sure if the event type necessarily fits, or if the event type does not apply to them. Participants were then asked to specify the event that was the worst for them, how they experienced the event (the level of exposure), and how long ago the event occurred.

Clinician-Administered PTSD Scale for DSM-5 (CAPS-5; Weathers, Blake, et al., 2013). The CAPS-5 is a semi-structured clinical interview created to assess the 20 core symptoms of PTSD in the DSM-5 (APA, 2013). The interviewer rated the intensity as well as frequency of each symptom on 4-point scales and combined these symptoms to determine a severity score of each symptom on a 5-point scale (ranging from 0 = *absent* to 4 = *extreme/incapacitating*). Total severity scores on the CAPS-5 were calculated by

summing the severity scores of each of the 20 core symptoms, "subjective distress," "impairment in social functioning," and "impairment in occupational functioning." The total severity score can range from 0 to 80. The CAPS-5 is used in the TFR study, and a diagnosis of PTSD was made if the participant has met all DSM-5 criteria for the disorder, such that participants must obtained scores of two or higher on at least one re-experiencing symptom, one avoidance symptoms, two negative alterations in cognition or mood, and two arousal symptoms. Symptoms must be present for at least one month and must cause clinically significant distress or impairment. Interviews were administered by trained graduate students, audio-recorded, and rated by another graduate student for inter-rater reliability (intra-class correlation [ICC] = .991).

Script-Driven Imagery (Orr et al., 1998; Lang, Kozak, Miller, Levin, & McLean Jr., 1980; Lang, Levin, Miller, & Kozak, 1983; Orr et al., 1998). Both neutral and trauma scripts were already developed during prior sessions of the TFR study. Participants were asked to provide information about the traumatic event that was focused on during the CAPS-5 and a neutral event that occurred around the same time in their life as the traumatic event. The neutral event was specified as an event that was neither positive nor negative for them. Participants were asked to provide details such as when the event occurred, what happened during the event, who was there, what they saw, what they heard, and how they felt (physiological reactions), among other details. The experimenter then wrote and audio-recorded a 60-second script for each type of event. Participants listened to an audio recording and were then asked to imagine the scene on their own.

Positive and Negative Affect Schedule – Expanded (PANAS-X) Form (Watson, Clark, and Tellegen, 1988). The PANAS is a 20-item self-report measure that assesses positive and negative affect. Participants were presented with a single word at a time (e.g., distressed, alert) and asked to what extent they feel this way. Participants made their rating on a 5-point Likert scale ranging from 1 = *very slightly or not at all* to 5 = *extremely*. For this particular study, the current mood version of the PANAS, which assesses how participants feel in the present moment, was used. Positive affect and negative affect subscales were calculated for the purpose of a manipulation check, to ensure that positive mood decreased and negative mood increased after listening to the trauma prime.

Self-Assessment Manikin (SAM) Ratings (Bradley & Lang, 1994). The SAM is a brief measure used to assess a participant's current feelings. Five pictures were shown, and participants were asked to rate their current mood on a 9-point Likert scale (see Figure 3). The valence scale (ranging from extremely happy to extremely sad) and the arousal scale (ranging from extremely aroused to extremely calm) were used in the present study.

Grounding Exercise (Najavits, 2002). The proposed study used a grounding exercise to help "ground" participants after they were reminded of and asked to think about their traumatic event. The grounding exercise used three types of grounding (mental, physical, and soothing) to help the individual shift their focus from their inner, negative feelings to the outside world. The grounding exercise was repeated until ten minutes had passed.

Filler Questionnaires. In order to further separate and ground participants in between the primed wheel-of-fortune tasks, participants were asked to fill out a battery of self-report questionnaires that took about 30 minutes to complete. The filler questionnaires included the Fear of Intimacy Scale (FIS; Descutner & Thelen, 1991), the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Ávila, Moltó, & Caseras, 2001), the BIS/BAS scales (Carver & White, 1994), the UPPS-P (Lynam, Smith, Whiteside, & Cyders, 2006), and the Temporal Experience of Pleasure Scale (TEPS; Gard, Gard, Kring, & John, 2006).

Wheel-of-Fortune Task (Hopper et al., 2008; Elman et al., 2009)**.** The task used here was similar to the task used in Hopper et al. (2008) and was presented on a computer. However, in the present study, the possible spinner outcomes were exactly half of those used in Hopper et al. (2008; see Figure 4). The participants were provided with instructions and asked to first complete a practice trial to acquaint themselves with the task. Once comfortable, the participants were shown a spinner and asked, "What do you expect the outcome of the trial to be?" (a measure of anticipatory pleasure). Using the computer mouse, participants made their rating on a 100 mm visual analog scale (VAS) shown beneath the question, with anchors *very negative* and *very positive* at the far left and right, respectively. The spinner "spun," and the outcome was highlighted and indicated by an arrow. The participants were then asked, "How happy are you with the outcome?" (a measure of consummatory pleasure). Ratings were made with the computer mouse on a 100 mm VAS shown beneath the question, with anchors *not happy at all* and *very happy* at the far left and right, respectively.

In the passive task, participants completed 36 trials, or 12 spinners of each type (i.e., Good, Bad, and Intermediate). Trials were set up in a pseudorandom order so that a spinner of a certain type was not shown before or after the same spinner type (e.g., a Good spinner will not follow or come before another Good spinner), and all outcomes were pre-set. After all 36 trials of the passive task were completed, participants were shown how much money they had made so far (which was fixed to $12). For the purpose of analysis, a total rating of anticipatory pleasure was calculated by summing and averaging reports across each spinner type for each participant. Similarly, an average consummatory rating was calculated for each spinner type. Separate calculations were made for the neutral- and trauma-primed tasks.

Third, a novel decision-making wheel-of-fortune task was added to the present study (Figure 5). Participants were given new instructions and asked to play a practice decision-making trial. Once comfortable, participants were shown one of the three spinner types and asked, "What do you expect the outcome of this trial to be?" Participants made their anticipatory ratings as they did in the passive task. Participants were then asked, "Would you like to play this trial or pass and move onto the next trial?" Participants pressed a key on the keyboard to indicate their decision. Whether or not the participant chose to play the current spinner, the spinner spun, and the outcome of the spinner was shown. The outcome of each trial was pre-set. Participants were then asked, "How happy are you with your decision?" (referred to as "decision satisfaction" from here on out). Participants made their ratings on a 100 mm VAS shown below the question, with anchors of *not happy at all* to *very happy*. Depending upon their decision

to pass or play the trial and the outcome of that particular trial, money was added or subtracted to their total winnings. Participants, however, were not shown the status of their winnings as the task progressed. At the end of the decision-making task, participants were shown how much money they earned or lost from this task. Depending on their decisions, participants had a chance to range between a loss of $6 and a gain of $10. Then, participants were reminded of the $12 they won in the previous task and shown the total amount, combining both the passive and the decision-making tasks.

In the decision-making task, participants were presented with 3 Good spinners, 3 Bad spinners, and 9 Intermediate spinners, for a total of 15 trials. For the purpose of analysis, an average rating of anticipatory pleasure was calculated for each spinner type, and average decision satisfaction was calculated for each outcome type (i.e., gain, loss, outcome of $0) for each decision option (i.e., play or pass). In order to compare the decision-making pattern of controls and individuals with PTSD, a "played proportion" was calculated for each spinner type. For example, if a participant played 3 of the 9 Intermediate spinners, the played proportion would equal 3 out of 9, or approximately 0.33. These calculations were repeated for the neutral- and trauma-primed tasks.

Procedures

The present study was approved by the Institutional Review Board at UNCG. Procedures for the present involved an online prescreening questionnaire and two visits to the CoPE Lab on two separate days. The online prescreening questionnaire included the health-related exclusion criteria of the TFR study. Then, participants completed the LEC-5 to be sure they have experienced a traumatic event during their lifetime. Participants

were then called by a research assistant, to verify that the specified even met DSM-5 criteria of an eligible "traumatic event" and that they have not experienced a traumatic event in the past month. (Individuals must have endured symptoms for at least one month to meet diagnosis per DSM-5 criteria. We excluded individuals who had experienced a trauma within the past month because it may be difficult to differentiate the origin of each symptom.) Participants who met all eligibility criteria were invited to participate in the study. In the first study session, participants first provided informed consent, the experimenter administered the CAPS-5, and the participant provided demographic information and completed details of a neutral event and the trauma for the script driven imagery used in the next session. Two participants were excluded from analyses, due to use of anti-depressants and experimenter error. In the second session, participants were seated in front of a computer monitor, a keyboard, and mouse. Participants completed the wheel-of-fortune task twice, once under a neutral prime and another time under a trauma prime. Order was randomly counterbalanced among participants, such that 25 individuals heard the trauma prime first, and 21 individuals heard the neutral prime first.

If a participant was randomized to complete the neutral-primed task first, they completed procedures in the following order: the neutral-primed task, a battery of self-report questionnaires, the trauma-primed task, and the grounding exercise. If a participant was randomized to complete the trauma-primed task first, they completed the trauma-primed task, the grounding exercise, the battery of self-report questionnaires, then the neutral-primed task. The grounding exercise immediately followed the trauma-primed task, whether or not it was completed first. During the primed tasks, participants

were first asked to complete the PANAS and SAM to assess their current affect. Participants then listened to the neutral or the trauma script, depending on the randomization. Following standard procedures for script-driven imagery, participants were asked to listen to the script and then to imagine the event for one minute. Participants were then asked to complete the PANAS and SAM again before completing the passive wheel-of-fortune task[1] and again before completing the decision-making task. After the task was completed, participants were asked to complete the PANAS and SAM a fourth time. Participants received the total amount of money they won from all tasks, which can range from $12 to $44.

Statistical Analyses

Repeated measures ANOVAs were used to test the hypotheses in Goal 1. To test anticipatory pleasure in the passive task, "Group" (PTSD or non-PTSD) was entered as a between-subjects variable and "Prime" (neutral- or trauma-prime) and "Spinner" (Good, Intermediate, or Bad) entered as within-subjects variables. We predicted a significant main effect of Group, a main effect of Spinner, and a significant two-way interaction between Group and Prime (Hypothesis 1a). We also planned follow-up paired samples *t*-tests within each group to decompose a significant interaction effect. To analyze consummatory pleasure in the passive task, our model included Group, Prime, and Outcome (gained money, outcome of $0, or lost money). We predicted a main effect of Group, a main effect of Outcome, and a two-way interaction of Group and Prime (Hypothesis 1b). Again, follow-up paired samples *t*-tests within each group would be run to decompose a significant Group by Prime interaction.

In order to test anticipatory pleasure in the decision-making task, we used the same ANOVA as the one above, and we again predicted a main effect of Group, a main effect of Spinner, and two-way interaction of Group and Prime (Hypothesis 2a). We conducted a repeated measures ANOVA to examine decision satisfaction with Group as the between-subjects variable and Prime as the within-subjects variable. We predicted a main effect of Group and a significant interaction of Group by Prime, which would be followed up by paired samples *t*-tests. An independent samples t-test will be used to test Hypothesis 2c, in which it is predicted that the PTSD group will earn less money overall compared to the control group. As a manipulation check, we ran a repeated measures ANOVA with Group as a between-subjects variable, Prime and Spinner type as within-subjects variable, and Proportion Played of each spinner type as the outcome variable, to verify that the majority of the Good spinners were played and the Bad spinners were passed. All following analyses focused primarily on Intermediate spinners, as this is the spinner type of interest. To examine Hypothesis 2d, repeated measures ANOVA was conducted with Group entered in as a between-subjects variable, Prime as within-subjects variable, and Proportion Played of the Intermediate spinner as the dependent variable. A main effect of Group for the Intermediate spinner is expected, as it would show that individuals with PTSD performed differently than trauma-exposed controls when presented with the Intermediate spinner, which is ambiguously advantageous. A significant interaction between Group and Prime on Proportion Played would be also supportive of Hypothesis 2d. Paired samples *t*-tests within each group would follow-up this interaction. A significant effect of Prime within the PTSD group would support the

prediction that individuals with PTSD will play the Intermediate spinner less in the trauma-primed condition compared to the neutral-primed condition. A non-significant effect of Prime within the control group would support the prediction that controls will play the Intermediate spinner a similar amount of times in the two primed conditions.

Power Analysis

In order to obtain a "large" effect size (g = .25) with power of .80 using α = .05, Cohen (1992) suggests 26 participants for each of the two groups, for a total of 52 participants. For this thesis, we recruited 46 participants (22 with PTSD, 24 trauma-exposed controls), providing adequate power to test an effect of ρ = .385.

CHAPTER III

RESULTS

Demographic information (gender and race/ethnicity) of the participants who completed study procedures thus far (n = 46) are presented in Table 1. Independent samples t-tests and chi-square tests indicated that there were no significant differences between the groups on age ($t(44) = -.005$, $p = .996$), gender ($\chi^2(1, N = 46) = .314$, $p = .575$), or race/ethnicity ($\chi^2(5, N = 46) = 2.948$, $p = .708$); as predicted, there was a significant difference in total CAPS score ($t(44) = 9.702$, $p < .001$), such that individuals with PTSD demonstrated more severe symptoms than trauma-exposed controls.

Passive Task

The first goal of the present study was to examine reported anticipatory and consummatory pleasure in each group, under both neutral and trauma primes, in the passive wheel-of-fortune task. It was predicted that individuals with PTSD would report lower overall anticipatory and consummatory pleasure in the passive wheel-of-fortune task, compared to trauma-exposed controls and that this effect would be moderated by the type of prime. To test these hypotheses, a repeated measures ANOVA was used to examine anticipatory pleasure in the passive task (Hypothesis 1a). Results demonstrated a non-significant main effect of Group ($F = 2.113$, $p = .153$), a non-significant main effect of Prime ($F = .897$, $p = .349$), a significant main effect of Spinner type (i.e., Good, Bad, and Intermediate; $F = 146.135$, $p < .001$), and all non-significant interactions: Group by

Prime (F = .009, p = .925), Group by Spinner (F = 2.146, p = .129), Prime by Spinner (F = .013, p = .988), and Group by Prime by Spinner (F = .024, p = .977). Figures 6 and 7 show the distribution of average reported anticipatory pleasure by group, type of prime, and type of spinner. Follow-up paired samples *t*-tests revealed that anticipatory pleasure was rated higher for Good spinners compared to Intermediate spinners (M(SD) = 80.30(11.63) and 52.59(14.41), respectively; t(45) = 11.826, p < .001), and anticipatory pleasure was rated highest for Intermediate spinners compared to Bad spinners (52.59(14.41) and 26.99(17.86), respectively; t(45) = 13.566, p < .001). As all results are preliminary due to lag in data collection and consequential low statistical power, mean comparisons were made to examine the direction of results thus far, with the caveat that the following results are not significant. Individuals with PTSD indeed reported lower anticipatory pleasure than controls (M = 50.8 vs 55.5, respectively), and in the PTSD group, ratings were lower following the trauma prime compared to the neutral prime (M = 50.1 vs 51.6, respectively).

A repeated measures ANOVA was used to examine consummatory pleasure in the passive task. Results showed a non-significant main effect of Group (F = .409, p = .526), a non-significant main effect of Prime (F = .042, p = .839), a significant main effect of Outcome type (i.e., gained money, outcome of $0, loss money; F = 187.214, p < .001), a marginally significant Group by Prime interaction (F = 3.832, p = .057) and non-significant interactions of Group by Outcome (F = .882, p = .421), Prime by Outcome (F = .840, p = .439), and Group by Prime by Outcome (F = .981, p = .383). Figures 6 and 8 show the distribution of average reported consummatory pleasure based on outcome and

type of prime. Paired samples *t*-tests indicated that consummatory pleasure was higher for positive outcomes than outcomes of $0 (*M*(SD) = 83.45(8.26) and 57.28(13.64), respectively; $t(45) = 12.038$, $p < .001$) and that ratings were higher for $0 outcomes than for negative outcomes (57.28(13.64) and 31.62(18.14), respectively; $t(45) = 7.925$, $p < .001$). Follow-up paired samples *t*-tests were run to analyze the marginally significant Group by Prime interaction that was found. Results showed that consummatory pleasure was not significantly different between types of prime in either group (PTSD group, $t(21) = 1.474$, $p = .155$; control group, $t(23) = -1.286$, $p = .211$). Though nonsignificant, the direction of these results was as predicted, such that individuals with PTSD rated consummatory pleasure lower following the trauma prime (*M*(SD) = 55.57(9.60)), compared to the neutral prime (*M*(SD) = 57.63(8.85)). In contrast, trauma-exposed controls rated consummatory pleasure higher following the trauma prime (*M*(SD) = 59.07(9.70), compared to the neutral prime (*M*(SD) = 57.39(8.75)), suggesting that the trauma prime does not have the same effect on controls as it does on the PTSD group. Following this, independent samples *t*-tests were run within each type of prime. In the neutral prime, ratings of consummatory pleasure did not differ between the PTSD and control groups (*M*(SD) = 57.63(8.85) and 57.39(8.75), respectively; $t(44) = .092$, $p = .927$). Although the PTSD group rated consummatory pleasure lower in the trauma prime compared to controls (*M*(SD) = 55.57(9.60) and 59.07(9.70), respectively), this difference was not statistically significant ($t(44) = -1.229$, $p = .226$).

Decision-Making Task

The second goal was to examine decisions made on the wheel-of-fortune task in each group, under both neutral and trauma primes. Similar to hypotheses of the passive task, it was hypothesized that individuals with PTSD would continue to report lower overall anticipatory pleasure in the decision-making task, compared to controls, and that this effect would be moderated by prime (Hypothesis 2a). Individuals with PTSD would report lower decision satisfaction than controls, and this would be moderated by type of prime (Hypothesis 2b). In addition, the PTSD group would, on average, earn less money than the control group (Hypothesis 2c). It was also predicted that individuals with PTSD would pass more often on the Intermediate spinners and that this effect would be moderated by the type of prime (Hypothesis 2d).

A repeated measures ANOVA was conducted to examine anticipatory pleasure in the decision-making task. Results demonstrated a significant main effect of Spinner type (F = 239.939, p < .001) and a marginally significant interaction of Group by Spinner (F = 3.099, p = .055). Results showed non-significant main effects of Group (F = 2.045, p = .160) and Prime (F = .798, p = .376) and non-significant interactions of Group by Prime (F = .012, p = .912), Prime by Spinner (F = 1.705, p = .194), and Group by Prime by Spinner (F = .239, p = .7). Figures 9 and 10 demonstrated reported anticipatory pleasure based on group, prime, and type of spinner. Paired samples t-tests revealed that ratings were higher for Good spinners compared to Intermediate spinners (M(SD) = 85.83(11.51) and 50.87(13.45), respectively; t(45) = 16.475, p < .001), and Intermediate spinners were rated higher than Bad spinners (50.87(13.45) and 19.41(17.29), respectively; t(45) =

14.935, $p < .001$). Additional analyses were run to examine the marginally significant Group by Spinner interaction that was found. As predicted, independent samples *t*-tests found that the PTSD group ($M = 23.9$) reported significantly lower anticipatory pleasure for the Intermediate spinners compared to the control group ($M = 27.6$, $t(44) = -2.138$, $p = .038$). However, this difference was not present for the Good ($t(44) = .517$, $p = .608$) or Bad spinners ($t(44) = -1.339$, $p = .187$).

A repeated measures ANOVA was used to examine decision satisfaction of the Intermediate spinners in the decision-making task. (As mentioned previously, the Intermediate are the experimental spinners, and the Good and Bad spinners are present as manipulation checks.) Results indicated, for the Intermediate spinners, non-significant main effects of Group ($F = 0$, $p = .988$) and Prime ($F = .288$, $p = .594$) and a non-significant interaction of Group by Prime ($F = .034$, $p = .855$). Figure 11 demonstrates average reported decision satisfaction for each group, under each prime. In addition, an independent samples *t*-test was run to examine the average amount of money won in each group. Results showed that there was not a significant difference in the average amount of money won by individuals with PTSD (M(SD) = \$18.76(\$1.64)) and controls (M(SD) = \$18.62(\$1.90); $t(44) = .269$, $p = .789$).

As mentioned previously, a manipulation check was conducted to ensure that Good spinners were more often played and that Bad spinners were usually passed. Results of this test revealed a significant main effect of Group ($F = 5.131$, $p = .028$), a significant main effect of Spinner ($F = 111.065$, $p < .001$), and a marginally significant main effect of Prime ($F = 3.830$, $p = .057$). Follow-up paired *t*-tests indicated that Good

spinners were played more than Intermediate spinners (*M* (SD) = .98(.08) and .68(.30), respectively; $t(45) = 6.688$, $p < .001$), Intermediate spinners were played more than Bad spinners (.68(.30) and .23(.36), respectively; $t(45) = 8.754$, $p < .001$). The results of the manipulation check were as expected; therefore, the following analyses are conducted using the Intermediate spinners.

A repeated measures ANOVA was used to determine if individuals with PTSD played the Intermediate spinners less often and if this effect was moderated by Prime (Hypotheses 2c and 2d). Results showed a marginally significant main effect of Group ($F = 3.369$, $p = .073$), non-significant main effect of Prime ($F = 2.545$, $p = .118$), and a non-significant interaction of Group x Prime ($F = .263$, $p = .611$). To explore the marginally significant main effect of Group, an independent samples *t*-test indicated that individuals with PTSD played the Intermediate spinners less than controls (*M*(SD) = .60(.33) and .76(.24), respectively). This difference was marginally significant but presented in the predicted direction ($t(44) = -1.836$, $p = .073$). Results from a paired samples *t*-test indicated that, within the PTSD group, there was no significant difference between the two types of prime in the proportion of Intermediate spinners played ($t(21) = -.616$, $p = .545$; Figure 12). Interestingly, though not statistically significant, the PTSD group played the Intermediate spinners more often following the trauma prime than the neutral prime (*M*(SD) = .62(.38) and .58(.36), respectively). This direction of results was also displayed in trauma-exposed controls ($t(23) = -2.034$, $p = .054$), a difference that was marginally significant.[2]

CHAPTER IV

DISCUSSION

The present study examined anticipatory and consummatory pleasure of individuals with PTSD and trauma-exposed controls, following script-driven imagery of their worst traumatic event and of a neutral event that occurred at about the same time in their life as the trauma. The study recruited 22 individuals with PTSD and 23 controls from the surrounding community and determined PTSD diagnosis based on the CAPS-5, a gold standard PTSD interview. To collect outcome measures, the study employed a wheel-of-fortune task adapted from previous research. In the 36 trials of the passive task, individuals reported their anticipatory pleasure with the displayed spinner, were presented with the outcome of the spin, and rated their consummatory pleasure with the displayed outcome. Analyses indicated that anticipatory pleasure was affected by the type of spinner that was presented, such that regardless of PTSD diagnosis, Good spinners were rated higher than Intermediate spinners, which were rated higher than Bad spinners. Contrary to predictions, results did not reveal a significant effect of PTSD diagnosis nor a significant interaction of PTSD diagnosis and the type of prime. These results suggest that reported anticipatory pleasure may be more dependent upon the type of spinner, or the outcome possibilities, above and beyond the presence of PTSD or trauma reminders.

Reports of consummatory pleasure were affected by the outcome of the spinner the report was based on. As expected, satisfaction with the outcome was higher for

positive outcomes than outcomes of $0, which were rated higher than negative outcomes. A marginally significant interaction of group and type of prime was found, such that following the neutral prime, the two groups rated consummatory pleasure generally the same. Following the trauma prime, though nonsignificant, individuals with PTSD rated consummatory pleasure lower than trauma-exposed controls, a result that was as predicted. Controls actually rated consummatory pleasure higher following the trauma prime, compared to the neutral prime, suggesting that individuals lacking a PTSD diagnosis are not affected by the trauma prime in an identical way as the PTSD group.

In the 15 trials of the decision-making task, individuals first rated their anticipatory pleasure, were asked if they would prefer to pass or play this spinner, were presented with the outcome of the spin despite their decision, and rated their happiness with their recent decision. Results support the conclusion that anticipatory pleasure is dependent upon the type of spinner that is presented (the potential rewards that are possible), such that expectation for reward was highest for Good spinners and that Intermediate spinners were rated higher than Bad spinners. Contrary to predictions, the groups did not differ in decision satisfaction, regardless of the type of prime, and they did not differ in the total amount of winnings. This study also examined the decisions made by each group, under each prime. As mentioned previously, Intermediate spinners are ambiguously advantageous, and it was expected that individuals with PTSD would not perceive the advantage of the Intermediate spinners as easily as controls. This was a finding that was marginally significant and may change with the addition of more participants. Results suggest that individuals with PTSD passed more often on the

advantageous Intermediate spinners than the control group; however, this effect was only marginally significant and should be interpreted with caution.

Limitations

A major limitation of the present study is the inadequate number of participants, which significantly affects the statistical power of the analyses and therefore does not produce accurate results. Data collection is expected to continue until a total of 52 participants have been recruited and completed study procedures. At that point, findings will be updated to reflect analyses run with strong statistical power. As such, marginally significant results should be interpreted with caution, as these results may change with the addition of data.

A second limitation of the study is the potential overlap of symptoms between the two groups. In other words, the classification of a "trauma-exposed control" for this study does not mean that the participant does not endorse *any* symptoms of PTSD. Controls may still experience a number of PTSD symptoms and resulting distress and functional impairment. However, a diagnosis of PTSD (i.e., the PTSD group of this study) depends on the specific combination of symptoms (see CAPS-5 description under "Materials"), not on the total severity score. Specifically, total CAPS-5 symptom severity ranges from 6 to 28 in trauma-exposed controls and 22 to 51 in those with PTSD. Although the control group does not meet for a full diagnosis of PTSD, their reward processing may still be impacted by their present symptoms, regardless of their classification in this particular study. Future research may want to compare participants based on their overall

symptom severity (i.e., analyzing the total CAPS score as a continuous variable) or based on the types of symptoms they endorse.

In this study, the analysis of decision satisfaction did not take into account the spinner type, outcome of the spinner, or the decision made on that trial by the participant. Unfortunately, this study was not designed with this type of analysis in mind and would be difficult to interpret with the structure of the data we collected. For example, a number of participants would be dropped from the analyses due to miss data because they passed or played all trials. These analyses may be conducted when the full dataset is compiled. Future research may further investigate decision satisfaction as an operational definition of consummatory please, by incorporating specifics regarding the potential rewards that were presented, the reward that was made available, and the decision that was made in a particular situation.

Lab-based studies, or studies conducted solely in a laboratory setting, present limitations that may be overcome with momentary reporting in the context of daily life. In this lab-based study, participants were located in a controlled environment, in which distractions are kept to a minimum. In addition, participants reported anticipatory and consummatory pleasure for a simulated monetary task, whereas participants may respond differently when being asked about events occurring during their daily lives. Future research may employ ambulatory assessment to assess individuals' anticipatory and consummatory pleasure in response to events that are more relevant to the treatment of those with PTSD.

Implications

Although the present study has limitations, its findings provide information that may be used in PTSD treatment. This study's results suggest that consummatory pleasure is affected by trauma reminders for individuals with PTSD, proposing that individuals with PTSD may find less pleasure in positive rewards, interactions, and events when they experience trauma intrusion symptoms. This may be important to be aware of in the treatment of PTSD, such that intrusion symptoms may need to be addressed before positive affect can be increased following an individual's experience of daily life events. As mentioned previously, individuals with PTSD made less advantageous decisions when the potential gain is not obvious. These results suggest that those with PTSD may make less advantageous decisions and take fewer risks that could potentially be rewarding. Clinicians may keep this in mind as clients examine choices in their lives, such as interpersonal interactions and occupational opportunities, as well as the decision to choose a protocol (e.g., Prolonged Exposure Therapy versus Cognitive Processing Therapy) or continue treatment that is emotionally challenging to complete.

Future Directions

The present study sets the stage for numerous avenues of continuing research. For example, future research may examine reward processing in other types of tasks, such as one that is more personally impacting to the individual (e.g., higher monetary gain). As mentioned previously, future research may examine anticipatory and consummatory pleasure in regard to daily life events personal to the individual, as daily life is arguably a setting that is more clinically relevant to treatment outcomes. In addition, ambulatory

assessment has the ability to assess for contextual factors in the moment that the questionnaire is requested to be completed, such as a participant's social activity, substance use, or level of physical activity. Future research may also examine other factors that influence reward processing, beyond PTSD diagnosis. For example, it may be helpful for clinicians to know how each type of PTSD symptoms (i.e., re-experiencing, avoidance, negative alterations of cognitive and mood, and arousal symptoms) affect reward processing and decision-making. The present study compares how participants respond under both trauma and neutral primes. However, future research may want to assess for the number of trauma intrusions that occur throughout one's day and how this affects their anticipation and consumption of particular events.

In conclusion, my master's thesis provides preliminary results of a study that investigates that effect of trauma reminders on the reward processing and decision-making of those suffering from PTSD. This study contributes to previous research and lays the foundation for future research on these topics. The objective of this study is to better understand how those with PTSD are affected by trauma reminders in their daily lives and how this effect may affect their ability to make advantageous decisions. The hope is to incorporate these findings into PTSD treatment and to target emotional numbing symptoms, particularly dampened positive affect, to lead to higher functioning in this population.

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APPENDIX A

FOOTNOTES

[1] A manipulation check was conducted to compare participants' first and second PANAS reports with the second and ensure that the trauma prime had an impact on subjective mood ratings. As expected, paired samples *t*-tests revealed that in the PTSD group, positive affect significantly reduced following the trauma prime (*M*(SD) = 25.3(12.2) reduced to 17.7(6.58), $t(21) = 3.694$, $p = .001$) but not following the neutral prime ($t(21) = -.152$, $p = .880$). In the control group, there was not a significant change in positive affect following either prime (trauma, $t(23) = 1.211$, $p = .238$; neutral, $t(23) = .336$, $p = .740$). In the PTSD group, negative affect significantly increased following the trauma prime (*M*(SD) = 12.9(4.12) increased to 22.7(10.40), $t(21) = -5.606$, $p < .001$) but not following the neutral prime ($t(21) = .071$, $p = .944$). In the control group, negative affect also increased following the trauma prime (*M*(SD) = 11.5(3.13) to 16.5(5.77), $t(23) = -5.523$, $p < .001$) and reduced following the neutral prime (*M*(SD) = 11.30(1.76) to 10.79(1.06), $t(23) = 2.220$, $p = .037$).

[2] After eight participants had completed the study procedures, the VAS was adjusted so that ratings of 0 and ratings of 100 matched the limits of the VAS present on the screen. Prior to this change, the actual range of the VAS went beyond the edges that showed on the screen. After these eight participants and two additional participants completed the study, we added a reminder to participants about which decision they had made. The reminder was a pop-up dialog box that read, "As a reminder, you chose to [PASS/PLAY] on this spinner. Press ENTER to continue." and was inserted after the

outcome of the spinner was shown, before participants rated their decision satisfaction. After excluding these ten participants, results remained the same (including differences between groups in demographic information and total CAPS scores), except for one minor change. In the ANOVA analyzing consummatory pleasure in the passive task, the interaction of Group and Prime that was marginally significant became statistically significant ($F = 4.274$, $p = .046$).

APPENDIX B

TABLES AND FIGURES

Table 1

Participant Descriptive Information

	PTSD (n = 22)	Controls (n = 24)	Total (n = 46)
	n (%)	*n* (%)	*n* (%)
Gender (percent Female)	18 (81.8%)	18 (75%)	36 (78.3%)
Race/Ethnicity			
American Indian/ Alaskan Native	0	1 (4.2%)	1 (2.2%)
Black/African American	8 (36.4%)	10 (41.7%)	18 (39.1%)
Hispanic Latino	2 (9.1%)	2 (8.3%)	4 (8.7%)
White (not Hispanic)	11 (50%)	8 (33.3%)	19 (41.3%)
Biracial	1 (4.5%)	2 (8.3%)	3 (6.5%)
Other	0	1 (4.2%)	1 (2.2%)
	M (SD)	*M* (SD)	*M* (SD)
Age	27.3 (9.6)	27.3 (9.7)	27.3 (9.5)
Total CAPS Symptom Score	33.7 (7.2)	13.9 (6.4)	23.2 (11.9)

Note. Analyses showed a significant difference ($p < .001$) between the two groups in total CAPS score.

Table 2

Reported Expectation/Satisfaction under Both Primes of Each Task

Anticipatory Pleasure in the Passive Task

Group	Overall *M* (SD)	Neutral *M* (SD)	Trauma *M* (SD)	*t*	*df*	*p*
PTSD	50.8 (9.6)	51.6 (8.7)	50.1 (13.9)	0.536	21	0.598
Controls	55.5 (12.1)	56.4 (12.9)	54.6 (13.4)	0.839	23	0.410

Consummatory Pleasure in the Passive Task

Group	Overall *M* (SD)	Neutral *M* (SD)	Trauma *M* (SD)	*t*	*df*	*p*
PTSD	56.6 (8.6)	57.6 (8.8)	55.6 (9.6)	1.474	21	0.155
Controls	58.2 (8.7)	57.4 (8.7)	59.1 (9.7)	-1.286	23	0.211

Anticipatory Pleasure in the Decision-Making Task

Group	Overall *M* (SD)	Neutral *M* (SD)	Trauma *M* (SD)	*t*	*df*	*p*
PTSD	48.5 (8.8)	49.7 (9.2)	47.3 (11.3)	1.068	21	0.297
Controls	54.4 (12.8)	55.2 (11.8)	53.5 (16.2)	0.714	23	0.482

Decision Satisfaction in the Decision-Making Task

Group	Overall *M* (SD)	Neutral *M* (SD)	Trauma *M* (SD)	*t*	*df*	*p*
PTSD	66.7 (10.6)	67.2 (13.9)	66.2 (10.7)	0.367	21	0.718
Controls	65.7 (8.8)	65.5 (8.3)	65.9 (12.2)	-0.158	23	0.876

Note. Paired samples t-tests were used to examine, within each group, reports under each prime of each task.

Figure 1

Spinners Used in Hopper et al. (2008)

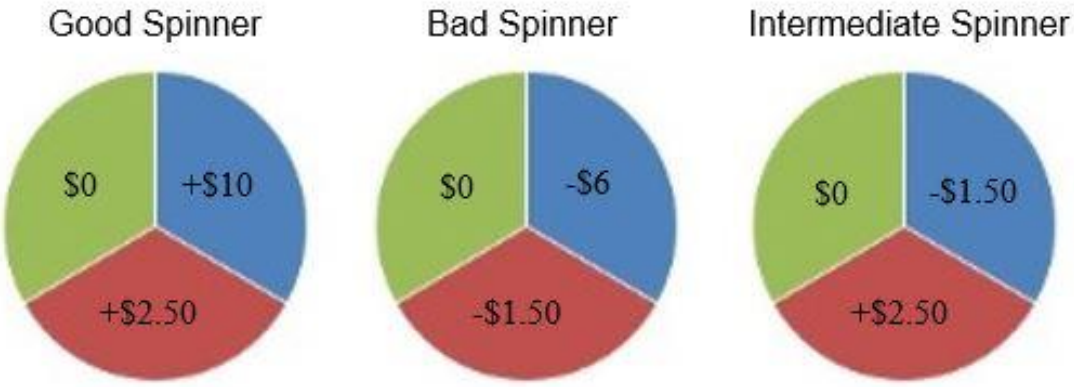


Figure 2

Passive Wheel-of-Fortune Task

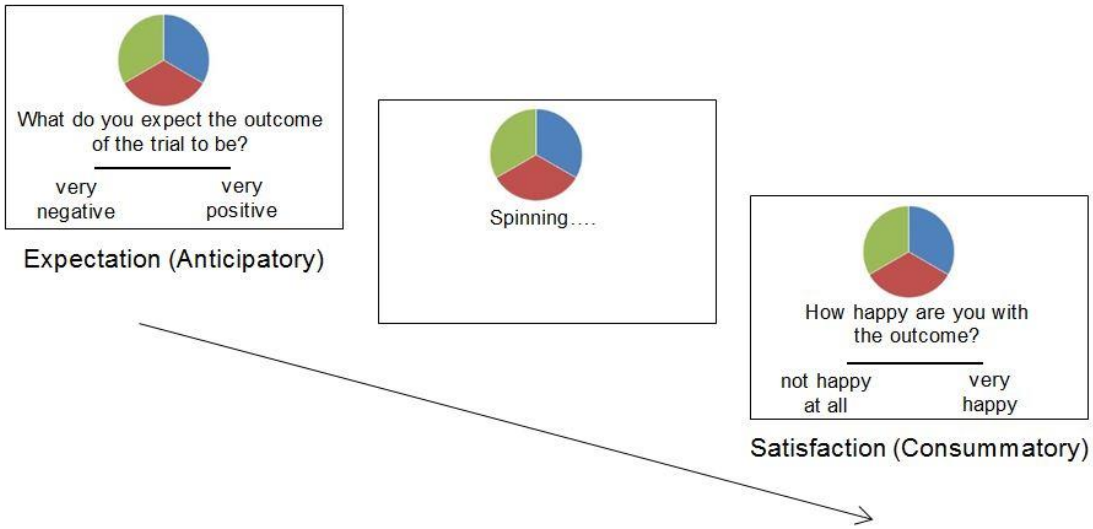
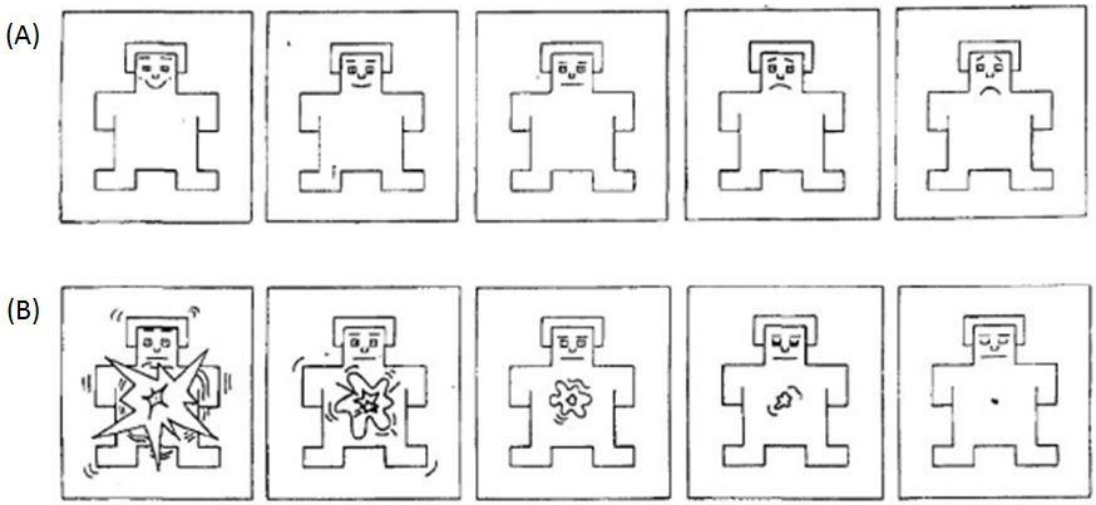


Figure 3

Self-Assessment Manikin



Note. The valence (A) and arousal (B) scales of the SAM.

Figure 4

Spinners Used in the Present Study

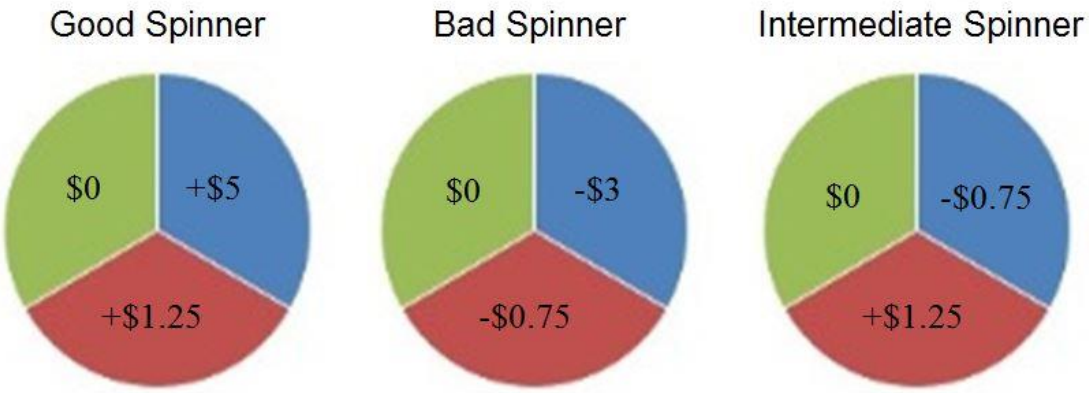
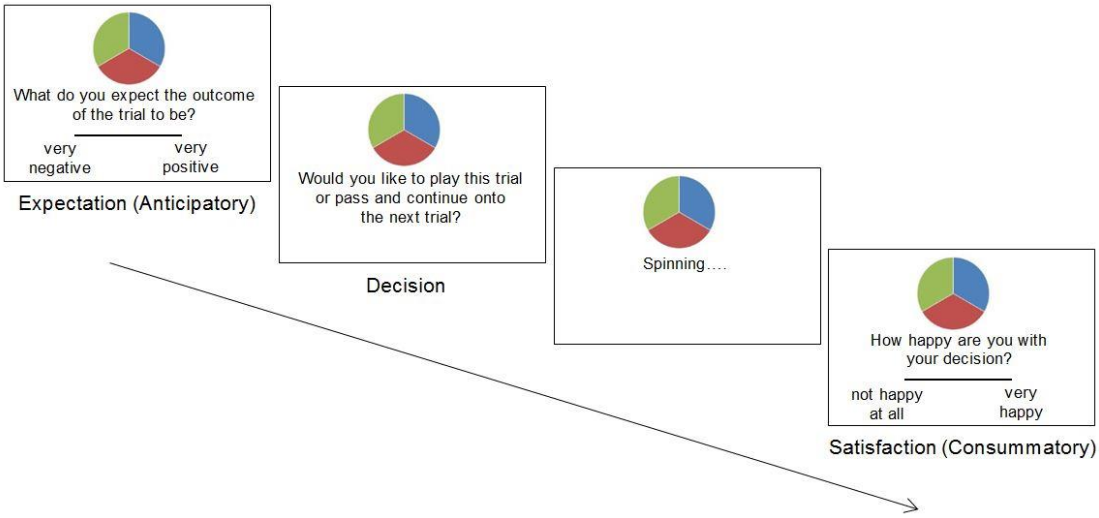


Figure 5

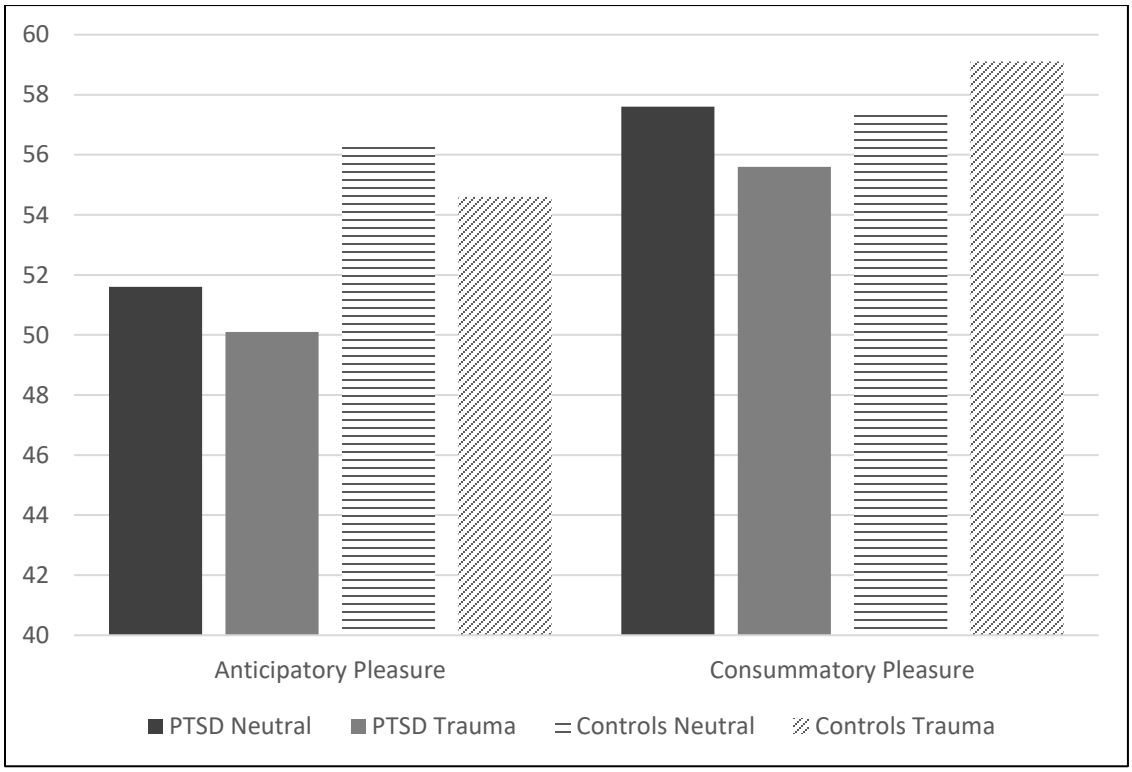
Decision-Making Wheel-of-Fortune Task



Note. If the participant decides to "pass" on the spinner and continue to the next trial, the participant will only see the first two slides and will not see the last two slides. If the participant chooses to "play" the current trial, the participant will see all four slides presented here.

Figure 6

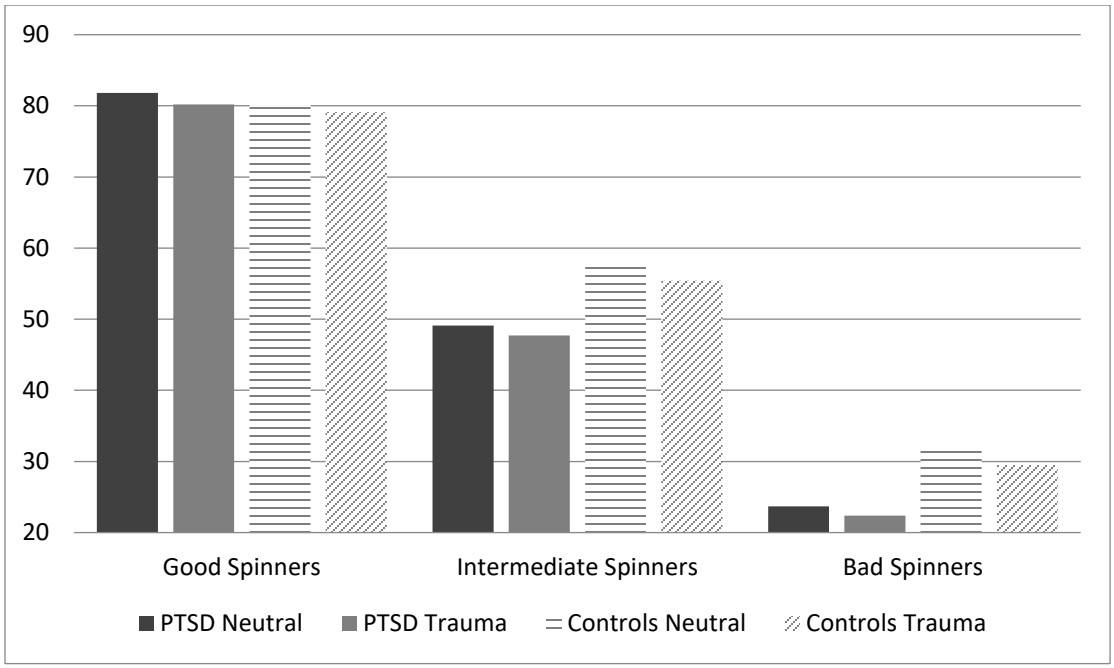
Average Ratings of Anticipatory and Consummatory Pleasure from the Passive Task



Note. Average ratings are broken down by anticipatory and consummatory ratings, group, and prime.

Figure 7

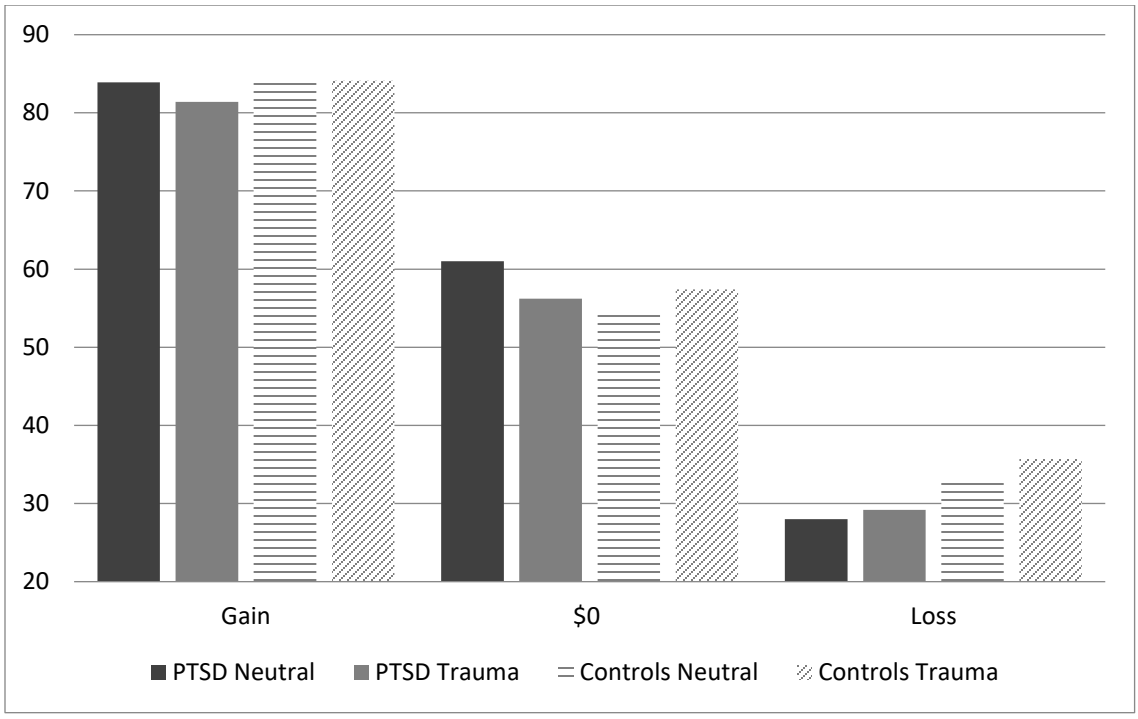
Anticipatory Pleasure from the Passive Task



Note. Average ratings of anticipatory pleasure from the passive task are broken down by group, prime, and type of spinner that was presented.

Figure 8

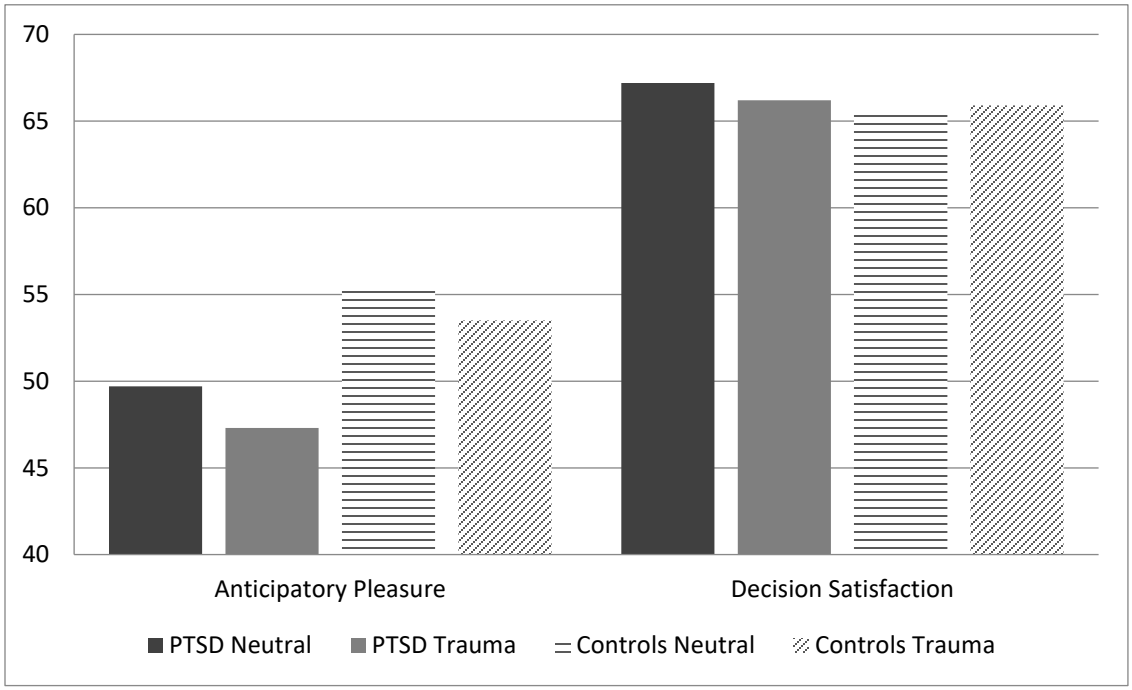
Consummatory Pleasure from the Passive Task



Note. Average ratings of consummatory pleasure from the passive task are broken down by group, prime, and the general type of outcome that was shown.

Figure 9

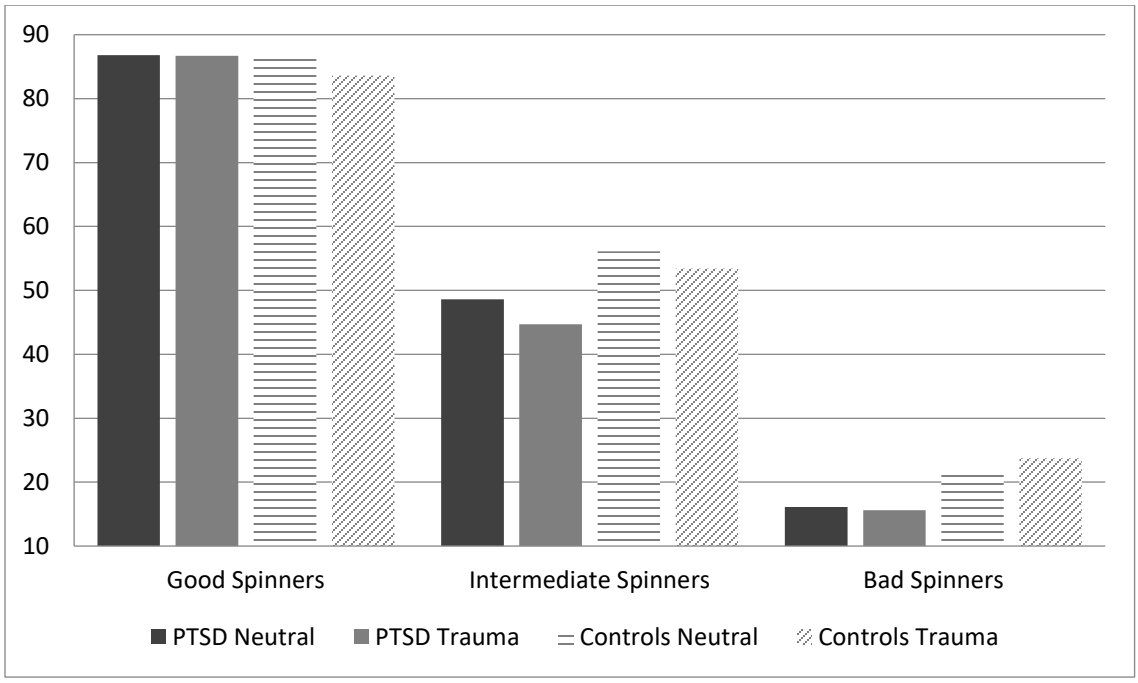
Average Ratings of Anticipatory Pleasure and Decision Satisfaction from the Decision-Making Task



Note. Average ratings on the decision-making task are broken down by anticipatory pleasure and decision satisfaction, group, and prime.

Figure 10

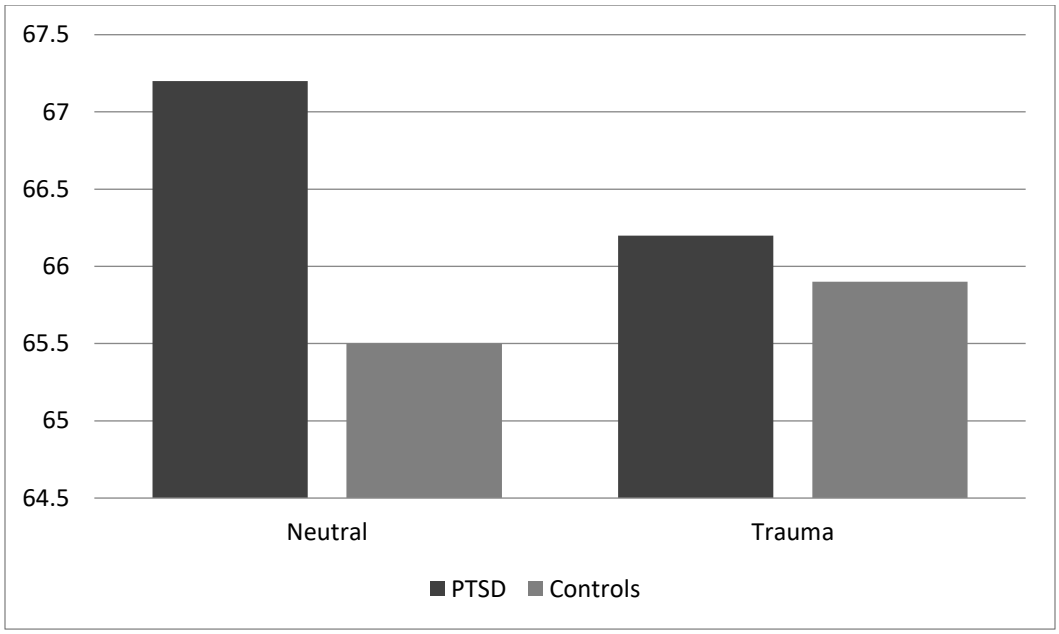
Anticipatory Pleasure from the Decision-Making Task



Note. Average ratings of anticipatory pleasure from the decision-making task are broken down by group, prime, and type of spinner.

Figure 11

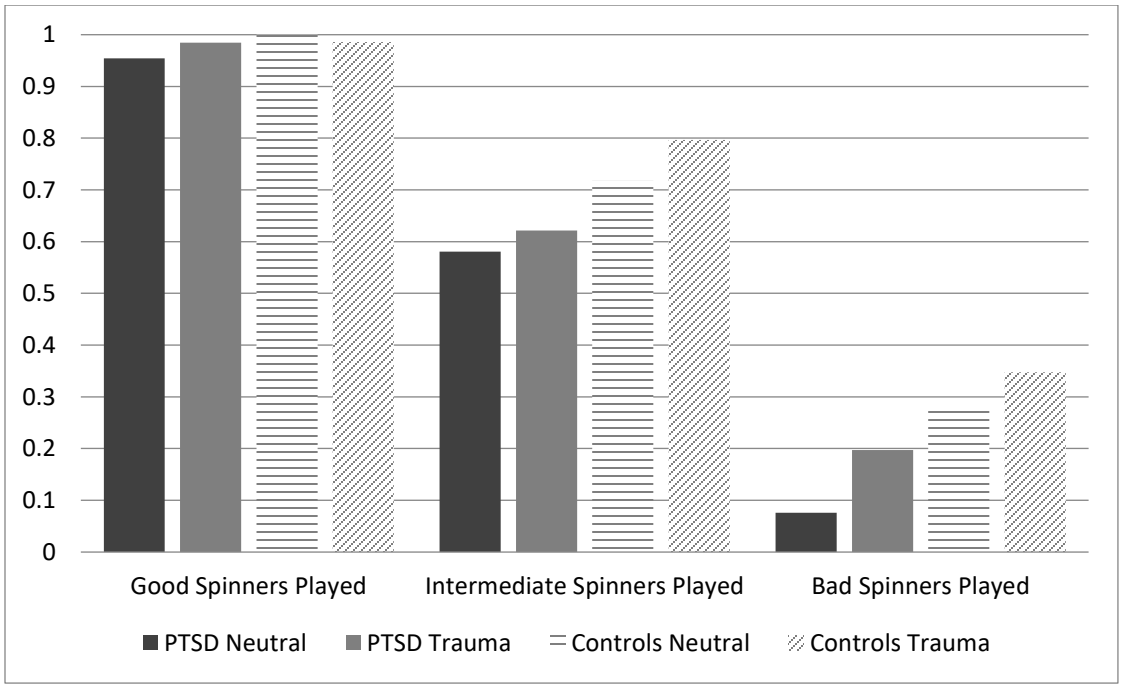
Decision Satisfaction from the Decision-Making Task



Note. Average ratings of decision satisfaction from the decision-making task are broken down by group and prime.

Figure 12

Proportion of Spinners Played



Note. Average proportion of spinners played are broken down by group, prime, and the type of spinner.