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Positive Urgency is Related to Difficulty Inhibiting Prepotent Responses

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Abstract

Positive urgency, the tendency to respond impulsively to positive affective states, has been linked to many psychopathologies, but little is known about mechanisms underpinning this form of impulsivity. We examined whether the Positive Urgency measure related to performance-based measures of impulsivity and cognitive control that were administered after a positive mood induction. Undergraduates ($n = 112$) completed the self-report Positive Urgency measure, several positive mood inductions, and behavioral measures of impulsivity and cognitive control. Positive Urgency scores were significantly related to poor performance on the antisaccade task, a measure of prepotent response inhibition, but not to other performance measures. Together with existing literature, findings implicate deficits in response inhibition as one mechanism involved in emotion-related impulsivity.

Keywords

urgency; positive urgency; impulsivity; cognitive control; response inhibition

A growing literature documents that impulsivity is a transdiagnostic risk factor for psychopathology (Brezo, Paris, & Turecki, 2006). Impulsivity, however, is a very broad construct, with little correlation among the various self-report or behavioral indices (Cyders & Coskunpinar, 2011; Sharma, Markon, & Clark, 2014). Whiteside and Lynam (2001) developed a model of impulsivity that differentiated urgency, defined as tendencies to act impulsively in response to emotions, from other forms of impulsivity, such as sensation seeking, lack of planning, and lack of perseverance. Across studies, urgency has been more closely tied to internalizing and externalizing psychopathologies than other forms of impulsivity such as difficulties with attention and follow-through (Carver, Johnson, & Joormann, 2013; Johnson, Carver, & Joormann, 2013; Dick, Smith, Olausson, et al., 2010).

Impulsive responses to emotion are not restricted to negative emotion, however. A tendency to overreact to positive emotions—called Positive Urgency (Cyders & Smith, 2007)—has

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also been related to externalizing problems (Zapolski, Cyders, & Smith, 2009). In fact, even disorders that are obviously grounded in negative affect, such as depression and anxiety, have been linked to Positive Urgency (Carver, et al., 2013). A recent meta-analysis of studies involving more than 40,000 individuals suggests that Positive as well as Negative Urgency is robustly related to a broad range of internalizing and externalizing outcomes (Berg, Latzman, Bliwise, & Lilienfield, 2015). In sum, support has accrued rapidly suggesting the transdiagnostic importance of impulsive reactions to emotions per se, without regard to the emotion's valence.

Negative Urgency and Positive Urgency are both self-reported tendencies. An important question is how they relate to performance on behavioral measures of impulsivity. The core hypothesis is that they should relate to deficits in inhibiting prepotent responses (Bechara & Van Der Linden, 2005). A good deal more information is available on this hypothesis regarding the Urgency scale (hereafter Negative Urgency) than the Positive Urgency measure. Consistent with this hypothesis, Negative Urgency has been related to poorer performance on several measures of inhibition of prepotent responses. Although null effects have also been observed, many of the null effects were in studies with small samples. To address the inconsistent findings, we calculated a meta-analysis (see Table 1), updating previous meta-analyses on this point (Cyders & Coskunpinar, 2011; Sharma, et al., 2014). In community and clinical samples, we obtained a weighted mean effect size, $r = .11$ for Negative Urgency, and a similar weighted mean effect size, $r = .14$ for Positive Urgency.

Previous meta-analyses also suggest that this effect is relatively specific. In one meta-analysis of 80 studies, Negative Urgency was not related to other performance measures of impulsivity, including delay response, resistance to distractor interference, and resistance to proactive interference (Cyders & Coskunpinar, 2011); in another it was not related to measures of shifting, inattention, or impulsive decision-making (Sharma et al., 2014). Such specificity is not well documented for Positive Urgency, however. Gaining further information on that question was one purpose of the study reported here.

A second purpose of the study was to test a core aspect of the mechanism presumed to underlie urgency effects. Because urgency is defined by impulsive responses to emotions, its influence on behavioral impulsiveness should be exacerbated during states of emotion. Evidence on this point is sparse (the issue was not addressed in the studies cited above). Two studies do bear on the issue, but both are limited. In one, a negative mood induction did not significantly alter the link between Negative Urgency and performance on a go/no-go task, but mood ratings were positive after the negative mood induction, suggesting that it was ineffective (Gunn & Finn, 2015). Another study found that Positive Urgency predicted greater increase in risk taking on the Balloon Analogue Risk Task (BART) after positive mood induction, compared to baseline (Cyders et al., 2010). This study included only the BART as a behavioral measure, however, thus not addressing the specificity of the effect. It is unsure, then, to what extent effects of emotion-related impulsivity on behavioral tasks depend on the existence of emotional states.

To more carefully examine this question, the study reported here examined how Positive Urgency related to a range of performance-based measures of impulsivity after positive mood inductions. We focused on impulsivity in the context of positive moods because negative mood (sadness) tends to produce a variety of properties that go beyond the affective response. Some of these properties (loss of motivation, psychomotor slowing) would likely interfere with performance on the behavioral tasks via pathways in which impulsivity is only a secondary issue. We reasoned that our hypotheses would be better tested using an affective state for which this issue does not arise.

Participants completed a self-report measure of Positive Urgency and a set of behavioral measures of impulsivity and cognitive control. These included inhibition of prepotent responses (antisaccade task), risk taking (the BART and the Risk Perception Scale), resistance to proactive interference (Immediate Memory Task), lack of planning (time to first move on the Tower of London task), and temporal discounting. Drawing on the literature reviewed above, we predicted that Positive Urgency would relate specifically to poor performance on the antisaccade task. Tonic skin conductance level (SCL) was measured throughout (a) as a manipulation check to assess whether the mood inductions elicited autonomic arousal compared to baseline and (b) to investigate whether Positive Urgency predicted greater effects on performance-based impulsivity measures among persons who demonstrated greater sympathetic reactivity.

A final issue addressed here draws on findings shown in Table 1 that the effect sizes for the Negative Urgency measure with response inhibition have been larger in clinical samples, weighted mean $r = .34$ studies than in control or community samples, weighted mean $r = .11$. This suggests the possibility of a curvilinear relationship between response inhibition and emotion-related impulsivity, with more robust linkage at higher levels of impulsivity. This study provided the first direct examination of this possibility, doing so with respect to Positive Urgency.

Method

Participants and Design

All procedures were approved by the university Institutional Review Board. Participants ($n = 112$) were undergraduates (68% female, age $M = 20.82$, $SD = 2.87$) who completed written informed consent before completing study procedures. Participants described their ethnicity as 31% European/Caucasian, 36% Asian, 16% Hispanic/Latino, and 17% other. They reported a mean GPA of 3.47 ($SD = 0.37$) on a four-point scale.

Participants completed a series of experimental manipulations designed to induce happy mood states, interspersed with behavioral indices of impulsivity and cognitive inhibition. Tasks and experimental mood induction procedures were administered in random order. Participants rated their mood only once at the end of the session, because several studies indicate that labeling emotion states diminishes both subjective affect and amygdala response to emotion cues (Lieberman, Inagaki, Tabibnia, & Crockett, 2011). Self-report measures (with the exception of the Risk Perception Scale) were given online before the session. With the exception of Delay Discounting, all tasks were completed via E-prime Studio (version 2.0.10.353). After completing study measures, participants completed funneled debriefing questions about the perceived purpose of the study, whether they noticed a focus on positive moods, whether they had heard about study procedures before the session, and the believability of study procedures. Due to scheduling difficulties, some measures were not administered to the full sample (*N*s for specific analyses are provided in the tables).

Measures of Impulsiveness

Positive Urgency Measure (PUM)—The PUM (Cyders, Smith, Spillane, et al., 2007) is a 14-item self-report scale designed to assess the tendency to act recklessly or inappropriately when experiencing positive emotions (Cyders & Smith, 2008). Participants responded to items on a 4-point scale, ranging from 1 = *Strongly Disagree* to 4 = *Strongly Agree*, maximum score = 56. Positive Urgency has also been found to be distinct from measures of positive affectivity (Cyders & Smith, 2008), and tendencies to respond with positive affect to mood manipulations (Cyders, et al., 2010). Internal consistency for this sample was excellent, alpha = .94. The mean (25.40) and *SD* (8.41) in this sample were comparable to those observed in adult community samples, *M*s = 21 to 28.4, *SD* = 7.29 to 13.17 out of a total possible score of 56 (Muhtadie et al., 2014; Rose & Segrist, 2014; Maher, Thomson & Carlson, 2015).

Antisaccade task—The antisaccade task (Kane, Bleckley, Conway, & Engle, 2001) was designed as a measure of cognitive control and has been validated as a measure of prepotent response inhibition (Miyake & Friedman, 2012). The task includes 50 trials that take one of two forms: prosaccade or antisaccade trials. Each trial begins with a central fixation of three blue asterisks displayed (randomly varying interval from 200 to 2200 ms), followed by a black screen (100 ms). An equal sign is then presented on the left or right side of the screen as a distractor (100 ms). One of three target letters (B, P, or R) is then randomly presented on the left or right side (100 ms). On prosaccade trials, the distractor appears on the same side of the screen as the target. On antisaccade trials, the target letter appears on the opposite side of the screen as the distractor, requiring the participant to rapidly override the tendency to attend to the distractor. The target is followed by a 50 ms mask (the letter H) and then the number 8, both in the same location as the target letter. The "8" stays on the screen until a response is made on the keyboard (but only up to 10 s). For each trial, participants pressed a key labeled to correspond to the target letter.

Participants completed 10 practice trials, then 10 prosaccade trials, 10 antisaccade practice trials, and then 40 antisaccade trials. The index of interest was accuracy on the anti-saccade trials (overall *M* = 0.63, *SD* = 0.16), controlling for accuracy on the prosaccade trials (overall *M* = 0.87, *SD* = 0.12; Roberts, Hager, & Heron, 1994). Reaction time during antisaccade trials (*M* = 907.38 ms) was unrelated to mood or self-ratings of impulsivity this study, and were not examined further.

Immediate Memory Task (IMT)—The IMT (Dougherty, Bjork, Huckabee, et al., 1999) is a variant of a continuous performance test that has been validated as an index of resistance to proactive interference (Friedman & Miyake, 2004). Previous work has shown that resistance to proactive interference and prepotent response inhibition are distinct dimensions of cognitive control (Friedman & Miyake, 2004). In this task, 5-digit numbers appear one-at-a-time on a computer screen and participants are asked to respond whenever two identical number strings appear consecutively. Catch trials are embedded in which numbers are similar but not identical (e.g., 24681 followed by 24618); false alarms are based on (incorrect) key presses in response to these catch trials. Participants have 500 ms to respond; a failure to do so is considered a miss. Participants were not given feedback as to whether their response was correct. Participants completed two five-minute blocks consisting of 25 targets, 25 catch trials, and 51 filler trials (in which numbers are dissimilar from the last number presented), presented in random order. The chief index derived from this task is D', which is equal to the Z score for false alarms minus Z score for correct hits. Scores on the task have been shown to be sensitive to psychopathology as well as to pharmacological manipulation (Dougherty, Bjork, Harper, et al., 2003). Although previous research found no relation between resistance to proactive interference and either Positive or Negative Urgency (Cyders & Coskunpinar, 2012; Gay, et al., 2008), we included this task here because the relation has not been tested after an affect induction.

Balloon Analogue Risk Task (BART)—The BART task was designed as a measure of risk taking (Lejuez et al., 2002). Participants are asked to use key presses to inflate a balloon on the computer screen. They earn one point per pump, and are instructed to earn as many points as possible without popping the balloon; if the balloon pops, no points are earned on that trial (nor are points subtracted). Participants can stop inflating the balloon at any point to collect the points earned for that trial. Balloons pop after a random number of pumps ranging from 6 to 50. At the beginning of the task, participants were told that if they earned 4000 points or more they would be entered into a prize drawing. The task lasted approximately four minutes and consisted of 31 trials (balloons). We assessed performance using proportion of balloons popped (Lejuez, et al., 2002).

Tower of London—The Tower of London task is typically used as a measure of executive function; however, latency to first move has also been used as a measure of impulsivity (Steinberg, 2010). Participants were shown two images on a computer screen. Each image showed three pegs and three different colored balls. Participants were asked to determine how to move the balls from the starting position shown in the top image to the goal position, shown in the lower image, in as few moves as possible, while following specific rules: “only one ball can move at a time” and “a ball cannot be moved if another ball is on top of it.” Before participants were allowed to make any moves, they were asked to imagine the moves they would use to solve the puzzle. Participants were asked to click the mouse once they had solved the problem. They were then asked to enter the number of moves it would take to complete the puzzle. Previous studies have shown that shorter latency to respond is related to poor response inhibition (cf. Steinberg, 2010).

Delay discounting—Delay discounting is a commonly used measure of difficulty in waiting to obtain larger rewards (Bickel & Marsch, 2001). For each of thirty trials, participants were asked to choose between an immediate, smaller reward and a fixed larger reward to be received 1 day, 1 week, 1 month, 6 months or 1 year later (Johnson & Bickel, 2002). Each time delay represented a block, and for each block there were 6 trials. The smaller immediate reward began at $50 and was adjusted trial to trial such that the amount increased in response to a "larger later" decision but decreased in response to the "smaller sooner" decision, while the larger reward remained constant at $100, allowing for the determination of an indifference point for each time delay (cf. Jarmolowicz, Bickel, & Gatchalian, 2013). Monetary rewards were hypothetical, as has been validated previously (Johnson & Bickel, 2002). Discounting rate was calculated by hyperbolic-power discounting function, $V = A/1+kD$ (Mazur & Coe, 1987), where k represents the index of discounting, A is the larger, delayed reward, V is the current value of the reward, and D is the delay. As in previous research, the natural logarithm of the discounting parameter k was used for analyses, and participants were excluded from analysis ($n = 22$) if their pattern of indifference points did not meet previously validated criteria designed to detect persons whose responses are non-systematic (Johnson & Bickel, 2008).

Time estimation—In this task, participants are asked to indicate when they think 1 minute has passed (Dougherty, et al., 2003). Distortions in time perception have been linked to Sensation Seeking (Cyders & Coskunpinar, 2012) and to psychological syndromes characterized by impulsive behavior (Dougherty et al., 2003). Participants are seated at a computer (with no clocks nearby). After receiving instructions, participants press the mouse to begin the trial, and they are instructed to press the mouse again when they believe 1 minute has passed.

Risk Perception Scale (RPS)—The RPS (Weber, Blais, & Betz, 2002) is 40-item self-report scale to assess perceptions of the risk involved in specific actions across five domains: financial risk, social risk, ethical risk, health or safety risk, and recreational risk. Participants were asked to make their "gut level" assessment of the riskiness of each situation on a 5-point Likert scale ranging from 1 = *Not at all risky* to 5 = *Extremely risky*. Internal consistency for this sample was good, Cronbach's alpha = .88.

Mood ratings—High arousal positive (HAP) affect was evaluated at the end of the session. Participants were asked to rate their current mood using three adjectives (Enthusiastic, Active and Amused) on a 5-point Likert scale of 1 = *Very slightly or not at all* to 5 = *Extremely*. The three items were averaged to form a composite score, which demonstrated adequate internal consistency, alpha = .73.

Mood Inductions

Well-validated experimental mood inductions were used to induce and sustain a positive mood state throughout the session.

Thought speed task—In the Thought Speed Task (Pronin & Jacobs, 2008), participants are asked to say aloud 60 statements presented on a computer screen. Each statement automatically scrolls into view one letter at a time in large print (Arial 44-point font), until appearing at full length in the middle of the screen. The statements advance at a speed of 40 ms per letter (with an additional 320 ms between slides), which requires participants to speak rapidly. The first six statements are neutral and become more positive as the task continues (e.g. to "Wow, I feel great!"). This task has been validated as inducing elevating mood, risk-taking and self-confidence (Pronin, 2013; Yang, Friedman-Wheeler, & Pronin, 2014).

Facial symmetry feedback—At the beginning of the session, participants were told that research demonstrates that facial symmetry is related to attractiveness. They were then asked to stand in front of a camera to have their picture taken. The experimenter adjusted the camera to focus on the participant's face. Participants were asked to complete other study procedures while the researcher "analyzed" their photo in "special facial symmetry software." Later in the session, participants were provided with (false) printed results from the facial symmetry software, which described their face as having above average symmetry and stated that 91% of people would be attracted to them. All participants received identical feedback, but each feedback report was tailored to include the participant's unique ID. This manipulation has been shown to induce positive moods (Cyders, Coskunpinar, & Lehman, 2012).

Shape tracing task—This task was introduced as being highly related to intelligence. Participants were provided with a set of figures (from Glass & Singer, 1972), and for each figure, they were asked to trace each line of the figure without raising their pencil from the paper or retracing any lines (Cyders, et al., 2012). They were told that the puzzles tended to be very difficult for most individuals and that, on average, only about 5% of individuals completed all the figures correctly within the allotted 5 minute time limit. The puzzles were actually easy to solve, mean completion time = 1.73 min, $SD = 0.85$. This task has been shown to be effective in inducing a positive mood (Cyders et al., 2012).

Modified Iowa Gambling Task—In this variant (2012) of the Iowa Gambling Task (Bechara, Damasio, Demasio, & Anderson, 1994), participants were told that they would be completing a gambling task. Four card decks were shown on the computer screen, and participants were told that the task would consist of drawing a card from one of the decks for each trial. Participants were informed that every card drawn would either result in a reward or penalty and that there are some "good decks" and some "bad decks." Participants were told that one person would randomly be chosen from all participants of the semester to receive 10% of the money won during the task. The task was rigged with four "good decks" so that all participants would win amounts ranging from $25 to $1250. To enhance believability, slightly less than 25% of the trials had one deck with a non-winning amount ranging from $0 to −$350. Participants completed 100 trials. This modified version of the task has been shown effectively induced a positive mood (Cyders et al., 2012).

Physiological Assessment

Sympathetic activity was indexed by skin conductance level (SCL). SCL was acquired using 8-channel chassis BioLab acquisition software version 2.5 (Mindware Technologies, Gahanna, OH) at 10000 Hz through two snap electrodes attached to participant's non-dominant palm. SCL was measured during a four-minute baseline session, during a 2-minute period at a mid-session after the administration of some of the mood inductions, and during the antisaccade, BART, IMT, Tower of London, and time estimation tasks. SCL was not gathered during the delay discounting task or Risk Perception Scale.

The SCL was calculated using the Mindware EDA 2.10 Module. SCL in each epoch below 1 microSeimen, which is below the expected range of SCL values, likely reflects poor electrode placement or dry hands and were coded as missing. SCL levels for each minute were averaged to index physiological arousal during baseline, at mid-session post mood inductions, and during the tasks.

Potential confounds

At the time of the session, participants were asked to rate hunger levels, caffeine, alcohol, and nicotine use in the past 12 hours, and number of hours of sleep.

Data Analysis Plan

Preliminary correlational analyses considered the effectiveness of the mood inductions and whether mood inductions worked comparably across levels of PUM. To test primary hypotheses, linear and curvilinear associations of the PUM scores with behavioral indices of impulsivity were computed. Correlational analyses were then used to assess whether between-subjects variability in mood state related to performance on the behavioral indices of impulsivity. Finally, regression models were constructed to test whether PUM moderated the effects of mood state on behavioral indices, such that those with higher PUM scores would show more degraded performance in the context of higher arousal and HAP states.

Results

All analyses were completed using IBM SPSS statistics software, version 22. Alpha was set to .05, and all analyses were two-tailed. Eleven participants were excluded from analyses: four for failing more than 50% of catch trials interspersed throughout the battery (e.g. "Please select "4" as your answer for this item"), three because they endorsed taking antipsychotic medications (which could influence cognition and reaction time), two because their limited English skills interfered with comprehending instructions, one because of reporting use of psychoactive substances within hours of arriving for a session, and one who accurately described the study goals during debriefing. After excluding these participants, 101 participants were included in analyses of most measures, with the exception of IMT, Time Estimation and Tower of London, where data were available for only 73 participants. Based on review of the patterns of missing data, missing data on all tasks except delay discounting were deemed to be missing at random; thus, missing data for the other performance tasks and SCL were imputed with Norm software version 2.03 using maximum likelihood estimation (Schafer, 2000). Distributions approximated normalcy. As expected, performance-based impulsivity measures were not significantly correlated with each other, $|r\text{s}| < .14$, *ns*.

Impulsivity performance scores were not related to caffeine, alcohol, nicotine use, hours of sleep, nor hunger ratings, with the exception that alcohol use in the past 12 hours was related to poorer performance on the antisaccade task, $r = -.22$, $N = 101$, $p = .03$. Task order and mood induction order were unrelated to performance on the impulsivity tasks or to the effectiveness of the mood inductions, all Fs < 1.65, ps > .11. Because controlling for alcohol and caffeine use did not substantively change effects noted below, analyses are presented without control over these variables. PUM scores did not differ significantly between females, $M = 24.79$ ($SD = 8.68$) and males, $M = 26.88$ ($SD = 7.79$), $t(98) = 1.17$, $p = .24$.

Effectiveness of the Mood Inductions

Participants showed greater sympathetic activation (SCL) at mid-session after the administration of mood induction procedures as compared to baseline (Wilcoxon signed rank $z = 7.30$, $n = 101$, $p < .001$)[1], indicating that the mood inductions were effective in activating sympathetic arousal. At the end of the session, the average HAP mood rating was 2.51 ($SD = 0.88$) on the five-point scale, intermittent between *mild* and *moderate* levels of HAP.

Mood inductions worked comparably across PUM levels, consistent with previous findings (Cyders, Zapolski et al., 2010). That is, PUM scores were not significantly related to self-rated HAP, $r = .05$, $N = 101$, $p = .61$, nor to sympathetic reactivity, as indexed by mid-session SCL controlling for baseline SCL, semi-partial $r(98) = -0.16$, $p = .11$.

Correlations of PUM with Performance-Based Measures of Impulsivity

As shown in Table 2, PUM was not significantly related to performance-based measures of impulsivity, all *r*s < .12, and was correlated opposite to the expected direction with IMT and Time Estimation. PUM scores did, however, have a significant curvilinear relationship with antisaccade performance, R^2 change ($N = 101$) = .07, $p = .04$. As shown in Figure 1, antisaccade performance deteriorated as PUM scores reached a higher range. Supplementary regression analyses suggested that gender did not significantly moderate the associations of PUM scores with any of the performance-based measures of impulsivity, all part *r*s < .02, *ns*.

Mood State Influences

Bivariate correlations were used to assess whether performance measures of impulsivity were influenced by mood state. As shown in Table 2, of the 20 correlations only one was significant, that of HAP ratings with BART performance. People who showed a larger response to the mood inductions, then, did not seem to be more impulsive on the behavioral tasks, with the exception of increased willingness to take risks on the BART task.

To test whether PUM moderated mood state effects on performance-based measures, simultaneous regression models were constructed to assess interactions of PUM with task SCL, controlling for baseline SCL in the first block, on the impulsivity tasks. Separate models were computed for the antisaccade task, BART, IMT, Tower of London, and Time Estimation. PUM scores did not interact significantly with SCL levels in the prediction of any of these tasks, $\beta_{\text{antisaccade task}} = .05$, $p = .61$, $\beta_{\text{BART}} = .15$, $p = .14$, $\beta_{\text{IMT}} = .22$, $p = .09$, $\beta_{\text{Time estimation}} = .05$, $p = .73$, $\beta_{\text{Tower of London}} = .21$, $p = .18$. Similar regression models were constructed to assess the interactions of PUM with HAP scores. No significant interactions were observed of PUM scores with HAP scores, $\beta_{\text{antisaccade task}} = .11$, $p = .30$, $\beta_{\text{BART}} = .09$, $p = .38$, $\beta_{\text{IMT}} = -.01$, $p = .95$, $\beta_{\text{Tower of London}} = .08$, $p = .49$, $\beta_{\text{Delay discounting}} = .17$, $p = .13$, with the exception of Time Estimation, which was opposite to the expected direction

[1]A Wilcoxon signed rank test was used because the SCL data violated the assumption of normally distributed differences.

$\beta_{\text{Time estimation}} = -.27$, $p = .02$. Thus, higher happiness ratings and task-related sympathetic arousal did not seem tied to a differential decrement in performance on impulsivity tasks for those with high PUM scores.

Discussion

Self-reported emotion-related impulsivity is a potentially important construct for understanding psychopathology. Yet relatively little research has examined how this variable relates to behavioral indices of impulsivity. The study reported here examined associations between self-reported positive urgency and several performance-based measures of impulsivity, which were administered after positive mood inductions.

Our findings provide evidence of both convergent and discriminant validity. There was convergence between Positive Urgency and prepotent response inhibition, as indexed by the antisaccade task. There was also evidence of discriminant validity, in the fact that Positive Urgency did not relate to other performance-based measures. Positive Urgency scores also were not tied to emotional hyper-reactivity, as indexed by affect ratings or physiological arousal, which is consistent with previous findings (Cyders et al., 2010).

This pattern of convergent and discriminant findings is conceptually consistent with evidence from a previous meta-analysis indicating that the Negative Urgency scale relates to deficits in prepotent response inhibition, but not to other forms of impulsive behavior (Cyders & Coskunpinar, 2011). Our findings extend that pattern to Positive Urgency.

It is important to note that the relationship between PUM scores and antisaccade performance was curvilinear rather than linear. Deficits in response inhibition were apparent only among persons with relatively high PUM scores, suggesting that this difficulty may emerge only among persons with pronounced tendencies to respond impulsively to emotion. This is a possibility that should be explored in future research, including research on Negative Urgency.

Independent of Positive Urgency, this study found evidence that high arousal positive mood states overall predicted greater willingness to take risks on the BART. This is consistent with previous findings (Cyders & Coskunpinar, 2010). Our finding suggests that positive mood shifts per se may be more influential for risk taking than for other manifestations of impulsivity (cf. Isen, 2000). This suggests a more specific model of which aspect of impulsivity is likely to emerge during high arousal positive mood states, which should be subjected to further testing.

Several limitations must be noted. First, the cross-sectional nature of the design precludes any comments about causality. Second, many of the performance-based tasks have themselves had relatively little validity testing to ensure that they do assess the behavioral property they are assumed to assess; indeed, recent research suggests that many may capture a broader range of constructs than is widely assumed (Sharma et al., 2014). Third, the sample was composed of undergraduate at a competitive university, and so it will be important to assess whether findings generalize to community samples. We would note, however, that the mean and variability of Positive Urgency in this sample were comparable to that observed general community samples, and college students may be in a developmental period of relatively high impulsivity (Steinberg, Albert et al., 2008; Forbes & Dahl, 2010).

Another important limitation is that we found little evidence that the mood inductions we employed had much bearing on performance-based impulsivity measures. That is, the effect size of Positive Urgency with response inhibition obtained here is similar to findings of studies that did not employ mood induction procedures. Even though we used well-validated procedures and observed significantly higher physiological arousal levels after mood induction compared to baseline, participants rated their moods as only mildly to moderately positive at the end of the session. Given the modest effects of the mood induction in our own study and other studies of response inhibition (Gunn & Finn, 2015), it remains difficult to make a clear statement about the role of mood state in driving deficits.

We also observed no significant interaction of Positive Urgency with the degree of mood or physiological arousal elevation on performance, although we were relatively underpowered for examining interactions. This absence of interaction may be attributable to the relatively low intensity of the affect created. Future work should perhaps turn to more intense affects, such as anger or fear. Another possibility is that further research use ambulatory monitoring of natural variation in mood state to more carefully assess whether highly elevated mood states interfere with response inhibition for persons with high levels of Positive Urgency.

Despite these limitations, understanding the mechanisms involved in emotion-relevant impulsivity remains an important goal. Our findings suggest that emotion-relevant impulsivity may be related to deficits in prepotent response inhibition. This finding is intriguing in that both emotion-relevant impulsivity (Berg, et al., 2015; Smith, Fischer, Cyders, et al., 2007) and response inhibition (Wright, Lipszyc, et al., 2014) have been found to be relevant to a broad range of psychopathologies. It is intriguing that emotion-relevant impulsivity appears to be fairly specifically linked to problems with response inhibition, and not other aspects of neurocognitive or impulsive performance. Difficulties with response inhibition also appear not to be evident until scores are in the higher ranges of the Positive Urgency scale. These findings provide a foundation for neural, cognitive remediation, and therapeutic research. To the extent that emotion-relevant impulsivity turns out to involve cognitive vulnerability, it will be important to consider interventions for people with this form of impulsivity that do not depend heavily on cognitive control.

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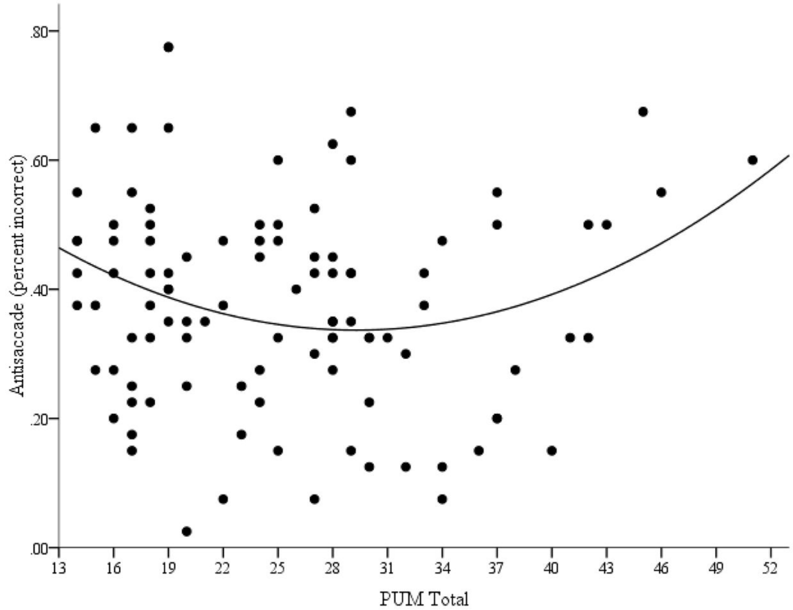

Figure 1.
Curvilinear relationship between PUM and performance on the antisaccade task

Table 1

Effect sizes (r) in previous studies of Negative or Positive Urgency and Response Inhibition

Author, year	Sample	Urgency measure	Performance-based measure	NUM in student or community samples	*n*	PUM in student or community samples	*n*	NUM in clinical samples	*n*
Bagge, Littlefield, Rosellini, & Coffey, 2013	Suicide attempters	UPPS	Go Stop	--		--		0.31	69
Billieux, Gay, Rochat, & Van der Linden, 2010	Community volunteers	French UPPS	Emotional Stop Signal	0.06	95	--		--	
Cyders and Coskunpinar, 2012	Undergraduates	UPPS-P	Go Stop Task (50 and 350 msec trials)	−0.04	77	0.11	77	--	
Denny & Siemer, 2010	Undergraduates	UPPS-P	Emotional Go-No Go	0.18	112	0.16	112	--	
Gay, Rochat, Billieux, d'Acremont, Van der Linden, 2008	Community volunteers	UPPS	Go-No Go	0.17	126	--		--	
Gunn & Finn, 2015	Undergraduates	NUM	Cued Go-No Go false alarm rate			--		--	
Jacob et al., 2010	Women with borderline personality disorder and controls	UPPS	Stroop (.27), Antisaccade errors (.14), and Stop Signal (.21) (AVG)	0.21	15	--		--	
Perales, Verdejo-Garcia, Moya, Lozano, & Perez-Garcia, 2009	Women with high and low UPPS total scores	Spanish UPPS-P	Go-No Go false alarm rate 1st 2 blocks	0.16	32	0.17	32	--	
Roberts, Fillmore, & Milich, 2011	ADHD and controls	UPPS	Cued Go-No Go (−.17), Manual Stopping Task (−.05), Visual Stopping Task (.03), Delayed Ocular Response Task (−.01)	−0.05	28	--		0.23	30
Rochat, Beni, Annoni, Vuadens, & Van der Linden, 2013	Patients with traumatic brain injury and matched controls	UPPS	Stop Signal reaction time	−0.04	27	--		0.54	28
Wilbertz, Deserno, Hortstmann, et al., 2014	High and low BIS scorers	UPPS	Stop Signal reaction time	0.28	26	--		--	
Total sample size					538		221		127
Weighted Mean effect *r*				0.11		0.14		0.34	

Notes: Torres et al. (2013) effect size was not available.

BIS = Barrett Impulsivity Scale; NUM = Negative Urgency; PUM = Positive Urgency Measure; UPPS = Impulsive Behavior Scale; UPPS-P = Impulsive Behavior Scale – Positive Urgency

Perales also examined the D2.

Table 2

Pearson correlations of impulsivity measures with mood and physiology (N = 101 except where noted)

	PUM	**Antisaccade**	**BART**	**IMT (*n* = 72)**	**Tower of London latency 6(*n* = 72)**	**Time Estimation (*n* = 70)**	**RPS (*n* = 100)**	**Delay Discounting (*n* = 79)**
SCL	n/a	−.01	.07	.04	−.16	−.02	not acquired	not acquired
HAP	.05	−.07	.27**	−.14	−.03	−.01	.00	n/a
PUM		−.04	.03	−.23	.09	−.13	.12	n/a
Antisaccade			−.06	.13	.17	.02	−.06	−.06
BART				−.05	−.03	.01	.32**	.03
IMT					−.03	−.01	−.01	.06
Tower of London latency						−.22	−.04	−.03
Time Estimation							.30*	−.04
RPS								.02

Note. BART = Balloon Risk Taking Task; HAP = High Arousal Positive affect rating at the end of the session; IMT = Immediate Memory Task; PUM = Positive Urgency Measure; SCL = Tonic Skin Conductance during task, controlling for baseline SCL; RPS = Risk Perception Scale

n/a = not applicable

* $p < .05$

** $p < .01$