Empirical Article

Clinical Psychological Science
2017, Vol. 5(6) 943–951

DOI: 10.1177/2167702617718181
www.psychologicalscience.org/CPS

Willingness to Expend Effort Toward Reward and Extreme Ambitions in Bipolar I Disorder

Sheri L. Johnson[1], Benjamin A. Swerdlow[1], Michael Treadway[2], Jordan A. Tharp[1], and Charles S. Carver[3]
[1]University of California, Berkeley; [2]Emory University; and [3]University of Miami

Abstract
More than a dozen recent studies have shown that bipolar disorder and key outcomes within bipolar disorder are related to heightened willingness to pursue extremely ambitious life goals, as measured by the Willingly Approached Set of Statistically Unlikely Pursuits (WASSUP). Although it has been argued that this willingness to pursue difficult lifetime ambitions in bipolar disorder could reflect willingness to expend effort toward reward, this has not been tested to date. In this study, 50 individuals with bipolar I disorder were followed until they achieved remission. They then completed the Effort Expenditure for Rewards Task (EEfRT) and the WASSUP. Scores on the WASSUP Financial Success subscale, but not the Popular Fame subscale, were significantly associated with decision making on the EEfRT, even after controlling for significant effects of reward magnitude, gender, and age. These two indices appear to measure related facets of reward sensitivity.

Keywords
reward, ambition, bipolar disorder, EEfRT, approach motivation

Received 7/18/16; Revision accepted 5/12/17

The RDoC initiative (Cuthbert, 2005) has led to a spate of research on the reward system and its role in psychopathology (Treadway & Zald, 2013). Increasingly, research in this vein has focused on the specific dimensions of psychopathology that are most relevant to reward functioning, such as anhedonia and melancholia (e.g., Liu, Sarapas, & Shankman, 2016; Treadway, Buckholtz, Schwartzman, Lambert, & Zald, 2009). In keeping with this trend toward greater specificity, whereas considerable research indicates that bipolar disorder involves a heightened sensitivity to reward, it has been argued that this model may be overly broad and that only certain aspects of the reward system may be dysregulated in bipolar disorder (Johnson, Edge, Holmes, & Carver, 2012). Specifically, a growing body of work suggests that bipolar disorder is characterized by an unusual willingness to set extremely ambitious life goals.

The willingness to set ambitious life goals has been measured most commonly using a self-report questionnaire called the Willingly Approached Set of Statistically Unlikely Pursuits (WASSUP; Johnson & Carver, 2006). Respondents rate the likelihood they will set difficult to attain lifetime goals, such as earning more than $20 million or appearing regularly on TV. Across more than a dozen studies, the WASSUP has been consistently linked to bipolar disorder, risk for bipolar disorder (as measured by subsyndromal mania), and related outcomes. Two subscales of the WASSUP in particular, those relating to the pursuit of fame (Popular Fame) and wealth (Financial Success), have been found to have elevated responses among persons diagnosed with bipolar disorder, as well as persons with subsyndromal symptoms of mania (for review see Johnson, Edge, et al., 2012). The WASSUP subscales have also been found to predict the onset of bipolar disorder (Alloy et al., 2012) and a more severe course of mania over time among those diagnosed with bipolar I disorder

Corresponding Author:
Sheri L. Johnson, Department of Psychology, University of California, Berkeley, 3210 Tolman Hall, Berkeley, CA 94720
E-mail: sljohnson@berkeley.edu

(Johnson, Carver, & Gotlib, 2012). At the same time, scores on the WASSUP have been linked to positive outcomes associated with the bipolar spectrum, such as lifetime creative accomplishment (Johnson, Murray, et al., 2015; Ruiter & Johnson, 2015). In parallel, researchers have found that those with high risk for mania describe themselves as highly ambitious (Eckblad & Chapman, 1986), and when asked to describe life goals in an open-ended narrative, the degree of ambition predicts a more severe course of mania (Tharp, Johnson, Sinclair, & Kumar, 2016). Overall, these bipolar-relevant effects associated with the WASSUP scale have been consistent, but small to moderate in magnitude. Nonetheless, it is striking that these effects appear to persist even in more severe clinical samples, suggesting that the ambitions that the WASSUP taps into are remarkably resilient to the considerable adversity often encountered by, and lower level of functioning sometimes observed in, persons with bipolar disorder. The phenomenon of heightened ambition is thought to be distinctive to bipolar disorder (see Johnson, Carver, et al., 2012, for further discussion).

Relatively little is known about mechanisms supporting this tendency to set ambitious goals. One possibility is that it might reflect elevated confidence. Little support has been found for this idea, however, as ambition and overconfidence appear relatively independent (Johnson, Freeman, & Staudenmaier, 2015). In another study, ambitious goal setting, as measured by the WASSUP, was tied to greater perseverance on a difficult creativity task (Ruiter & Johnson, 2015). This suggests that a willingness to expend great effort toward reward is related to the willingness to pursue difficult life ambitions (Johnson, Edge, et al., 2012). Specifically, it is possible that those who set extremely high life goals might show an insensitivity to degree of effort expenditure in the pursuit of reward.

Extensive animal research suggests that striatal dopaminergic function is necessary to support the pursuit of rewards requiring greater effort (high cost/high reward option over a low cost/low reward option (Salamone, Correa, Farrar, & Mingote, 2007). In humans, several tasks have been developed to assess this effort-based decision making in humans, typically using monetary incentives. Treadway and colleagues (2009) developed a finger pressing task called the Effort Expenditure for Rewards Task (EEfRT) to parametrically assess willingness to exert effort for varying amounts of reward. Lack of motivation, as indexed on the EEfRT, has been observed among persons diagnosed with major depressive disorder (Treadway, Bossaller, Shelton, & Zald, 2012), persons with subsyndromal depressive symptoms (Yang et al., 2014), and persons with schizophrenia (Fervaha et al., 2013). Willingness to work for rewards on the EEfRT has also been found to be enhanced in a dose-dependent manner by administration of the dopamine (DA) agonist *d*-amphetamine (Wardle, Treadway, Mayo, Zald, & de Wit, 2011). This finding is particularly relevant given the role that dopamine sensitivity plays in the specific reward processing characteristics of bipolar disorder (Whitton, Treadway, & Pizzagalli, 2015) and in light of recent work showing that scores on the WASSUP scales are associated with spontaneous eye blink, an indicator of striatal dopamine function, in individuals with bipolar disorder preparing for a reward task (Peckham & Johnson, 2016).

In the study reported here we tested the hypothesis that setting highly ambitious life goals would be related to effort-based decision making among persons with bipolar disorder. Persons diagnosed with bipolar I disorder were followed until they achieved symptom remission, and they then completed the EEfRT and the WASSUP. We focus on the relationship between the EEfRT and the WASSUP Popular Fame and Financial Success subscales.

Method

All procedures were approved by the institutional review board before data collection began.

Participants

Participants from the San Francisco Bay Area were recruited from online advertisements, community flyers, and clinical referrals. Participants were 50 individuals between the ages of 18 and 60 diagnosed with remitted bipolar I disorder. Individuals were excluded if they were not fluent English speakers. Additional exclusion criteria included primary psychotic disorder, diagnosis of substance abuse or dependence in the past 6 months, brain injury or disease, medical conditions impairing the central nervous system, impaired mental status, or developmental disability that would hinder task completion, daily substance use, and electroconvulsive treatment in the past 18 months. Participant ethnicities were self-reported as 76% Caucasian, 10% Asian American, 4% African American, and 10% other.

Measures

Structured Clinical Interview for* DSM-IV *(SCID). The SCID (First, Spitzer, Gibbon, & Williams, 1995), a well-validated semistructured interview, is the most commonly used system for diagnosing major *DSM* disorders. Clinical psychology graduate students completed intensive role-play training and established excellent reliability before administering study interviews. Ten randomly selected audio recorded interviews (a mixture of diagnostic background,

recruited across studies) were selected for interrater agreement; absolute agreement was high (intraclass *r*s = .88–.89 for current mania, lifetime mania, lifetime major depressive episode, .99 for current major depressive episode, and ≥.99 for mania and depression symptom severity. Age of onset, number of episodes and previous hospitalizations were assessed during the SCID interview).

Medications. Medication regimens and adherence were assessed by interview, and scored to create dose equivalency scores per medication class, adjusting for nonadherence levels, based on the somatotherapy index (Bauer et al., 1997). Antidepressant dosages were converted to imipramine equivalents; atypical antipsychotic dosages were converted to a dose equivalency for risperidone. Of the 50 people, 39 were taking at least one medication, with 25 taking multiple medications (19 were taking atypical antipsychotics, 17 were taking antidepressants, 15 were taking lithium, 12 were taking lamotrigine, and 6 were taking anticonvulsants). Mean doses for each class of medication are shown in Table 1.

Young Mania Rating Scale (YMRS). The YMRS (Young, Biggs, Ziegler, & Meyer, 1978) is a standardized interview designed to assess manic symptom severity. The YMRS has strong predictive validity for outcomes such as duration of hospital stay (Young et al., 1978). Similar training and reliability procedures as the SCID were completed using four randomly selected recordings prior to interviews. Interrater reliability for this sample was excellent (intraclass $r > .99$).

Modified Hamilton Rating Scale for Depression (MHRSD). The MHRSD (Miller, Bishop, Norman, & Maddever, 1985) is a standardized symptom severity interview that is widely used to assess depressive symptom severity. This modification of the original version (Hamilton, 1967) contains interview probes and detailed anchor points for each rating. The scale has been validated in bipolar disorder (Gonzalez-Pinto et al., 2003; Johnson et al., 2008). As with YMRS, interviewers completed reliability training on four randomly selected tapes. Interrater reliability for was high ($r = .99$).

Altman Self-Rating Mania Scale (ASRM). The ASRM (Altman, Hedeker, Peterson, & Davis, 1997) is a self-report current symptom severity questionnaire assessing the key features of mania: elevated mood, inflated confidence, decreased need for sleep, excessive physical activity, and talkativeness. Participants responded to each of the five items by choosing one of five statements that best fit their current mood (i.e., "I do not talk more than usual" to "I talk constantly and cannot be interrupted"). For this sample, internal consistency was good ($\alpha = .73$).

Table 1. Descriptive Data ($N = 50$)

Variable	*M* (*SD*)
Age	35.52 (11.67)
Percentage female	53.4
Years education	15.17 (1.85)
Hollingshead socioeconomic status	5.28 (2.21)
Percentage employed	45.6
Percentage with anxiety disorder	58.6
Percentage with past substance use disorder	59.6
WASSUP Financial Success	7.9 (3.87)
WASSUP Popular Fame	11.38 (5.37)
EEfRT percentage hard trials selected	51.38 (26.5)
EEfRT percentage trials completed	94.88 (12.05)
EEfRT total winnings before payout selected	43.07 (9.72)
Manic symptom level (YMRS)	1.58 (2.00)
Depressive symptom level (MHRSD)	2.84 (2.56)
Manic symptom level (ASRM)	3.10 (2.63)
Depressive symptom level (BDI-SF)	3.83 (3.11)
Age of first manic episode	20.94 (7.16)
Number of previous manic episodes	7.45 (8.15)
Previous hospitalizations for mania	1.75 (2.51)
Age of first MDE	15.26 (8.80)
Number of previous MDEs	8.85 (9.53)
Previous hospitalizations for MDE	0.54 (1.13)
Lithium dose (mg)	894.22 (388.92)
Imipramine equivalency dose (mg)	183.97 (95.15)
Risperidone equivalency dose (mg)	4.63 (4.29)
Anticonvulsant dose (mg)	0.47 (0.25)
Lamotrigine dose (mg)	208.88 (92.56)
Wechsler backward digit span	7.73 (2.15)

Note: ASRM = Altman Self-Rating Mania Scale; BDI-SF = Beck Depression Inventory–Short Form; EEfRT = Effort Expenditure for Rewards Task; MDE = Major Depressive Episode; MHRSD = Modified Hamilton Rating Scale for Depression; WASSUP = Willingly Approached Set of Statistically Unlikely Pursuits; YMRS = Young Mania Rating Scale.

Beck Depression Inventory–Short Form (BDI-SF). The BDI-SF (Beck, Steer, & Brown, 1996) is based on the original 21-item measure (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) assessing current depressive symptoms, such as hopelessness, guilt, and decreased energy. Participants responded to each of the 13 items by choosing one of four statements, ranging from no endorsement (i.e., "I do not feel sad") to full endorsement (i.e., "I feel so sad or unhappy that I can't stand it"). The BDI-SF is validly correlated with other indices of depression severity, such as the Depression Anxiety Stress Scale and HRSD (Lovibond & Lovibond, 1995; Steer, Beck, Riskind, & Brown, 1987). Internal consistency in this sample was high ($\alpha = .84$).

Willingly Approached Set of Statistically Unlikely Pursuits (WASSUP), Popular Fame and Financial Success subscales. The WASSUP (Johnson & Carver, 2006) self-report measure was designed to assess extremely high life ambitions. Scores on two of the subscales,

Popular Fame (7 items) and Financial Success (4 items), have been consistently found to be elevated among persons with bipolar disorder (cf. Johnson, Carver, et al., 2012). Participants indicate on each of the items how likely they are to set a specific life goal (e.g., "You will have 20 million dollars or more") on a 5-point scale (1 = *no chance I will set this goal for myself* to 5 = *definitely will set this goal for myself*). The internal consistency alpha coefficients of .85 for Popular Fame and .71 for Financial Success for scores in this sample were adequate. The two subscales were highly intercorrelated (r = .66).

Weschler Reverse Digit Span. We included the reverse digit span subscale of the Wechsler Adult Intelligence Scale, Fourth Edition (Wechsler, 2008) as a control variable given the robust deficits in various facets of executive function observed among adults with bipolar I disorder (Tsitsipa & Fountaoulakis, 2015). Span tasks are the most commonly used index of working memory.

Effort Expenditure for Rewards Task (EEfRT). The EEfRT (Treadway et al., 2009) was developed for humans based on animal research (Salamone, Cousins, McCullough, Carriero, & Berkowitz, 1994). For each trial, participants are given the option to choose an easy task, which requires 30 key presses with the index finger of the dominant hand in 7 s, or a hard task, which requires 100 key presses with the pinky finger of the nondominant hand in 21 s.

Participants were eligible to win money on each successful (difficult or easy) trial only 50% of the time. Monetary rewards were fixed at $1.00 for "easy" trials, but varied from $1.24 to $4.30 for the "hard" trials. A rectangular box showed progress toward the goal. Trials were presented in random order. Slightly fewer than half (23) of the participants completed a version of the EEfRT that included "bonus" trials designed to increase the salience of reward in the task. In this version of the EEfRT, three bonus trials randomly appeared within the first 20 trials; participants automatically won $3.00 for each bonus trial without having to make any choice or key press. Pooled data from other published and unpublished samples using the EEfRT (pooled n = 800) show that participants are robustly more likely to choose the high effort option as the reward level increases, $F(2, 732) = 876.89$, $p = 4.696 \times 10^{-195}$, partial $\eta^2 = .71$, indicating that participants find the hard task to be advantageous at least some of the time.

Each trial began with a 1-s fixation. Participants were then shown the amount of the reward that they could win if they chose the "hard" task. Participants were given 5 s to choose the task difficulty by pressing the corresponding difficulty level key on the keyboard. If they did not make their decision within the 5-s period, they were randomly assigned a difficulty level. After the selection was made, a preparation screen ("Ready?") appeared for 1 s, and then participants were given 7 or 21 s, depending on their choice, to make key presses. Then a screen displayed feedback about whether they had completed the task (2 s), followed by feedback about trial earnings (5 s; e.g., "You won $3.42" or "No money won").

Experimenters reviewed the instructions of the task carefully with participants by gradually introducing each part of the task (e.g., the button press, the choice of the hard versus easy task, the varying worth of the hard trials). Before beginning the task, participants completed four practice trials to ensure that they comprehended the task. Participants were then told they would receive money with their session payment for two randomly selected trials they successfully won. Therefore, the maximum payout for a participant who exclusively selected the easy task was $2.00, whereas the maximum payout for a participant who selected only the hard task was $8.66. They were asked to complete as many trials as they could in the 20 min allowed for the task. They were also informed that "hard" trials take three times as long as "easy" trials to complete, and because they would only have 20 min to complete the task, the number of trials they were able to complete would depend on their choices. Participants were not informed of when or how many bonus trials would appear. The EEfRT task was programmed in Matlab (Matlab for Windows, Rel. 2007, Mathworks Inc., Natick, MA) using the Psychtoolbox version 2.0.

Procedure

Potential participants completed preliminary screening via phone interviews. If determined to be potentially eligible, the participant was invited to the university to complete written informed consent procedures and a SCID. Telephone interviews, which have been shown to be reliable and valid in symptom evaluation (Simon, Revicki, & VonKroff, 1993), were conducted monthly until symptoms were determined to be within the remitted range using the MHRSD and YMRS, according to previously validated (Chengappa et al., 2003; Thompson et al., 2005) cutoff scores of 6 or lower (Miller et al., 1985; Young et al., 1978). Symptom severity scores within a remitted range were confirmed within 48 hr of the in-person session. Participants who met eligibility and symptom requirements were scheduled for in-person sessions to complete study questionnaires and tasks, including additional measures not discussed here (Johnson, Tharp, Peckham, & McMaster, 2016; Muhtadie & Johnson, 2015).

Analyses

The number of trials completed varied across participants (M = 54.95, SD = 9.98, range = 41–84 trials). For consistency of analysis, an upper bound of the first 50 trials was used. Data were exported into IBM SPSS statistical software, Version 20 for analysis. Before conducting analyses, potential confounds were considered using bivariate correlations with the WASSUP subscales and the proportion of hard tasks selected.

Following Treadway et al. (2009), data were analyzed in two ways. For the first set of analyses, the mean proportion of hard task selections was calculated for each participant. Zero-order correlations were computed to assess relationships between mean proportion of hard task selections and the subscales of the WASSUP. Partial correlations were then computed to further control for potential confounds.

For the second set of analyses, significant bivariate correlations were examined further using generalized estimating equations (GEE; Zeger & Liang, 1986) as a more stringent test of the relationship between the EEfRT and the WASSUP. GEE is a generalized regression model that is used to estimate model parameters when residuals may be correlated. In this case, GEE was used to model participants' trial-by-trial task selection as a function of both time-varying parameters (e.g., changes in reward value of the hard task) and time-invariant parameters (e.g., scores on the WASSUP). GEE models were implemented using an unstructured working correlation matrix. The dependent variable for the GEE models was the dichotomous outcome of easy or hard task choice, modeled using a binary logistic distribution.

Based on the zero-order and partial correlations, the base GEE model included reward magnitude, trial number (to account for task fatigue), bonus status (whether or not the EEfRT version included bonus trials was coded as a group-level dichotomous variable), gender, age, and the Financial Success subscale of the WASSUP as independent variables. Continuous variables were standardized before analysis. The Popular Fame subscale was not included. In addition to the base model, we also tested a second GEE model to explore the possibility of an interaction between reward magnitude and WASSUP Financial Success.

Results

Before testing hypotheses, variable distributions were examined for normalcy and for potential confounds of gender, age, employment status, years of education, perceived socioeconomic status, working memory functioning, illness severity, comorbid anxiety disorder, past substance disorder, and medication status. A significant difference was detected between male and female participants, $t(48) = 2.74$, $p < .01$, with men selecting the hard task significantly more often than women. Women also tended to endorse fewer items on the Financial Success subscale of the WASSUP, although this effect was only significant at a trend level, $t(48) = 1.95$, $p = .06$. Older participants exhibited nonsignificant tendencies to select the hard task less frequently than younger participants ($r = -.25$, $p = .08$) and to endorse fewer items on the Popular Fame subscale ($r = -.24$, $p = .09$), but not on the Financial Success subscale. On average, participants who were not working at the time of the study selected the hard task at a slightly higher rate than participants who were working, but this difference was significant only at a trend level ($t = 1.82$, $p = .07$), and employment status was not significantly related to the WASSUP subscale scores.

No significant effects of years of education, perceived socioeconomic status, current depression (MHRSD) or mania (YMRS) symptom severity, working memory functioning (Wechsler backward digit span), comorbid anxiety disorder, or past substance disorder were detected on either EEfRT task selection or WASSUP subscale scores. No significant effects of medication were detected except for atypical antipsychotic use, which was associated with a decreased likelihood of selecting the hard task ($r = -.34$, $p < .05$).

On average, participants who selected the hard task more frequently tended to win more money over the course of the EEfRT ($r = .54$, $p < .001$), indicating that participants who were motivated to earn money did well to select the hard task at least some of the time. No significant difference in the proportion of hard tasks selected was detected between participants in the bonus versus no bonus conditions, $t(48) = 1.21$ *ns*.

Bivariate correlations of WASSUP with EEfRT

As shown in Figure 1, the mean proportion of hard tasks selected on the EEfRT was significantly correlated with WASSUP Financial Success ($r = .35$, $p < .01$), but not with WASSUP Popular Fame subscale ($r = .10$, $p = .48$). The correlation between Financial Success and task selection was significantly larger than the correlation between Popular Fame and task selection ($z = 2.17$, $p < .05$). These associations were not changed substantively by controlling for gender, age, or atypical antipsychotic dose using partial correlations. Results were not altered substantively by the removal of high leverage cases, so all cases were retained in the final analysis.

Generalized estimating equations

As shown in Table 2, as hypothesized, higher WASSUP Financial Success scores were significantly related to

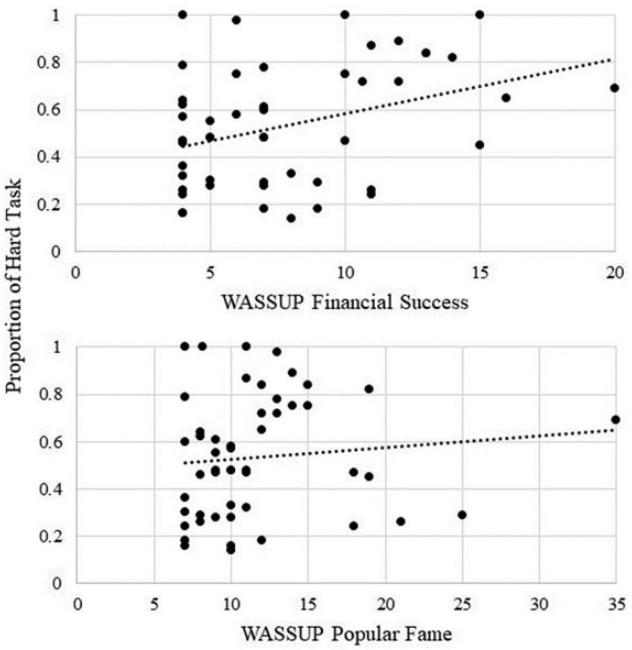

Fig. 1. Plots of the zero-order relationships between WASSUP subscales and proportion of hard task choices.

selection of the hard task, as was higher reward magnitude offered for the hard task. As did the correlational analyses, GEE indicated that women were less likely to select the hard task than were men, and age was negatively associated with choosing the hard task. A significant interaction between WASSUP Financial Success and reward magnitude emerged in Model 2 (Fig. 2). This interaction suggested that the WASSUP subscale was more strongly related to hard task choice when the reward magnitude was low than when reward magnitude was high. Atypical antipsychotic effects were reexamined in the context of the GEE models and found to be nonsignificant; nor did they affect the significance of key study variables, and so were not included in the models presented here. All effects reported in Table 2 reflect controls for all of the other variables in the model.

Discussion

As described earlier, a growing body of research indicates that persons with bipolar disorder and persons with subsyndromal manic symptoms endorse highly ambitious life goals. This profile, in turn, has been shown to predict the onset of bipolar disorder, a more severe course of manic symptoms, and to be correlated with lifetime creative accomplishment. Although these associations are clinically important, little is known about processes that might relate to this willingness to set extremely high life goals.

We examined whether tendencies to set extremely high goals among those diagnosed with bipolar I disorder are tied to effort-based decision making on a laboratory task. Findings suggest that willingness to pursue highly ambitious financial goals was moderately related to selection of a higher-cost physical task in return for higher monetary rewards at the zero-order level. Moreover, at the trial-by-trial level, higher WASSUP scores were associated with an increased likelihood of selecting the hard task (OR = 1.62), even after adjusting for reward magnitude. The association between WASSUP scores and task selection was relatively weaker when the magnitude of the reward being offered was high, suggesting that most individuals were willing to choose the hard task when the reward value was sufficiently high. Conversely, when the reward magnitude was relatively low, ambitious goal setting exerted a stronger influence on decision making, indicating that highly ambitious participants were more willing to exert effort for comparatively small rewards.

That male participants tended to select the hard task at a higher rate than female participants is consistent with findings from prior EEfRT studies. Similarly, prior investigations of the WASSUP have suggested that men tend to endorse more items on the Financial Success subscale (but not the Popular Fame subscale), perhaps reflecting an effect of cultural gender roles and stereotypes that is relatively specific to monetary ambition and that shapes effort-related decision making. On the other hand, the finding that scores on the WASSUP were not robustly tied to educational attainment, employment status, or perceived socioeconomic status is consistent with prior research suggesting that ambition and willingness to exert effort appear to be sustained in individuals with bipolar disorder across occupational and socioeconomic contexts (see Johnson, Carver, et al., 2012).

Overall, the finding of an association between laboratory and self-report measures of an underlying reward system is highly relevant to the RDoC initiative. These findings indicate that individual differences in these important facets of reward sensitivity can be measured across self-report and behavioral levels and that a behavioral lab task of willingness to pursue rewards can predict reports of broader life goals. It is particularly noteworthy that this association emerged in a sample of persons with bipolar I disorder, as the WASSUP has consistently been linked to important positive and negative outcomes in bipolar samples.

It is important to acknowledge several limitations of the study. Most important, the sample size was small, limiting our ability to fully account for multiple sources of sample heterogeneity in the context of the GEE models or to examine potential moderators of the relationship between indices. The observed effect sizes were

Table 2. Generalized Estimating Equations Modeling Trial-by-Trial Participant Task Choice (Easy vs. Hard)

Variable	Unstandardized *B*	*SE*	*p*	OR
Model 1				
Gender	–0.62	0.195	<.001	0.54
Age	–0.24	0.069	<.001	0.79
Bonus	0.43	0.174	<.01	1.54
Trial number	0.02	0.033	*ns*	1.02
Reward level of the hard task	0.65	0.061	<.001	1.92
WASSUP Financial Success	0.48	0.074	<.001	1.62
Model 2				
Gender	–0.69	0.198	<.001	0.50
Age	–0.22	0.072	<.001	0.80
Bonus	0.50	0.179	<.01	1.65
Trial number	0.09	0.036	<.05	1.09
Reward level of the hard task	0.60	0.058	<.001	1.82
WASSUP Financial Success	0.44	0.073	<.001	1.55
Financial Success × Reward level	–0.14	0.058	<.05	0.87

Note: Gender was coded as 1 = *male*, 2 = *female*.

small to moderate, which signals a need for replication. Gender effects merit more attention, given that men appeared more willing to engage in effort for reward on this task; other types of tasks might be more engaging across genders. It is notable that the WASSUP Financial Success subscale was correlated with laboratory performance, but the Popular Fame subscale was not. Although this may reflect the more limited number of people who endorsed heightened ambitions for Popular Fame, this also highlights the need to consider nonmonetary forms of reward, and whether those exert similar effects in laboratory tasks. There is also a need to examine generalizability across other populations, as we focused on those with bipolar I disorder here, given the importance of ambition within that population. In particular, the lack of a nonclinical comparison group limits our ability to delineate the extent to which the effects observed in this sample are or are not unique to individuals with bipolar disorder. Finally, it was not possible to adequately disentangle whether willingness to expend high levels of effort for reward can be considered a mechanism driving ambition. Further research, including longitudinal follow-ups and control over a host of other potential contributors to ambition, should be undertaken to build a more precise conceptual model.

Notwithstanding limitations, the current work has important clinical implications, given that high scores on the WASSUP scales have been found to predict the onset of bipolar disorder, the severity of mania over time, as well as positive outcomes associated with the disorder, such as creative accomplishment. Current

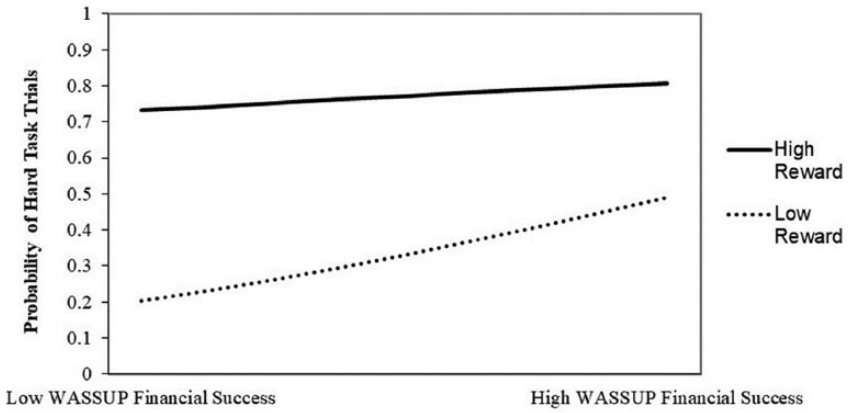

Fig. 2. Simple slope analysis of the interaction between WASSUP Financial Success and reward magnitude. Lines represent the highest ($4.21) and lowest ($1.24) amounts available for completing the hard task.

findings, then, provide a window into explaining a facet of reward sensitivity that seems tied to the underlying disorder, as well as related to adaptive advantages. We hope the current findings will inspire more behavioral research on facets of bipolar disorder that might be tied to positive outcomes.

Author Contributions

S. L. Johnson designed the study, in collaboration with C. S. Carver. M. Treadway designed the task. J. A. Tharp managed data collection and provided task design feedback from piloting. B. A. Swerdlow conducted statistical analyses. S. L. Johnson drafted the initial article, and all authors contributed to the writing.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

References

Alloy, L. B., Bender, R. E., Whitehouse, W. G., Wagner, C. A., Liu, R. T., Grant, D. A., . . . Abramson, L. Y. (2012). High Behavioral Approach System (BAS) sensitivity, reward responsiveness, and goal-striving predict first onset of bipolar spectrum disorders: A prospective behavioral high-risk design. *Journal of Abnormal Psychology*, *121*, 339–351. doi:10.1037/a0025877

Altman, E. G., Hedeker, D., Peterson, J. L., & Davis, J. M. (1997). The Altman Self-Rating Mania Scale. *Biological Psychiatry*, *42*, 948–955. doi:10.1016/S0006-3223(96)00548-3

Bauer, M., McBride, L., Shea, N., Gavin, C., Holden, F., & Kendall, S. (1997). Impact of an easy-access VA clinic-based program for patients with bipolar disorder. *Psychiatric Services*, *48*, 491–496.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Manual for the Beck Depression Inventory* (2nd ed.). San Antonio, TX: Psychological Corporation.

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry*, *4*, 561–571.

Chengappa, K. N., Kupfer, D. J., Frank, E., Houck, P. R., Grochocinski, V. J., Cluss, P. A., & Stapf, D. A. (2003). Relationship of birth cohort and early age at onset of illness in a bipolar disorder case registry. *American Journal of Psychiatry*, *160*, 1636–1642. doi:10.1176/appi.ajp.160.9.1636

Cuthbert, B. N. (2005). Dimensional models of psychopathology: Research agenda and clinical utility. *Journal of Abnormal Psychology*, *114*, 565–569.

Eckblad, M., & Chapman, L. J. (1986). Development and validation of a scale for hypomanic personality. *Journal of Abnormal Psychology*, *95*, 214–222.

Fervaha, G., Graff-Guerrero, A., Zakzanis, K. K., Foussias, G., Agid, O., & Remington, G. (2013). Incentive motivation deficits in schizophrenia reflect effort computation impairments during cost-benefit decision-making. *Journal of Psychiatric Research*, *47*, 1590–1596. doi:10.1016/j.jpsychires.2013.08.003

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (1995). *Structured Clinical Interview for Axis I DSM-IV Disorders Patient Edition (SCID Version 2.0)*. New York: New York State Psychiatric Institute, Biomedics Research Department.

Gonzalez-Pinto, A., Ballesteros, J., Aldama, A., Perez de Heredia, J. L., Gutierrez, M., & Mosquera, F. (2003). Principal components of mania. *Journal of Affective Disorders*, *76*, 95–102.

Hamilton, M. (1967). Development of a rating scale for primary depressive illness. *British Journal of Social and Clinical Psychology*, *6*, 278–296.

Johnson, S. L., & Carver, C. S. (2006). Extreme goal setting and vulnerability to mania among undiagnosed young adults. *Cognitive Therapy and Research*, *30*, 377–395. doi:10.1007/s10608-006-9044-7

Johnson, S. L., Carver, C. S., & Gotlib, I. H. (2012). Elevated ambitions for fame among persons diagnosed with bipolar I disorder. *Journal of Abnormal Psychology*, *121*, 602–609. doi:10.1037/a0026370

Johnson, S. L., Cuellar, A. K., Ruggero, C., Winett-Perlman, C., Goodnick, P., White, R., & Miller, I. (2008). Life events as predictors of mania and depression in bipolar I disorder. *Journal of Abnormal Psychology*, *117*, 268–277. doi:10.1037/0021-843X.117.2.268

Johnson, S. L., Edge, M. D., Holmes, M. K., & Carver, C. S. (2012). The behavioral activation system and mania. *Annual Review of Clinical Psychology*, *8*, 243–267. doi:10.1146/annurev-clinpsy-032511-143148

Johnson, S. L., Freeman, M. A., & Staudenmaier, P. J. (2015). Manic tendencies are not related to being an entrepreneur, intending to become an entrepreneur, or succeeding as an entrepreneur. *Journal of Affective Disorders*, *173*, 154–158. doi:10.1016/j.jad.2014.10.049

Johnson, S. L., Murray, G., Hou, S., Staudenmaier, P. J., Freeman, M. A., & Michalak, E. E. (2015). Creativity is linked to ambition across the bipolar spectrum. *Journal of Affective Disorders*, *178*, 160–164. doi:10.1016/j.jad.2015.02.021

Johnson, S. L., Tharp, J. A., Peckham, A. D., & McMaster, K. J. (2016). Emotion in bipolar I disorder: Implications for functional and symptom outcomes. *Journal of Abnormal Psychology*, *125*, 40–52. doi:10.1037/abn0000116

Liu, H., Sarapas, C., & Shankman, S. A. (2016). Anticipatory reward deficits in melancholia. *Journal of Abnormal Psychology*, *125*, 631–640. doi:10.1037/abn0000172

Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour Research and Therapy*, *33*, 335–343. doi:10.1016/0005-7967(94)00075-U

Miller, I. W., Bishop, S., Norman, W. H., & Maddever, H. (1985). The Modified Hamilton Rating Scale for Depression: Reliability and validity. *Psychiatry Research*, *14*, 131–142.

Muhtadie, L., & Johnson, S. L. (2015). Threat sensitivity in bipolar disorder. *Journal of Abnormal Psychology*, *124*, 93–101. doi:10.1037/a0038065

Peckham, A. D., & Johnson, S. L. (2016). Spontaneous eyeblink rate as an index of reward responsivity: Validation

and links to bipolar disorder. *Clinical Psychological Science*, *4*, 451–463. doi:10.1177/2167702615594999

Ruiter, M., & Johnson, S. L. (2015). Mania risk and creativity: A multi-method study of the role of motivation. *Journal of Affective Disorders*, *170*, 52–58. doi:10.1016/j.jad.2014.08.049

Salamone, J. D., Correa, M., Farrar, A., & Mingote, S. M. (2007). Effort-related functions of nucleus accumbens dopamine and associated forebrain circuits. *Psychopharmacology*, *191*, 461–482. doi:10.1007/s00213-006-0668-9

Salamone, J. D., Cousins, M. S., McCullough, L. D., Carriero, D. L., & Berkowitz, R. J. (1994). Nucleus accumbens dopamine release increases during instrumental lever pressing for food but not free food consumption. *Pharmacology, Biochemistry, and Behavior*, *49*, 25–31.

Simon, G. E., Revicki, D., & VonKroff, M. (1993). Telephone assessment of depression severity. *Journal of Psychiatric Research*, *27*, 247–252.

Steer, R. A., Beck, A. T., Riskind, J. H., & Brown, G. (1987). Relationships between the Beck Depression Inventory and the Hamilton Psychiatric Rating Scale for Depression in depressed outpatients. *Journal of Psychopathology and Behavioral Assessment*, *9*, 327–339.

Tharp, J. A., Johnson, S. L., Sinclair, S., & Kumar, S. (2016). Goals in bipolar I disorder: Big dreams predict more mania. *Motivation and Emotion*, *40*, 290–299.

Thompson, J. M., Gallagher, P., Hughes, J. H., Watson, S., Gray, J. M., Ferrier, I. N., & Young, A. H. (2005). Neurocognitive impairment in euthymic patients with bipolar affective disorder. *British Journal of Psychiatry*, *186*, 32–40.

Treadway, M. T., Bossaller, N. A., Shelton, R. C., & Zald, D. H. (2012). Effort-based decision-making in major depressive disorder: A translational model of motivational anhedonia. *Journal of Abnormal Psychology*, *121*, 553–558. doi:10.1037/a0028813

Treadway, M. T., Buckholtz, J. W., Schwartzman, A. N., Lambert, W. E., & Zald, D. H. (2009). Worth the "EEfRT"? The Effort Expenditure for Rewards Task as an objective measure of motivation and anhedonia. *PLoS ONE*, *4*, e6598. doi:10.1371/journal.pone.0006598

Treadway, M. T., & Zald, D. H. (2013). Parsing anhedonia: Translational models of reward-processing deficits in psychopathology. *Current Directions in Psychological Science*, *22*, 244–249. doi:10.1177/0963721412474460

Tsitsipa, E., & Fountoulakis, K. N. (2015). The neurocognitive functioning in bipolar disorder: a systematic review of data. *Annals of General Psychiatry, 14*, 42. doi:10.1186/s12991-015-0081-z

Wardle, M. C., Treadway, M. T., Mayo, L. M., Zald, D. H., & de Wit, H. (2011). Amping up effort: Effects of d-amphetamine on human effort-based decision-making. *Journal of Neuroscience*, *31*, 16597–16602. doi:10.1523/jneurosci.4387-11.2011

Wechsler D. (2008). *Wechsler Adult Intelligence Scale–Fourth Edition*. San Antonio, TX: Pearson.

Whitton, A. E., Treadway, M. T., & Pizzagalli, D. A. (2015). Reward processing dysfunction in major depression, bipolar disorder and schizophrenia. *Current Opinion in Psychiatry*, *28*, 7–12. doi:10.1097/YCO.0000000000000122

Yang, X. H., Huang, J., Zhu, C. Y., Wang, Y. F., Cheung, E. F., Chan, R. C., & Xie, G. R. (2014). Motivational deficits in effort-based decision making in individuals with subsyndromal depression, first-episode and remitted depression patients. *Psychiatry Research*, *220*, 874–882. doi:10.1016/j.psychres.2014.08.056

Young, R. C., Biggs, J. T., Ziegler, V. E., & Meyer, D. A. (1978). A rating scale for mania: Reliability, validity and sensitivity. *British Journal of Psychiatry*, *133*, 429–435.

Zeger, S. L., & Liang, K. Y. (1986). Longitudinal data analysis for discrete and continuous outcomes. *Biometrics*, *42*, 121–130.