



Motivation and effort in individuals with social anhedonia



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ABSTRACT

It has been proposed that anhedonia may, in part, reflect difficulties in reward processing and effortful decision making. The current study aimed to replicate previous findings of effortful decision making deficits associated with elevated anhedonia and expand upon these findings by investigating whether these decision making deficits are specific to elevated social anhedonia or are also associated with elevated positive schizotypy characteristics. The current study compared controls ($n = 40$) to individuals elevated on social anhedonia ($n = 30$), and individuals elevated on perceptual aberration/magical ideation ($n = 30$) on the Effort Expenditure for Rewards Task (EEfRT). Across groups, participants chose a higher proportion of hard tasks with increasing probability of reward and reward magnitude, demonstrating sensitivity to probability and reward values. Contrary to our expectations, when the probability of reward was most uncertain (50% probability), at low and medium reward values, the social anhedonia group demonstrated more effortful decision making than either individuals high in positive schizotypy or controls. The positive schizotypy group only differed from controls (making less effortful choices than controls) when reward probability was lowest (12%) and the magnitude of reward was the smallest. Our results suggest that social anhedonia is related to intact motivation and effort for monetary rewards, but that individuals with this characteristic display a unique and perhaps inefficient pattern of effort allocation when the probability of reward is most uncertain. Future research is needed to better understand effortful decision making and the processing of reward across a range of individual difference characteristics.

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1. Introduction

Anhedonia refers to a lack of pleasure from physical experiences and/or social interactions (Chapman et al., 1976). Anhedonia has been of interest to researchers as this characteristic may be an important indicator of risk for particular forms psychopathology such as depression (Treadway and Zald, 2011), schizophrenia-related spectrum personality disorders, and psychosis (Kwapil, 1998; Gooding et al., 2005; Blanchard et al., 2011). Additionally, it is a prominent characteristic of schizophrenia (e.g., Andreasen, 1982; Blanchard et al., 1998) that may provide a promising target for translational research exploring the neural mechanisms underlying this disorder.

In considering the core deficit that contributes to anhedonia (physical and social), Treadway and Zald (2011) proposed that it is useful to distinguish between hedonic responses to rewards (consummatory anhedonia) and diminished motivation to pursue them (motivational anhedonia). On one hand, anhedonia may reflect a diminution of positive affect when encountering evocative stimuli or experiences consummatory anhedonia. Consistent with this perspective, at least in nonclinical samples, self-reported elevated

anhedonia has been found to be related to diminished positive emotional responding to evocative stimuli in laboratory tasks (Kerns et al., 2008; Leung et al., 2010; Llerena et al., 2012) and to experiences individuals encounter in their daily lives (Brown et al., 2007; Kerns et al., 2008). However, this is not always the case, as individuals with elevated social anhedonia have also displayed normative startle responding to positive stimuli in a laboratory setting (Gooding et al., 2002). In addition to consummatory deficits, anhedonia may be associated with impaired reward-based decision making and motivational deficits to pursue rewards (Treadway and Zald, 2011). Considering this motivational aspect of anhedonia may be useful as consummatory pleasure deficits are not consistently associated with anhedonia, especially in clinical populations. In particular, self-reported anhedonia has been found to be unrelated to consummatory pleasure deficits in schizophrenia (e.g., Earnst and Kring, 1999; Trémeau et al., 2009; Cohen et al., 2012). Thus, it has been suggested (e.g., Barch and Dowd, 2010) that anhedonia in schizophrenia may not reflect an impairment in hedonic experience but rather be related to impairment in reward learning (Strauss et al., 2011), failure to represent expected rewards (Gold et al., 2012), and cost/effort computation deficits (Fervaha et al., 2013; Gold et al., 2013; Barch et al., 2014).

In addressing the possible role of impaired reward-based decision making in anhedonia, Treadway et al. (2009) developed a

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translational measure of effort-based decision making, the Effort Expenditure for Rewards Task (EEfRT). Initial findings in a nonclinical sample indicated that greater anhedonia was related to less willingness to expend effort for rewards (Treadway et al., 2009). Specifically, compared to controls, those with greater anhedonia were less likely to choose 'hard' tasks requiring more effort when the potential reward was 'high' and the probability of reward was uncertain (Treadway et al., 2009). Self-reported depression in this nonclinical sample was also inversely related to willingness to expend effort for rewards.

The above results regarding reward-based decision making and anhedonia are promising and suggest the potential use of a novel translational paradigm to better parse the underlying deficits associated with anhedonia. However, questions remain about the relationship between reward-based decision making and one specific type of anhedonia, namely, social anhedonia. Our interest in social anhedonia stems from research suggesting that this is a particularly important individual difference characteristic associated with schizophrenia-spectrum personality disorder symptoms and outcomes (Chapman et al., 1994; Kwapil, 1998; Gooding et al., 2005; Blanchard et al., 2011). Additionally, in nonclinical samples, elevated social anhedonia is an important research target because it is associated with clinical symptoms, decreased social support (Blanchard et al., 2011), and impaired social functioning (Diaz et al., 2003; Diaz, 2006). Moreover, cognitive deficits in executive functioning, working memory, and attention have also been implicated in individuals with elevated social anhedonia in nonclinical samples (Tallent and Gooding, 1999; Cohen et al., 2006; Diaz, 2006), and such impairments may compromise reward-based decision making. Prior studies of motivation and effort have generally utilized a summary measure of anhedonia, integrating both physical and social anhedonia (e.g., Treadway et al., 2009; Barch et al., 2014). Given potential differential correlates of physical and social anhedonia (e.g., Chapman et al., 1994; Blanchard et al., 1998; Gard et al., 2007), it would be important to examine social anhedonia independently to determine if the initial findings hold for this aspect of anhedonia. Furthermore, since some individuals high in social anhedonia manifest other positive schizotypal symptoms and characteristics (Kwapil, 1998; Gooding et al., 2005; Blanchard et al., 2011), it would be informative to determine whether the positive schizotypal characteristics of perceptual aberration (Chapman et al., 1978) and magical ideation (Eckblad and Chapman, 1983) contribute to decision making deficits related to reward. Finally, the replication of general anhedonia's relation to decision making deficits is important given findings from a recent study of clinical depression (Treadway et al., 2012): although the depression group evidenced less willingness to expend effort for rewards compared to controls, unexpectedly within the depressed group overall depressive symptom severity, and more specifically an item related to reduced enjoyment (anhedonia), were associated with *more* effortful decision making.

The purpose of the current study was to determine if reward-based decision making deficits were evident in nonclinical individuals high in social anhedonia. Identifying and exploring social anhedonia in nonclinical populations affords several advantages including minimizing factors that complicate research in schizophrenia such as medication effects, economic deprivation, severe cognitive decline, social stigma, and institutionalization (Blanchard and Neale, 1992; Lenzenweger, 2006). We also sought to examine if these deficits were unique to social anhedonia or if other schizotypal characteristics (perceptual aberration/magical ideation) might be tied to impaired reward-based decision making. Performance on the EEfRT was examined in three groups: high social anhedonia, high perceptual aberration/magical ideation, and a control group. We hypothesized that the social anhedonia group would demonstrate diminished effortful decision making compared to controls and those high in positive schizotypal traits.

2. Methods

2.1. Participants

One hundred participants were recruited from the University of Maryland at College Park (UMD) after completing online screening measures. Eligible study participants were between the ages of 17 and 40; individuals who were 17 years of age obtained parental consent and completed an assent form to participate. Participants were screened using the 17-item Social Anhedonia Scale–Brief (SAS-B; Reise et al., 2011) composed of the 17 most discriminating items identified by factor analyses of the Revised Social Anhedonia Scale (Eckblad et al., 1982), 7 items from the Perceptual Aberration Scale (PerAb; Chapman et al., 1978), and 8 items from the Magical Ideation Scale (MagicId; Eckblad and Chapman, 1983). Due to limitations in the length of screening instruments permitted in UMD mass testing, we relied on abbreviated versions of the scales. The latter two scales comprise what is referred to as the PerMag scale, which is used to identify positive schizotypal traits. Screening items for the abbreviated PerMag scale were those used in a prior study (Kerns et al., 2008) that selected items based on highest item-total correlation (J. Kerns, personal communication, August 1, 2011) for mass testing before administering the complete schizotypy scales in the laboratory. The present study administered the Schizotypal Personality Questionnaire (SPQ; Raine, 1991) during the study visit to confirm group differences in schizotypal characteristics. Additionally, the 13-item Infrequency Scale (Chapman and Chapman, 1983) was used to measure invalid responding, and people who responded in the unexpected direction on three or more items were excluded (Kerns et al., 2008; Martin et al., 2011). The social anhedonia (SocAnh) and positive schizotypy (PerMag) groups consisted of individuals with scores falling within the top 10% of the collected SAS-B and PerMag scores, respectively. Individuals who met criteria for both groups were excluded from the study to establish an extreme-group design (Kerns et al., 2008). The control group was recruited from people who scored less than 0.5 standard deviations above the SAS-B and PerMag means (Chapman et al., 1994; Horan et al., 2007).

2.2. Measures

The Effort Expenditure for Rewards Task (EEfRT; Treadway et al., 2009) combines reward processing and effortful decision making to produce an objective assessment of effort. The EEfRT has been utilized in a range of sample to examine effortful decision making deficits in a range of sample including individuals with depression (Treadway et al., 2012) and schizophrenia (e.g., Barch et al., 2014). This computer task is 20 min in duration and consists of a series of trials with potential reward values ranging from \$1 (easy task) to \$1.24–\$4.30 (hard task) and probabilities (low = 12%, medium = 50%, high = 88% chance) of receiving each reward. Participants chose to perform either an easy task (pushing a computer key 30 times in 7 s) or a hard task (pushing a computer key 100 times in 21 s). Following each task, participants viewed feedback about whether they won the reward; see Treadway et al. (2009) for a full description of the EEfRT. The proportion of hard tasks chosen was the dependent variable of effortful decision making. Participants also completed items from the Beck Depression Inventory-II (Beck et al., 1996) that measured depressive symptoms.¹

¹ Due to the University of Maryland Institutional Review Board requirements and experimenter error, the first 14 items of the BDI-II questionnaire were collected from all participants, and the suicide item was excluded. Although using the incomplete set of 14 items is not ideal, these items demonstrated good internal consistency (Cronbach's $\alpha = .86$).

2.3. Procedure

Project approval was obtained from the UMD Institutional Review Board. People who were interested in the research study completed an online screening questionnaire and a demographic form; those who were eligible and interested were e-mailed an online link to complete the SPQ prior to their appointment. Following informed consent procedures with a researcher in the lab, participants completed the EEfRT and the BDI-II. Participants were debriefed and compensated with UMD course credit or cash (\$10/hour) and the “reward” of \$8 for the EEfRT.

2.4. Data analysis

SPSS 20 was used to conduct the analyses. Generalized estimating equation (GEE) models were used to test the effects of probability, reward, and group on effortful decision making. All participants completed 20 min of trials on the EEfRT, and we used up to the first 50 trials for each participant, which is consistent with the original study using the EEfRT (Treadway et al., 2009). Participants who completed less than 50 trials were included in analyses with missing trial data only comprising 3.1% of the total data representing effortful decision making. There were no significant group differences in total trials, $F(2, 97) = 1.27$, $p = .28$, and on average, each group completed between 95% and 99% of trials with an overall average of 97%, suggesting minimal evidence of task fatigue. One-way ANOVAs and Pearson chi-squared analyses were conducted to examine demographic and clinical characteristics across groups.

3. Results

3.1. Clinical characteristics

Demographic and clinical characteristics are presented in Table 1. The three groups significantly differed with respect to total schizotypal (SPQ) scores. Specifically, the SocAnh and PerMag groups displayed elevated total schizotypy scores compared to the control group, $t(43.45) = -5.95$, $p < .001$ and $t(40.19) = -4.09$, $p < .001$, respectively. Upon examining the subscales of the SPQ, the SocAnh and PerMag groups exhibited significantly greater scores in the cognitive perceptual

Table 1
Demographic and clinical characteristics for social anhedonia (SocAnh), perceptual aberration and magical ideation (PerMag), and control groups.

	SocAnh (n = 30)	PerMag (n = 30)	Control (n = 40)	F or χ^2
Age, M(SD)	20.40 (3.35)	18.77 (.97)	20.35 (2.47)	$F = 4.45^*$
Gender (%(ct))				$\chi^2 = 0.35$
Male	30 (9)	23.3 (7)	27.5 (11)	
Female	70 (21)	76.7 (23)	72.5 (29)	
Race (%(ct))				$\chi^2 = 14.79$
Caucasian	40.0 (12)	46.7 (14)	67.5 (27)	
African American	33.3 (10)	20 (6)	7.5 (3)	
Hispanic	10.0 (3)	3.3 (1)	2.5 (1)	
Asian	16.7 (5)	26.7 (8)	15 (6)	
Other	0 (0)	3.3 (1)	7.5 (3)	
Handedness (%(ct))				$\chi^2 = 1.44$
Right-handed	86.7 (26)	90 (27)	80 (32)	
Left-handed	13.3 (4)	10 (3)	20 (8)	
SPQ total	27.10 (13.09)	23.37 (14.96)	11.18 (7.60)	$F = 17.52^{**}$
Cognitive perceptual	9.30 (6.87)	11.30 (7.69)	3.70 (3.01)	$F = 15.60^{**}$
Interpersonal	8.47 (3.85)	4.87 (3.85)	3.48 (3.14)	$F = 17.13^{**}$
BDI-II	6.90 (6.18)	3.83 (4.08)	2.75 (3.21)	$F = 7.44^{**}$

SPQ = Schizotypal Personality Questionnaire; BDI-II = Beck Depression Inventory; ct = count.

* $p < 0.05$.

** $p < 0.01$.

domain of the SPQ (positive schizotypy) relative to controls, $t(37.36) = -4.18$, $p < .001$ and $t(35.67) = -5.13$, $p < .001$, respectively. The SocAnh and PerMag groups did not significantly differ on total SPQ or cognitive perceptual scores. The SocAnh group displayed significantly higher scores in the interpersonal domain of the SPQ (negative schizotypy) relative to both the PerMag, $t(58) = -3.62$, $p = .001$, and control groups, $t(68) = -5.98$, $p < .001$. However, there were no differences on interpersonal scores between the PerMag and control groups. Additionally, higher depressive scores were evident in the SocAnh group compared to controls ($t(40.68) = 3.36$, $p = .002$) and the PerMag group ($t(50.24) = 2.27$, $p = .03$). However, the control and PerMag groups demonstrated similar levels of depressive symptoms.

3.2. Effortful decision making

Proportions of choosing the hard task and estimated marginal means across groups are presented in Table 2. Following Treadway, reward value was decomposed into three levels according to Damiano et al. (2012): small is defined as any value between \$1.24 and \$2.00, medium as values between \$2.01 and \$3.00, and large as values between \$3.01 and \$4.12. The GEE analyses were conducted using an unstructured correlation matrix and a binary logistic distribution to model the dichotomous outcome of choosing the hard vs. easy task in the EEfRT. Wald chi-square statistics were tested with a Type III sums of squares approach, two-tailed. We conducted a full-factorial GEE analysis that included main effects of Group (SocAnh vs. PerMag vs. Controls), Probability (12% vs. 50% vs. 88%), and Reward (Low vs. Medium vs. High), two-way interactions of interest (Group \times Probability, Group \times Reward, Probability \times Reward), and the three-way interaction between Group, Probability, and Reward. Group, Probability and Reward were entered as between subjects factors and Trial Number was entered as a within subjects variable.

Table 2
Proportion of hard tasks chosen on the EEfRT for social anhedonia (SocAnh), perceptual aberration and magical ideation (PerMag), and control groups.

	SocAnh (n = 30)	PerMag (n = 30)	Control (n = 40)
Estimated marginal means (SE)			
Probability			
12%	.31 (.04)	.19 (.03)	.24 (.03)
50%	.64 (.05)	.45 (.05)	.49 (.05)
88%	.78 (.04)	.79 (.03)	.76 (.02)
Reward level			
Low	.39 (.04)	.23 (.03)	.28 (.03)
Medium	.60 (.04)	.54 (.05)	.50 (.04)
High	.73 (.05)	.66 (.04)	.71 (.04)
Probability \times Reward			
12%			
Low	.22 (.03)	.08 (.02)	.16 (.02)
Medium	.30 (.04)	.23 (.04)	.24 (.03)
High	.42 (.06)	.30 (.05)	.35 (.05)
50%			
Low	.40 (.05)	.24 (.04)	.24 (.04)
Medium	.68 (.05)	.49 (.06)	.53 (.05)
High	.80 (.05)	.62 (.06)	.71 (.06)
88%			
Low	.61 (.05)	.48 (.05)	.50 (.04)
Medium	.79 (.06)	.84 (.05)	.75 (.05)
High	.88 (.04)	.91 (.02)	.91 (.02)
M% (SD)			
Hard tasks chosen	.58 (.04)	.47 (.04)	.50 (.03)
Total trials	52.03 (7.92)	52.13 (7.30)	54.5 (7.09)
Invariant responders	3% (n = 1)	0% (n = 0)	2.5% (n = 1)
Trials completed	.99 (.02)	.98 (.05)	.95 (.16)

Invariant Responders = participants who chose either all “hard” or all “easy” trials on the EEfRT.

3.2.1. Main effects

Our GEE model revealed a non-significant main effect of group, $\chi^2(2) = 4.384, p = .11$. However, the main effect of probability on the tendency to choose the hard task to obtain rewards was significant, $\chi^2(2) = 417.10, p < .001$. Post hoc pairwise comparisons indicated that greater probability of reward was associated with more effort (choosing the hard task more frequently) across all three groups ($p < .001$); pairwise comparisons are presented in the Supplemental Table. Participants chose the hard task more often with the high (88%) probability of reward compared to the medium (50%) probability of reward and the low (12%) probability of reward. Participants also displayed a higher proportion of hard tasks chosen in trials with a medium probability trials compared to those with a low probability of reward.

The main effect of reward was also significant in that participants more frequently chose the hard task with the opportunity for greater magnitude of reward, $\chi^2(2) = 274.82, p < .001$. Post hoc analyses revealed that participants chose the hard task more often with high reward values above \$3.00 than with medium reward values between \$2.01 and \$3.00 or low reward values \$2.00 and below ($p < .001$). Participants also chose the hard task more frequently in trials with medium reward values relative to those with low reward values ($p < .001$).

3.2.2. Interactions

There was a significant two-way interaction between group and probability, $\chi^2(4) = 9.55, p < .05$. Post hoc comparisons indicated that within trials with a low (12%) probability of reward, the control group chose a similar proportion of hard tasks to the SocAnh and PerMag groups ($p > .05$); however, the SocAnh group chose the hard task significantly more than the PerMag group ($p < .05$). Within trials with a medium (50%) probability of reward, the SocAnh group chose the hard task more often than the control ($p < .05$) and PerMag groups ($p < .01$), but the control and PerMag groups were not significantly different in choosing the hard task on trials with medium probability of reward ($p > .05$). In the trials with a high (88%) probability of reward, there were no significant differences in proportion of hard tasks chosen between the SocAnh group and controls, between the SocAnh and PerMag groups, or between the control and PerMag groups ($p > .05$).

The two-way group \times reward interaction was not significant ($\chi^2(4) = 7.36, p = .12$), but we did find that the three-way group \times probability \times reward interaction was significant, $\chi^2(8) = 17.71, p = .02$. We conducted post hoc analyses for the three-way interaction, and results from the pairwise comparisons are described as follows (see Fig. 1). In trials with low (12%) probability of reward and low reward value, there were no group differences in effort between the SocAnh and control groups ($p > .05$). However, the SocAnh and control groups chose the hard task significantly more than the PerMag group ($p < .01$). For trials with the medium and high reward values in the condition with low probability of receiving those rewards, there were no group differences ($p > .05$). In trials with medium (50%) probability of reward and low reward value, the SocAnh group displayed greater levels of effort than both controls and the PerMag group ($p < .05$). Similar results were found in the 50% probability condition with medium reward value trials with the SocAnh group showing higher levels of effort compared to controls and the PerMag group ($p < .05$). In trials in the 50% probability condition with high reward values, the SocAnh group showed significantly greater effort than the PerMag group ($p < .05$), but not the control group ($p > .05$). There were no additional group differences of significance in trials with a medium probability of reward ($p > .05$). The results remained significant when controlling for depression. Finally, in trials with a high (88%) probability of reward and low reward values, the post hoc analyses revealed no significant group differences in trials across all reward levels ($p > .05$).

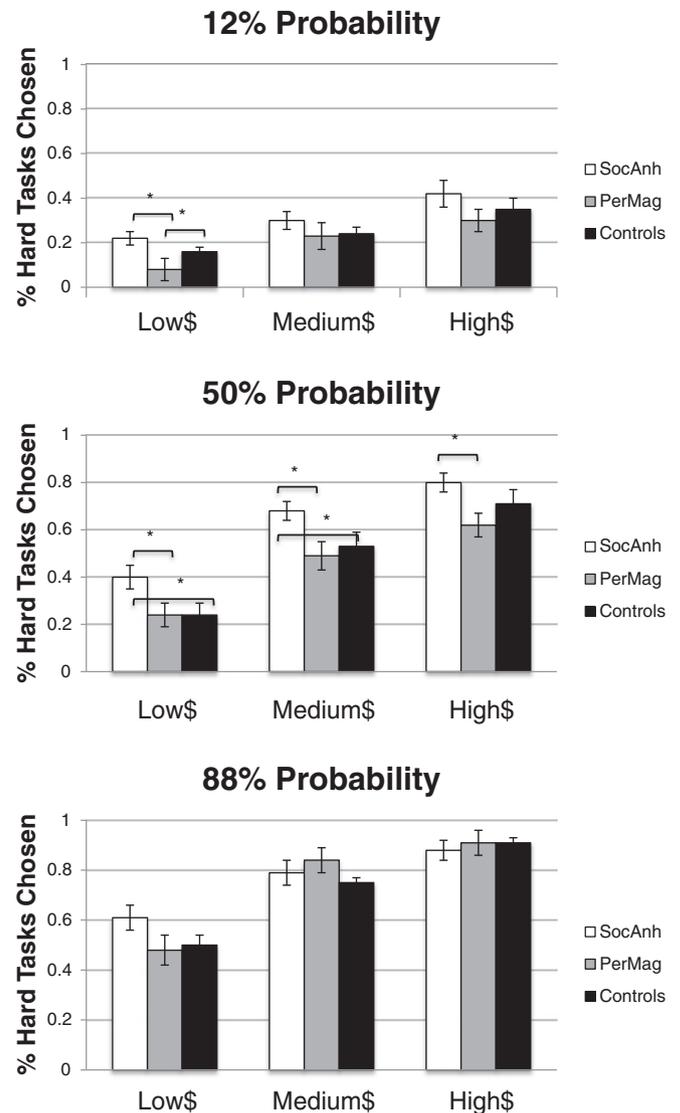


Fig. 1. Proportion of hard tasks chosen on the EEfRT for social anhedonia (SocAnh), perceptual aberration and magical ideation (PerMag), and control groups. * $p < .05$; low = \$1.24 to \$2.00; med = medium \$2.01 to \$3.00; high = \$3.01 to \$4.12.

4. Discussion

This study sought to examine whether reward-based decision making deficits that had been previously found to be related to a broad measure of anhedonia (Treadway et al., 2009) were associated with, specifically, social anhedonia. Further, we sought to determine if reward-based decision making deficits were unique to social anhedonia by including a comparison group with elevated positive schizotypy characteristics (perceptual aberration/magical ideation). Decision making was evaluated with a novel behavioral task requiring the allocation of effort based on the magnitude and probability of reward, the EEfRT (Treadway et al., 2009).

Across groups, participants chose a higher proportion of hard tasks with increasing probability of reward and reward magnitude, demonstrating sensitivity to probability and reward values and replicating Treadway et al. (2009) findings. Additionally, a significant three-way interaction emerged, indicating that individuals with elevated social anhedonia in our sample made more effortful choices for rewards in trials with 12% probability of reward and low reward magnitude (vs. PerMag group), in trials with 50% probability of reward across both low and medium reward magnitudes (vs. PerMag and control groups), and in trials with 50% probability of reward and high reward magnitude

(vs. PerMag group). This unexpected pattern of findings indicates that individuals high in social anhedonia were actually making decisions to expend *more* effort than controls under the condition of greatest uncertainty for reward (50% probability). These results were not accounted for by depression nor can the group differences be accounted for by positive schizotypy characteristics within the social anhedonia group as the PerMag group did not show this same pattern of performance. Our findings fail to support the hypothesis that the SocAnh group would be characterized by diminished effortful decision making.

The results of the present study are inconsistent with prior findings (Treadway et al., 2009) that increased anhedonia in a nonclinical sample was associated with less effortful decision making overall. Importantly, Treadway et al. (2009) utilized a combined measure of anhedonia based on physical and social anhedonia scales, whereas the current study focused on the facet of social anhedonia. Although these measures of anhedonia share some common variance (approximately 25 percent; Blanchard et al., 1998), they do have differential correlates (Blanchard et al., 1998), including differential predictive value in measuring proneness to psychosis (Chapman et al., 1994). Given that we did not assess physical anhedonia we are unable to speculate about whether this facet of hedonic experience accounted for the prior findings. In any case, the present results raise questions about anhedonia's link to reward-based decision making deficits and suggest the need to replicate prior findings with attention to assessing different facets of anhedonia.

Interestingly, the current finding that social anhedonia is related to more effortful choices appears to be somewhat consistent with Treadway et al.'s (2012) findings within a clinical sample. Treadway et al. (2012) found that in a depressed group, self-reported anhedonia was unexpectedly related to more effortful responding. Caution is warranted in extrapolating from nonclinical samples to clinical disorders and correlates of anhedonia have been found to differ depending on clinical status (e.g., Cohen et al., 2012). However, the results from the current study and Treadway et al. (2012) indicate the need to further examine how anhedonia may relate to reward-based decision making.

In considering the finding of more effortful choices made by the social anhedonia group, one might conclude that this group was performing in a manner that was superior to, or more adaptive than, control participants in terms of the amount of effort made. However, an alternative perspective to consider is that individuals in the social anhedonia group may actually be allocating their resources *less* efficiently than controls because the social anhedonia group chose to expend greater effort in trials with high uncertainty of reward (50% probability) when the magnitude of reward was low or medium. One could speculate that in conditions of uncertain and low reward that a more conservative allocation of effort is actually more efficient. This pattern of inefficient effort allocation has been a consistent finding across recent studies using the EEfRT or similar tasks in schizophrenia samples (Fervaha et al., 2013; Gold et al., 2013; Barch et al., 2014). Extrapolating from this laboratory paradigm, individuals high in social anhedonia may engage in inefficient resource allocation that could result in frustrated non-reward under conditions of uncertain probability of reward and ultimately lead to declining motivation over time. Of course, this is entirely speculative but it raises the point that the observed behavioral performance associated with social anhedonia may actually be suboptimal and could have implications for understanding diminished motivation and functional impairment related to anhedonia.

4.1. Limitations and conclusions

As noted above, the present study focused on a particular facet of anhedonia (social anhedonia), thus we are unable to speculate about whether physical anhedonia may have a distinct relationship with effortful decision making different from that obtained in the current study. Additionally, since we utilized a nonclinical sample, caution must be taken when generalizing these findings to clinical groups

that may experience anhedonia, like individuals with schizophrenia or depression (e.g., see Cohen et al., 2012). Also, given that we screened and selected participants for group selection with a subset of items from the original versions of the Revised Social Anhedonia Scale, Perceptual Aberration Scale, and Magical Ideation Scale, there may be limits to comparing the current study's results to other studies that employ the full versions of these measures. Although group differences in endorsed schizotypy traits, as independently measured by a well-validated schizotypy questionnaire (the SPQ), indicate that our screening methods were successful, the replication of the present findings using the full Chapman scales and other measures of anhedonia and schizotypy would be informative. Finally, we only assessed effortful decision making as it relates to monetary reward, but reward-based decision making may vary with different types of reward (e.g., social; Lin et al., 2012; Xie et al., 2014).

Although our research design is not without limitations, the present study is the first to our knowledge to examine differences in groups of individuals with social anhedonia, positive schizotypy, and controls with respect to effortful decision making. Our findings indicate a unique effortful decision making profile in individuals with social anhedonia, but the nature of this profile warrants further investigation and replication.

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Contributors

Julie McCarthy completed the literature search, implemented the study, and conducted analyses. Michael Treadway designed the study task and assisted with manuscript preparation. Jack Blanchard and Julie McCarthy were responsible for study design/development and drafting of the manuscript. All authors contributed to and have approved the final manuscript.

Conflict of interest

Dr. Blanchard has consulted with and served on a scientific advisory board for Genentech/Roche. All other authors declare that they have no conflicts of interest.

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