



Published in final edited form as:

Schizophr Res. 2015 June ; 165(1): 70–75. doi:10.1016/j.schres.2015.03.030.

Motivation and effort in individuals with social anhedonia

Julie M. McCarthy^a, Michael T. Treadway^b, and Jack J. Blanchard^a

Julie M. McCarthy: jmccarth@umd.edu; Michael T. Treadway: mtreadway@mclean.harvard.edu; Jack J. Blanchard: jblancha@umd.edu

^aDepartment of Psychology, University of Maryland College Park, College Park, MD 20742 United States

^bMcLean Hospital/Harvard Medical School, Belmont, MA 02478

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.

© 2015 Published by Elsevier B.V.

Corresponding author: Julie M. McCarthy, Department of Psychology, University of Maryland College Park, College Park, MD 20742, United States, jmccarth@umd.edu, Phone: +1-301-405-1531, Fax: +1-301-314-9566.

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.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Keywords

anhedonia; schizotypy; motivation; effort; reward

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 (Blanchard et al., 2011; Gooding et al., 2005; Kwapil, 1998). 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., Cohen et al., 2012; Earnst and Kring, 1999; Trémeau et al., 2009). 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 (Barch et al., 2014; Gold et al., 2013; Fervaha et al., 2013).

In addressing the possible role of impaired reward-based decision-making in anhedonia, Treadway et al. (2009) developed a translational measure of effort-based decision-making, the Effort-Expenditure for Rewards Task (EEfRT). Initial findings in a non-clinical 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 non-clinical 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 (Blanchard et al., 2011; Chapman et al., 1994; Gooding et al., 2005; Kwapil 1998). Additionally, in nonclinical samples, elevated social anhedonia is an important research target, because it 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 (Cohen et al., 2006; Diaz, 2006, Tallent and Gooding, 1999), 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., Blanchard et al., 1998; Chapman et al., 1994; 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 (Blanchard et al., 2011; Gooding et al., 2005; Kwapil, 1998), 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, 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 schizotypy 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) comprised 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 were comprised 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-groups 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 minutes 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=86% chance) of receiving each reward. Participants chose to perform either an easy task (pushing a computer key 30 times in 7 seconds) or a hard task (pushing a computer key 100 times in 21 seconds). 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 symptoms¹.

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 emailed 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 minutes 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 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

¹Due 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 $\alpha = .86$).

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 and colleagues (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 x Probability, Group x Reward, Probability x 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.

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 x reward interaction was not significant ($\chi^2(4) = 7.36, p = .12$), but we did find that the three-way group x probability x 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 Figure 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 ($p > .05$).

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 and colleagues' (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 non-clinical 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 (Barch et al., 2014; Gold et al., 2013; Fervaha et al., 2013). 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, 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.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Role of the Funding Source

Funding for this research project was provided by the NIH/NIMH T32 Schizophrenia Research Training Program (MH20075).

We thank the participants and research assistants who made this study possible.

References

- Andreasen NC. Negative symptoms in schizophrenia: definition and reliability. *Arch Gen Psychiat*. 1982; 39(7):784–788. [PubMed: 7165477]
- Barch DM, Dowd EC. Goal representations and motivational drive in schizophrenia: the role of prefrontal-striatal interactions. *Schizophr Bull*. 2010; 36(5):919–934. [PubMed: 20566491]
- Barch DM, Treadway MT, Schoen N. Effort, anhedonia, and function in schizophrenia: Reduced effort allocation predicts amotivation and functional impairment. *J Abnorm Psychol*. 2014; 123(2):387–397. [PubMed: 24886012]
- Beck, AT.; Steer, RA.; Brown, GK. *Beck Depression Inventory-II (BDI-II)*. San Antonio, TX: Psychological Corporation; 1996.

- Blanchard JJ, Collins LM, Aghevli M, Leung WW, Cohen AS. Social anhedonia and schizotypy in a community sample: The Maryland longitudinal study of schizotypy. *Schizophr Bull.* 2011; 37(3): 587–602. [PubMed: 19850669]
- Blanchard JJ, Mueser KT, Bellack AS. Anhedonia, positive and negative affect, and social functioning in schizophrenia. *Schizophr Bull.* 1998; 24(3):413–424. [PubMed: 9718633]
- Blanchard JJ, Neale JM. Medication status of participants in psychopathology research: selective review of current reporting practices. *J Abnorm Psychol.* 1992; 101(4):732–734. [PubMed: 1430615]
- Brown LH, Silvia PJ, Myin-Germeys I, Kwapil TR. When the need to belong goes wrong: The expression of social anhedonia and social anxiety in daily life. *Psychol Sci.* 2007; 18(9):778–782. [PubMed: 17760772]
- Chapman LJ, Chapman JP, Raulin ML. Scales for physical and social anhedonia. *J Ab Psychology.* 1976; 85(4):374–382.
- Chapman LJ, Chapman JP, Raulin ML. Body-image aberration in schizophrenia. *J Abnorm Psychol.* 1978; 87(4):399–407. [PubMed: 681612]
- Chapman L, Chapman J. Infrequency scale. 1983 Unpublished test.
- Chapman LJ, Chapman JP, Kwapil TR, Eckblad M, Zinser MC. Putatively psychosis-prone subjects 10 years later. *J Abnorm Psychol.* 1994; 103(2):171–183. [PubMed: 8040487]
- Cohen AS, Callaway DA, Najolia GM, Larsen JT, Strauss GP. On “risk” and reward: Investigating state anhedonia in psychometrically defined schizotypy and schizophrenia. *J Abnorm Psychol.* 2012; 121(2):407–415. [PubMed: 22149913]
- Cohen AS, Leung WW, Saperstein AM, Blanchard JJ. Neuropsychological functioning and social anhedonia: Results from a community high-risk study. *Schizophr Res.* 2006; 85(1–3):132–141. [PubMed: 16730428]
- Damiano CR, Aloï J, Treadway M, Bodfish JW, Dichter GS. Adults with autism spectrum disorders exhibit decreased sensitivity to reward parameters when making effort-based decisions. *J Neurodev Disord.* 2012; 4(1):13. [PubMed: 22958545]
- Diaz MA, Dickerson LA, Kwapil TR. A two-year follow-up assessment of schizotypic young adults. *Schizophr Res.* 2003; 60(1):167–168. [PubMed: 12591580]
- Diaz MA. A three-year longitudinal study of social anhedonia and comparison groups. *Diss Abstr Int.* 2006; 66:AAI3186007.
- Earnst K, Kring A. Emotional responding in deficit and non-deficit schizophrenia. *Psychiatr Res.* 1999; 88(3):191–207.
- Eckblad M, Chapman LJ. Magical ideation as an indicator of schizotypy. *J Consult Clinic Psychol.* 1983; 51(2):215–225.
- Eckblad, ML.; Chapman, LJ.; Chapman, JP.; Mishlove, M. The Revised Social Anhedonia Scale. University of Wisconsin; Madison, WI: 1982. Unpublished test
- Fervaha G, Graff-Guerrero A, Zakzanis KK, Foussias G, Agid O, Remington G. Incentive motivation deficits in schizophrenia reflect effort computation impairments during cost-benefit decision-making. *Psychiatr Res.* 2013; 47(11):1590–1596.
- Gard DE, Kring AM, Gard MG, Horan WP, Green MF. Anhedonia in schizophrenia: distinctions between anticipatory and consummatory pleasure. *Schizophr Res.* 2007; 93(1–3):253–260. [PubMed: 17490858]
- Gold JM, Waltz JA, Matveeva TM, Kasanova Z, Strauss GP, Herbener ES, Frank MJ. Negative symptoms and the failure to represent the expected reward value of actions: behavioral and computational modeling evidence. *Arch Gen Psychiat.* 2012; 69(2):129–138. [PubMed: 22310503]
- Gold JM, Strauss GP, Waltz JA, Robinson BM, Brown JK, Frank MJ. Negative symptoms of schizophrenia are associated with abnormal effort-cost computations. *Biol Psychiat.* 2013; 74(2): 130–136. [PubMed: 23394903]
- Gooding DC, Tallent KA, Matts CW. Clinical status of at-risk individuals 5 years later: further validation of the psychometric high-risk strategy. *J Abnorm Psychol.* 2005; 114(1):170–175. [PubMed: 15709824]

- Gooding DC, Davidson RJ, Putnam KM, Tallent KA. Normative emotion-modulated startle response in individuals at risk for schizophrenia–spectrum disorders. *Schizophr Res.* 2002; 57(1):109–120. [PubMed: 12165381]
- Horan WP, Brown SA, Blanchard JJ. Social anhedonia and schizotypy: The contribution of individual differences in affective traits, stress, and coping. *Psychiatr Res.* 2007; 149(1–3):147–156.
- Kerns JG, Docherty AR, Martin EA. Social and physical anhedonia and valence and arousal aspects of emotional experience. *J Abnorm Psychol.* 2008; 117(4):735–746. [PubMed: 19025222]
- Kwapil TR. Social anhedonia as a predictor of the development of schizophrenia-spectrum disorders. *J Abnorm Psychol.* 1998; 107(4):558–565. [PubMed: 9830243]
- Lenzenweger MF. Schizotypy: An organizing framework for schizophrenia research. *Curr Dir Psychol Sci.* 2006; 15(4):162–166.
- Leung WW, Couture SM, Blanchard JJ, Lin S, Llerena K. Is social anhedonia related to emotional responsivity and expressivity? A laboratory study in women. *Schizophr Res.* 2010; 124(1–3):66–73. [PubMed: 20620020]
- Lin A, Rangel A, Adolphs R. Impaired learning of social compared to monetary rewards in autism. *Front Neurosci.* 2012; 6(1):143. [PubMed: 23060743]
- Llerena K, Park SG, Couture SM, Blanchard JJ. Social anhedonia and affiliation: Examining behavior and subjective reactions within a social interaction. *Psychiatri Res.* 2012; 200(2):679–686.
- Martin EA, Becker TM, Cicero DC, Docherty AR, Kerns JG. Differential associations between schizotypy facets and emotion traits. *Psychiatri Res.* 2011; 187(1–2):94–99.
- Raine A. The SPQ: A scale for the assessment of schizotypal personality based on DSM-III-R criteria. *Schizophr Bull.* 1991; 17(4):556–564.
- Reise SP, Horan WP, Blanchard JJ. The challenges of fitting an item response theory model to the Social Anhedonia Scale. *J Personal Assess.* 2011; 93(3):213–224.
- Strauss GP, Frank MJ, Waltz JA, Kasanova Z, Herbener ES, Gold JM. Deficits in positive reinforcement learning and uncertainty-driven exploration are associated with distinct aspects of negative symptoms in schizophrenia. *Biol Psychiatr.* 2011; 69(5):424–431.
- Tallent KA, Gooding DC. Working memory and Wisconsin Card Sorting Test performance in schizotypic individuals: a replication and extension. *Psychiatr Res.* 1999; 89(3):161–170.
- Treadway MT, Bossaller NA, Shelton RC, Zald DH. Effort-based decision-making in major depressive disorder: A translational model of motivational anhedonia. *J Abnorm Psychol.* 2012; 121(3):553. [PubMed: 22775583]
- Treadway MT, Buckholtz JW, Schwartzman AN, Lambert WE, Zald DH. Worth the ‘EEfRT’? The effort expenditure for rewards task as an objective measure of motivation and anhedonia. *PLoS One.* 2009; 4(8)
- Treadway MT, Zald DH. Reconsidering anhedonia in depression: lessons from translational neuroscience. *Neurosci Biobehav R.* 2011; 35(3):537–555.
- Trémeau F, Antonius D, Cacioppo JT, Ziwich R, Jalbrzikowski M, Saccante E, Javitt D. In support of Bleuler: objective evidence for increased affective ambivalence in schizophrenia based upon evocative testing. *Schizophr Res.* 2009; 107(2):223–231. [PubMed: 18947981]
- Xie WZ, Yan C, Ying XY, Zhu SY, Shi HS, Wang Y, Chan RC. Domain-specific hedonic deficits towards social affective but not monetary incentives in social anhedonia. *Scientific Reports.* 2014; 4

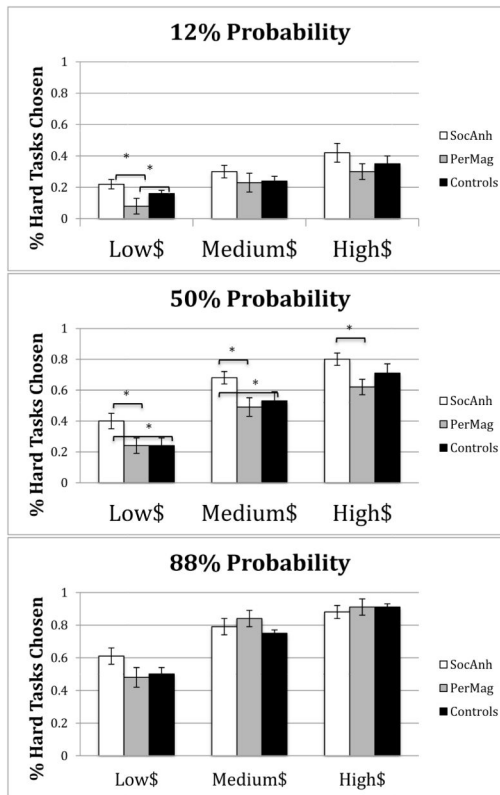


Figure 1. Proportion of Hard Tasks Chosen on the EEfRT for Social Anhedonia (SocAnh), Perceptual Aberration and Magical Ideation (PerMag), and Control Groups
 *p < .05; Low = \$1.24 to \$2.00; Med = Medium \$2.01 to \$3.00; High = \$3.01 to \$4.12

Table 1

Demographic and Clinical Characteristics for Social Anhedonia (SocAnh), Perceptual Aberration and Magical Ideation (PerMag), and Control Groups

	SocAnh (<i>n</i> = 30)	PerMag (<i>n</i> = 30)	Control (<i>n</i> = 40)	<i>F</i> or χ^2
Age M(SD)	20.40 (3.35)	18.77 (.97)	20.35 (2.47)	<i>F</i> =4.45*
Gender (%(ct))				χ^2 = 0.35
Male	30 (9)	23.3 (7)	27.5 (11)	
Female	70 (21)	76.7 (23)	72.5 (29)	
Race (%(ct))				χ^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))				χ^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)	<i>F</i> =17.52**
Cognitive-Perceptual	9.30 (6.87)	11.30 (7.69)	3.70 (3.01)	<i>F</i> =15.60**
Interpersonal	8.47 (3.85)	4.87 (3.85)	3.48 (3.14)	<i>F</i> =17.13**
BDI-II	6.90 (6.18)	3.83 (4.08)	2.75 (3.21)	<i>F</i> =7.44**

* $p < 0.05$

** $p < 0.01$

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

Table 2

Proportion of Hard Tasks Chosen on the EEfRT for Social Anhedonia (SocAnh), Perceptual Aberration and Magical Ideation (PerMag), and Control Groups

	SocAnh (<i>n</i> = 30)	PerMag (<i>n</i> = 30)	Control (<i>n</i> = 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 x 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% (<i>n</i> = 1)	0% (<i>n</i> = 0)	2.5% (<i>n</i> = 1)
Trials Completed	.99 (.02)	.98 (.05)	.95 (.16)

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