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Temporal discounting across three psychiatric disorders: Anorexia nervosa, obsessive compulsive disorder, and social anxiety disorder

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Abstract

Background—Temporal discounting refers to the tendency for rewards to lose value as the expected delay to receipt increases. Individuals with anorexia nervosa (AN) have been found to show reduced temporal discounting rates, indicating a greater preference for delayed rewards compared to healthy peers. Obsessive–compulsive disorder (OCD) and social anxiety disorder (SAD) commonly co-occur with AN, and anxiety has been related to development and prognosis of AN. We examined whether reduced temporal discounting is present across these potentially related disorders, and explored the relationship between temporal discounting and anxiety trans-diagnostically.

Methods—One hundred ninety six individuals (75 healthy controls (HC); 50 OCD; 27 AN; 44 SAD) completed two temporal discounting tasks in which they chose between smaller-sooner and larger-later monetary rewards. Two measures of discounting—discount rate and discount factor—were compared between diagnostic groups, and associations with anxious traits were examined.

Results—Individuals with AN showed decreased temporal discounting compared to HC. OCD and SAD groups did not differ significantly from HC. Across the sample, anxiety was associated with decreased discounting; more anxious individuals showed a greater preference for delayed reward.

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ETHICAL STANDARDS

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

CONFLICT OF INTEREST

Drs. Steinglass and Walsh receive royalties from Up To Date, Inc. Dr. Walsh receives royalties from Guilford Press, and McGraw-Hill. Dr. Simpson has received royalties from Cambridge University Press and UpToDate, Inc. Dr. Schneier has received research support from Forest Allergan, served on a scientific advisory board for Genentech, and received royalties from Cambridge University Press and UpTo-Date, Inc. Drs. Lempert, Kimeldorf, Wall, Choo, and Fyer, reported no biomedical financial interests or potential conflicts of interest.

Conclusions—We replicated the findings that individuals with AN show an increased preference for delayed reward relative to HC and that individuals with OCD do not differ from HC. We also showed that individuals with SAD do not differ from HC in discounting. Across this large sample, two measures of anxious temperament were associated with temporal discounting. These data raise new questions about the relationship between this dimensional trait and psychopathology.

Keywords

anorexia nervosa; anxiety disorders; delay discounting; eating disorders; obsessive compulsive disorder; social anxiety disorder; temporal discounting

1 | INTRODUCTION

People usually prefer rewards sooner rather than later, even when the later reward is larger. This phenomenon is known as temporal discounting (or “delay discounting”). The degree to which people discount future rewards varies across individuals and across contexts (Lempert & Phelps, 2016). The tendency to choose immediate rewards has been associated with risky behaviors, such as smoking (Ohmura, Takahashi, & Kitamura, 2005) and texting while driving (Hayashi, Russo, & Wirth, 2015). Delaying rewards can be advantageous, and has been associated with better academic achievement (Kirby, Winston, & Santiesteban, 2005) and lower credit card debt (Meier & Sprenger, 2012). However, the tendency to choose delayed rewards beyond the norm has also been associated with psychopathology (Dombrovski et al., 2011; Pinto, Steinglass, Greene, Weber, & Simpson, 2014; Steinglass et al., 2012). As psychiatric illnesses are increasingly considered to share dimensions of psychopathology (Insel et al., 2010), we examined temporal discounting across three psychiatric illnesses—*anorexia nervosa* (AN), *obsessive–compulsive disorder* (OCD), and *social anxiety disorder* (SAD)—that commonly co-occur and also share clinical features.

Temporal discounting is measured by asking individuals to make choices between smaller monetary amounts that are available now or after a short delay (“smaller-sooner”; e.g., “\$25 today”) and larger amounts available after a longer delay (“larger-later”; e.g., “\$100 in 2 months”). Through a series of such choices, an individual’s discount function can be estimated (Kable, 2014). The steepness of the discount function indicates the degree to which an individual prefers smaller-sooner versus larger-later rewards.

Abnormalities in temporal discounting have been observed in psychiatric disorders. Individuals with substance use disorders, compulsive gambling, and attention deficit disorder tend to discount future rewards at a very steep rate (Barkley, Edwards, Laneri, Fletcher, & Metevia, 2001; Demurie, Roeyers, Baeyens, & Sonuga-Barke, 2012; Dixon, Jacobs, & Sanders, 2006; Reynolds, 2006). At the other extreme, two studies of AN (Decker, Figner, & Steinglass, 2015; Steinglass et al., 2012) and one of obsessive–compulsive personality disorder (OCPD) (Pinto et al., 2014) reported a tendency for these individuals to discount significantly *less* than healthy peers. While findings in AN have not been entirely consistent (King et al., 2016; Ritschel et al., 2015), these studies suggest that a propensity to choose larger-later rewards can also be associated with pathology. Clinically, individuals

with AN appear to be forgoing an immediate reward (food) in favor of the potential for delayed reward (weight loss).

In this study, we sought to determine whether the preference for delayed rewards described in AN might also be present in other disorders that phenotypically overlap with AN. While AN is defined and differentiated from other disorders by abnormalities in eating behavior, other clinical features of AN suggest possible shared underlying features with anxiety disorders (Steinglass et al., 2011). For example, the avoidance of feared foods and stereotyped eating behaviors overlap with avoidant and stereotyped behaviors in OCD and anxiety disorders, and the preoccupations across these disorders involve an irrational belief system with maladaptive behaviors organized around these beliefs (Steinglass et al., 2011). The symptomatic similarity between AN and OCD has long been noted (Hsu, Kaye, & Weltzin, 1993), with the presence of intrusive thoughts and corresponding ritualized behaviors in both disorders. In fact, OCD and SAD are the most common co-occurring anxiety disorders with AN (Halmi et al., 1991; Kaye, Bulik, Thornton, Barbarich, & Masters, 2004). Moreover, anxious traits have been related to the heritability of AN (Jacobs et al., 2009), as well as illness course and prognosis (Guarda et al., 2015; Zerwas et al., 2013). Retrospective studies have suggested that an anxiety disorder often precedes the onset of AN (Godart et al., 2003; Kaye et al., 2004). Social fears, including fear of eating in front of others, are also common in AN (Levinson et al., 2013). Together, these studies suggest AN, OCD, and SAD might share an underlying anxious diathesis, or vulnerability.

We assessed temporal discounting behavior across AN, OCD, and SAD, compared with healthy controls (HC). Based on prior work, our primary hypothesis was that individuals with AN would show less steep discounting than HC. We explored whether OCD and SAD patients differed from HC on temporal discounting. Secondarily, we hypothesized that temporal discounting is associated with dimensional measures of anxiety across these groups.

2 | MATERIALS AND METHODS

The data in this paper were obtained at the New York State Psychiatric Institute/Columbia University Medical Center in a study using neurobehavioral probes of different neural processes across AN, OCD, and SAD. The institutional review board approved this study and participants provided written informed consent.

2.1 | Participants

Participants were adults between the ages of 18 and 50 years with no psychiatric diagnosis (HC) or with a primary diagnosis of AN, OCD, or SAD. Primary diagnosis was made by clinical interview with a doctoral-level clinician, and confirmed by a Structured Clinical Interview for DSM-IV (SCID) (First, Spitzer, Gibbon, & Williams, 2002). HC had no lifetime psychiatric illness. Participants with AN were not excluded for comorbid SAD or OCD of lesser severity, as these illnesses commonly co-occur with AN (Hudson, Hiripi, Pope, & Kessler, 2007), and this overlap was relevant to the hypotheses being studied. Participants with OCD or SAD could have only one of these disorders. Other current comorbid Axis I disorders, except for specific phobias or tic disorders, were exclusionary for

all groups. Individuals with AN were inpatients (individuals with OCD and SAD were outpatients) and had a body mass index (BMI) between 16.0 and 18.5 kg/m². Participants had no significant medical illness, were not taking psychotropic medications, and (except for AN) had a BMI in the normal range. Women were excluded if they were pregnant, nursing, postmenopausal, or using hormonal methods of birth control. HC were group matched for age, sex, and ethnicity. All participants were monetarily compensated for participation in this study.

Of the 217 who consented to participate, data from 17 were not analyzed because: the participant did not return after consenting (5 SAD, 1 OCD, 1 HC), toxicology screen was positive (1 SAD, 2 HC), the participant was later found to meet an exclusion criterion (3 SAD, 3 OCD, 1 HC), or the computer malfunctioned ($n = 3$). The single male with AN was excluded. Five included participants with AN had participated in the author's previous study (Decker, Figner, & Steinglass, 2015). For menstruating women, study procedures were conducted during the early follicular phase of the menstrual cycle.

2.2 | Clinical assessment

A uniform battery of assessments was used for all participants. OCD symptoms were measured with the Yale-Brown Obsessive Compulsive Scale (Y-BOCS, Goodman et al., 1989). SAD symptoms were assessed with the Liebowitz Social Anxiety Scale (LSAS, Liebowitz, 1987). Interviews were administered by a clinical psychologist. Eating disorder symptoms were assessed with the Eating Disorder Examination-Questionnaire (EDE-Q, Fairburn, 2008), a self-report measure.

Anxiety was assessed across groups using the State Trait Anxiety Inventory (STAI, Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), trait scale. The personality factor of neuroticism, which is closely related to trait anxiety, was examined using the NEO-Five Factor Inventory Neuroticism subscale (NEO-FFI, Costa & McCrae, 1992). Estimated IQ was determined using the North American Adult Reading Test (NAART, Blair & Spreen, 1989).

2.3 | Intertemporal choice task

Participants were told at the beginning of this task that one of their choices would be randomly selected and they would receive the amount they had selected on that trial, at the time indicated, in the form of an Amazon gift card delivered by e-mail.

In the Intertemporal Choice Task (Fig. 1A), participants made 72 choices between smaller-sooner rewards (pseudorandomly drawn from a normal distribution with a mean of \$45 [range: \$15–\$85]) and larger-later rewards (0.5–75% larger than the smaller-sooner). For half the trials, the smaller-sooner option was available immediately and the larger-later was available in 2 or 4 weeks. For the other half, the smaller-sooner was available in 2 weeks, and the larger-later was available in 4 or 6 weeks. Trials were presented in six random orders, counterbalanced across subjects.

The intertemporal choice task yielded a *discount rate* for each individual, quantified by fitting a hyperbolic model of delay discounting to his/her choices (Green & Myerson, 2004;

Mazur, 1987). The hyperbolic model is the most commonly used model in psychology, and has been shown to characterize behavior in this task better than most other models (Frederick, Loewenstein, & O'Donoghue, 2002; McKerchar et al., 2009). In the hyperbolic model:

$$SV_{\text{del}} = \frac{A}{1+kD}$$

SV_{del} is the subjective value of the delayed reward, A is the amount of the delayed reward, D is the delay (in days), and k is the parameter that represents the participant's discount rate. We determined the best-fitting discount rate parameter k , which minimized the negative log-likelihood of individual choice probability. Higher k values (i.e., increased discount rates) indicate steeper discounting of delayed reward, or tendency to prefer the smaller-sooner reward, while lower k values indicate greater preference for the larger-later option. For individuals who selected all smaller-sooner or all larger-later responses, discount rates could not be fit to the model, and extreme k values were assigned as described elsewhere (Decker et al., 2015).

2.4 | Titration task

In this task, 4 screens were presented to the subject, with 11 choices on each screen (Fig. 1B). On two screens, participants chose between a smaller-sooner amount today ($\$50 \pm \2) and a larger-later amount in three months that increased in increments of $\$5$ [range: $\$55$ – $\$105$]. On the other two screens, the smaller-sooner amount ($\$30 \pm \2) was available in 2 months and the larger-later in 5 months [range: $\$35$ – $\$85$]. From each screen, an “indifference point” at which an individual's preference switches from the default choice could be determined. Each indifference point was used to calculate a *discount factor* (δ) for each screen for each participant, following the methods of Weber et al. (2007) where:

$$\delta = (X_1/X_2)^{(1/(t_2-t_1))}$$

Here, X_1 refers to the value of the smaller-sooner reward, X_2 refers to the indifference point at which subjects switched between the smaller-sooner and larger-later reward, and $t_2 - t_1$ refers to the difference in the delay between the smaller-sooner and the larger-later in days (90 days). For cases in which participants did not switch, the indifference point was assigned using the smallest or the largest larger-later amount, as appropriate. Four discount factors were derived for each individual from the four titration screens, and an average *discount factor* was calculated. Higher discount factor indicates greater tendency to delay reward.

2.5 | Statistical analyses

Clinical characteristics of diagnostic groups were compared using ANOVA to compare the means of continuous variables, and Fisher's exact test for categorical variables. The primary outcome measure was the discount rate k derived from the intertemporal choice task. The secondary outcome measure was the discount factor δ , from the titration task. Pearson's correlation coefficient was calculated to assess the relationship between the two outcome

measures. One-way ANOVAs were used to examine differences in discount rate and discount factor by diagnostic group. The discount rate k was log-transformed to improve normality for analyses. Preplanned pairwise contrasts compared means for each diagnostic group with HC. Other covariates (age, sex, education, IQ, and race) were considered for inclusion as control variables if they were significantly different across groups and were also significantly associated with discount rate.

Spearman's correlation coefficients were computed to examine the relationships between discount rate and discount factor and two measures of anxious traits, the STAI-T and NEO-FFI. Spearman's correlation was used because STAI-T and NEO-FFI scores were not normally distributed within diagnostic groups. Correlations were examined both for the whole sample, and within each diagnostic group.

3 | RESULTS

The final sample included 196 individuals (HC, $n = 75$; OCD, $n = 50$; AN, $n = 27$; SAD, $n = 44$; Table 1). Among individuals with AN, 2 were diagnosed with comorbid OCD, 7 with SAD, and one with both. The distribution of age, sex, education, IQ, and race did not differ across the diagnostic groups with the exception of race and sex, which differed among the AN compared to HC. Further consideration of race found no significant association between race (dichotomized as White/non-White because of the limited racial diversity in the AN sample) and discount rate ($t(193) = 1.40$, $P = .16$). There were no significant relationships between discount rate and age ($r = -0.04$, $P = .61$), IQ ($r = -0.12$, $P = .10$), gender ($t(194) = 0.83$, $P = .41$), or education ($r = -0.05$, $P = 0.52$). Thus, none of these covariates were included in further analyses.

There was a significant overall effect of diagnosis on discount rate k ($F(3,195) = 4.19$; $P = 0.011$; Table 2). Individuals with AN had significantly lower discount rates (i.e., less steep discounting) in the intertemporal choice task than HC ($t(189) = 2.38$; $P = .018$, Cohen's $d = 0.527$). There were no significant differences between HC and individuals with OCD ($t(189) = 1.33$; $P = .187$), or with SAD ($t(189) = -0.84$; $P = .403$). To ensure that the effect in AN was not driven by gender differences (all AN were female), we compared AN with female HC, and found a significant difference ($t(189) = -2.07$; $P = .042$, Cohen's $d = -0.495$).

There was also a significant effect of diagnosis on discount factor ($F(3,191) = 3.36$; $P = .020$). Individuals with AN had significantly higher discount factors (less steep discounting) than HC ($t(188) = -2.37$, $P = .019$, Cohen's $d = -0.526$; when compared with female HC only, $t(188) = 1.82$, $P = .074$). Individuals with SAD showed a trend toward exhibiting higher discount factors compared to HC ($t(188) = 1.82$; $P = .071$). There were no significant differences between HC and OCD ($t(188) = -0.49$; $P = .621$). Discount rate, derived from the intertemporal choice task, and discount factor, computed from the titration task, were highly correlated with each other ($r = -0.788$; $P < .001$).

There was a significant association between trait anxiety (STAI-T) and discount rate ($r = -0.210$; $P = .003$; Fig. 2A). Among all participants, higher anxiety was significantly associated with lower discount rate, or a preference for the larger-later reward. Within AN

and HC groups, there were no significant correlations between discount rate and STAI-T (AN: $r = 0.04$; $P = .859$; HC: $r = 0.04$; $P = .702$). However, the relationships were significant among individuals with OCD ($r = -0.313$, $P = .027$), and at a trend level for individuals with SAD ($r = -0.282$, $P = 0.063$). Neuroticism (NEO-FFI) was also related to discount rate across the whole sample ($r = -0.157$, $P = .028$, Fig. 2B), but there were no significant correlations between NEO-FFI and discount rate within the diagnostic groups (AN: $r = 0.01$; $P = .968$; HC: $r = 0.06$; $P = .619$; OCD: $r = -0.14$; $P = .318$; SAD: $r = -0.14$; $P = .354$).

There was a significant association between STAI-T and discount factor ($r = 0.244$; $P < .001$; higher anxiety was associated with preference for larger-later reward). Within the OCD and SAD groups, the correlation between STAI-T and discount factor was significant (OCD: $r = 0.366$, $P = .009$; SAD: $r = 0.314$, $P = .038$). The correlations were not significant within AN ($r = -0.11$; $P = .590$) or HC ($r = 0.09$; $P = .453$) groups. NEO-FFI was related to discount factor across the whole sample ($r = 0.155$, $P = .031$), but not within any of the diagnostic groups (AN: $r = 0.02$; $P = .937$; HC: $r = -0.12$; $P = .300$; OCD: $r = 0.13$; $P = .372$; SAD: $r = 0.20$; $p = 0.203$).

4 | DISCUSSION

Here, we measured temporal discounting across three psychiatric diagnoses, AN, OCD, and SAD, compared to HC. Consistent with our prior research (Decker et al., 2015; Steinglass et al., 2012), individuals with AN differed from HC, showing less steep discounting, suggesting greater preference for larger-later rewards over smaller-sooner rewards. Similarities between AN and OCD have long been noted (Hsu et al., 1993), yet individuals with OCD did not differ from HC in temporal discounting, also replicating our prior finding (Pinto et al., 2014). While social anxiety has been studied in nonclinical populations (Jenks & Lawyer, 2015; Rounds, Beck, & Grant, 2007), to our knowledge these are the first data investigating temporal discounting in individuals with SAD, and they showed no differences from HC.

Our study is the third to document less steep discounting among AN (Decker et al., 2015; Steinglass et al., 2012). The first reported less steep discounting as measured by the titration task, in a heterogeneous sample of patients with AN, including inpatients and outpatients at differing stages in treatment (Steinglass et al., 2012). The second study, using an intertemporal choice task during fMRI scanning, showed less steep discounting among acutely ill, hospitalized patients with AN (similar to patients in the current study), and normalization of discount rate with acute (weight restoration) treatment (Decker et al., 2015). However, the result did not reach significance in the subset studied in the scanner. Two other studies involving adolescents with AN did not find differences between AN and HC (King et al., 2016; Ritschel et al., 2015). Interestingly, adolescents with AN are known to have a better prognosis and a better response to treatment (Lock et al., 2010), and in the adolescent sample 80% were in their first episode of illness (King et al., 2016). It is difficult to determine whether the null finding suggests an age-related difference in delay discounting or suggests a relationship between less steep discounting and more chronic illness. One study has shown that individuals who recovered from AN did not differ from HC in discounting rates (Wierenga et al., 2015). There are also some methodological differences in

the delay discounting tasks between these studies. Null findings were found with an adjusting-delayed amount task (Ripke et al., 2012), which may result in differences in inferred discount rate compared to our choice tasks. Previous research has shown that the structure of the task can influence discount rate (Lempert & Phelps, 2016). The finding of altered temporal discounting among low-weight adults with AN contributes to a growing literature that starvation impacts decision-making in ways that may contribute to the persistence of AN (Cavedini et al., 2004; Foerde, Steinglass, Shohamy, & Walsh, 2015; Tchanturia et al., 2004, 2007).

There were no differences in discounting between HC and patients with either OCD or SAD. Two prior studies in healthy participants examined the impact of features of social anxiety on temporal discounting and had conflicting findings—one showed no effect (Jenks & Lawyer, 2015), and one suggested that more socially anxious individuals show steeper discounting (Rounds et al., 2007). In the present study, neither the diagnosis of SAD nor socially anxious symptoms in HC (measured by the LSAS) were associated with temporal discounting.

High levels of trait anxiety, as measured by the STAI-T, were present across all three psychiatric groups. Higher trait anxiety scores were associated with less steep temporal discounting, meaning that greater anxiety was associated with greater tendency to prefer the larger-later reward. This result held both when discount rate and discount factor were used as outcome variables, providing convergent evidence for this finding. The relationship between trait anxiety and temporal discounting has not been directly investigated previously, and the role of anxiety in decision-making has been relatively underexplored (Hartley & Phelps, 2012). We also found that neuroticism (which is closely related to trait anxiety) was associated with less temporal discounting. We found no relationship between temporal discounting and anxiety or neuroticism in our HC sample, consistent with prior studies of healthy individuals (Augustine & Larsen, 2011; Manning et al., 2014). Healthy individuals have a narrower range of neuroticism and anxiety scores, however, thus decreasing power to detect any association with behavior. It is notable that AN, which did show a group difference, had the highest mean STAI-T score, perhaps reflecting more severe pathology in this group.

Steeper temporal discounting has been shown to be associated with impulsive behaviors among healthy individuals and is often interpreted as a measure of impulsivity (Lange & Eggert, 2015; Reynolds, Ortengren, Richards, & de Wit, 2006; Reynolds, Penfold, & Patak, 2008). Less steep discounting has been presumed to confer benefits (e.g., Kirby et al., 2005). However, our results coupled with one study in OCPD (Pinto et al., 2014) and one study of suicidal individuals (Dombrovski et al., 2011) suggest a relationship between less steep discounting and psychopathology. We conclude that individual variability in temporal discounting exists along a continuum and extremes at either end may be associated with behavioral disturbances.

This study has several methodological strengths. Patients were not taking any medications, eliminating confounding effects of psychotropic medications. The sample sizes for the HC, OCD, and SAD groups were substantial, allowing for meaningful conclusions from these

negative findings. Additionally, we used two well-established measures of temporal discounting, involving real monetary rewards. The limitations of this study include that the AN group was small and had a restricted range of trait anxiety, potentially limiting the ability to detect an effect between trait anxiety and temporal discounting in that group. The AN population also differed from the other diagnostic groups in that they were more demographically homogeneous and were hospitalized.

5 | CONCLUSION

We found a preference for larger-later rewards over smaller-sooner rewards in AN, and contributed to a small literature suggesting no difference in delay discounting in OCD or SAD. We also found that this behavior is related to trait anxiety. These findings suggest three avenues of future research. First, it will be useful to examine the specificity of the relationship between trait anxiety and temporal discounting, since these measures are highly correlated with depression. The range of depressive symptomatology was limited in the present study where a diagnosis of depression was an exclusion criterion. Second, cognitive neuroscience approaches are needed to examine the neural substrates that underlie the relationship between anxiety and the brain circuits that subserve temporal discounting. Finally, research is needed to examine whether temporal discounting provides a novel target for transdiagnostic treatment interventions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

AN	anorexia nervosa
BMI	body mass index
HC	healthy controls
OCD	Obsessive–compulsive disorder
OCPD	obsessive–compulsive personality disorder
STAI	State Trait Anxiety Inventory
SAD	social anxiety disorder

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A

<div style="text-align: center;">\$53.10 Today</div> <div style="text-align: center;">☒</div>	<div style="text-align: center;">\$66.90 2 weeks</div> <div style="text-align: center;">☐</div>
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B

Please choose one option in each row.

☒ \$ 50 today	☐ \$ 55 in 3 months
☒ \$ 50 today	☐ \$ 60 in 3 months
☐ \$ 50 today	☒ \$ 65 in 3 months
☐ \$ 50 today	☒ \$ 70 in 3 months
☐ \$ 50 today	☒ \$ 75 in 3 months
☐ \$ 50 today	☒ \$ 80 in 3 months

FIGURE 1. Temporal discounting tasks

(A) Example trial from the Titration Task. Participants chose between the two options in each line. The SS reward did not change in value, while the LL reward increased in amount. The point at which individuals switched from the SS to the LL option was used to calculate a discount factor. For presentation purposes, this screen is truncated, but amounts in the column on the right side increased to \$105. (B) Example trial from the Intertemporal Choice Task. On each trial, individuals selected between a smaller/sooner (SS) reward and a larger/later (LL) reward by clicking on the radio button below it. When they finished making their choice, they clicked on the “Next” button to move on to the next trial.

FIGURE 2. Trait anxiety is associated with less temporal discounting

The relationship between (A) STAI-T score and (B) NEO-FFI score and log-transformed discount rate. Across all groups, there was a significant negative relationship between discount rate and both STAI-T (trait anxiety) score and NEO-FFI (neuroticism), suggesting that more anxious individuals exhibited greater preference for the larger, delayed reward.

TABLE 1

Demographics and clinical characteristics

	Healthy controls (<i>n</i> = 75) Mean ± SD	Anorexia nervosa (<i>n</i> = 27) Mean ± SD	Obsessive compulsive Disorder (<i>n</i> = 50) Mean ± SD	Social anxiety disorder (<i>n</i> = 44) Mean ± SD	<i>P</i> *
Age (years)	29.0 ± 7.6	27.7 ± 7.5	29.2 ± 5.8	30.0 ± 4	.635
Male	36 (48%)	0 (0%)	26 (52%)	19 (43%)	.886
Non-Hispanic White	42 (56%)	26 (96%)	25 (56%)	17 (38%)	.342
Hispanic White	12 (16%)	1 (4%)	8 (16%)	11 (25%)	
Asian	5 (7%)	0 (0%)	4 (8%)	5 (11%)	
Black	15 (30%)	0 (0%)	12 (24%)	7 (15%)	
Other	1 (1%)	0 (0%)	1 (2%)	4 (9%)	
BMI (kg/m ²)	24.1 ± 4.4	17.5 ± 1.0	24.6 ± 5.3	23.9 ± 6.3	<.001
Years of Education	15.7 ± 2.2	14.9 ± 2.0	15.4 ± 2.0	15.5 ± 2.0	.399
Estimated IQ (NAART)	108.8 ± 14.5	108.1 ± 8.2	109.6 ± 8.5	110.2 ± 7.7	.722
EDE-Q, global	0.49 ± 0.63	3.57 ± 1.52	0.98 ± 0.96	0.92 ± 0.92	<.001
Y-BOCS, total	0.27 ± 0.99	9.85 ± 10.60	25.12 ± 3.38	3.17 ± 5.88	<.001
LSAS, total	11.39 ± 7.96	52.44 ± 23.07	24.18 ± 16.66	75.72 ± 20.05	<.001
STAI-trait	31.41 ± 5.20	53.90 ± 8.67	43.36 ± 10.61	47.78 ± 8.70	<.001
Neuroticism NEO-FFI	15.07 ± 4.37	24.74 ± 4.19	17.84 ± 5.89	22.57 ± 4.73	<.001

BMI, Body Mass Index; NAART, North American Adult Reading Test; EDE-Q, Eating Disorder Examination Questionnaire; YBOCS, Yale-Brown Obsessive Compulsive Scale; LSAS, Liebowitz Social Anxiety Scale; STAI, State Trait Anxiety Inventory; NEO-FFI, NEO Five Factor Inventory Neuroticism subscale.

* *p* refers to ANOVA comparing groups on each measure.

TABLE 2

Temporal discounting

	Discount rate, <i>K</i> Mean (SD)	Comparison to HC		
		<i>t</i>	<i>P</i>	<i>d</i>
HC (<i>n</i> = 75)	0.007 (0.011)	–	–	–
AN (<i>n</i> = 27)	0.003 (0.006)	2.38	.018	0.53
OCD (<i>n</i> = 50)	0.011 (0.018)	1.33	.187	0.24
SAD (<i>n</i> = 44)	0.005 (0.009)	–0.84	.403	–0.16

Notes: Means and SDs presented here are in original units, though analyses were performed on log-transformed discount rates.

HC, healthy controls; AN, anorexia nervosa; OCD, obsessive compulsive disorder; SAD, social anxiety disorder.