Published in final edited form as:

Eur Eat Disord Rev. 2015 July ; 23(4): 327–332. doi:10.1002/erv.2363.

The Functional Significance of Shyness in Anorexia Nervosa

Amy A. Winecoff¹, Lawrence Ngo^{2,3}, Ashley Moskovich^{4,5}, Rhonda Merwin⁵, and Nancy Zucker^{4,5,*}

¹Department of Psychology, Bard College, Annandale-On-Hudson, NY, USA

²Medical Scientist Training Program, Duke University School of Medicine, Durham, NC, USA

³Department of Neurobiology, Duke University School of Medicine, Durham, NC, USA

⁴Department of Psychology and Neuroscience, Duke University, Durham, NC, USA

⁵Department of Psychiatry and Behavioral Sciences, Duke University School of Medicine, Durham, NC, USA

Abstract

The defining features of anorexia nervosa (AN) include disordered eating and disturbance in the experience of their bodies. However, many women with AN also demonstrate higher harm avoidance (HA), lower novelty seeking, and challenges with interpersonal functioning. The current study explored whether HA and novelty seeking could explain variation in disordered eating and social functioning in healthy control women ($n = 18$), weight-restored women with a history of AN ($n = 17$), and women currently-ill with AN (AN; $n = 17$). Our results indicated that clinical participants (AN + weight-restored women) reported poorer social skills than healthy control participants. Moreover, the relationship between eating disorder symptoms and social skill deficits was mediated by HA. Follow-up analyses indicated that only the ‘shyness with strangers’ factor of HA independently mediated this relationship. Collectively, our results suggest a better understanding of shyness in many individuals with eating disorders could inform models of interpersonal functioning in AN.

Keywords

anorexia nervosa; harm avoidance; social functioning; shyness; temperament

Introduction and aims

Alterations in reward and punishment sensitivity are hypothesized to contribute to the pathophysiology of anorexia nervosa (AN; Kaye, Wierenga, Bailer, Simmons, & Bischoff-Grethe, 2013; Watson, Werling, Zucker, & Platt, 2010). Both behavioural decision-making tasks involving monetary rewards (Steinglass et al., 2012) as well as self-report measures

*Correspondence. Nancy Zucker, PHD, 2608 Erwin Rd, Suite 300, Department of Psychology and Neuroscience, Duke University, Durham, NC 27705 USA. Phone: (919)-668-2281. zucke001@mc.duke.edu.

Supporting information

Additional supporting information may be found in the online version of this article at the publisher's web-site.

(Harrison, O'Brien, Lopez, & Treasure, 2010) suggest that many women with AN are less sensitive to or motivated by rewards and more sensitive to threat and punishment. For example, women with AN exhibit more negative affective reactivity to food cues (stimuli typically considered rewarding) and more attention bias to negative social cues (stimuli typically considered punishing) (Friederich et al., 2006; Harrison, Tchanturia, & Treasure, 2010; Quinton, 2004). What is unknown is *how* alterations in reward and punishment sensitivity impact the pathophysiology of AN.

Evidence suggests that variation in reward and punishment sensitivity in AN may be associated with increased challenges in interacting with others. For example, low novelty seeking (NS) correlates with more stress reactivity in response to the Trier Social Stress Test (Tyrka et al., 2007), and high harm avoidance (HA) correlates with excessive and debilitating awareness of the feelings and behaviours of others (Otani, Suzuki, Ishii, Matsumoto, & Kamata, 2008). An individual's temperament provides a persisting framework that guides how she/he interacts with the environment (Cloninger, 1986). As such, temperament has been shown to contribute to whether individuals approach or avoid uncertain circumstances (Frank et al., 2012). In the ill state of AN, the behavioural predilections of temperament become exacerbated: individuals whose tendency is to avoid uncertainty do so to a greater degree (Bulik, Sullivan, Fear, & Pickering, 2000). As social contexts are rife with uncertainty, those with AN have been reported to become increasingly socially isolated in the ill state (Cunha, Relvas, & Soares, 2009). Thus, HA and NS may influence behaviours that lead to this avoidance. With decreased practice, those with AN may experience increased decrements in social competence. Indeed, difficulties in social functioning have been documented in AN (refer to Oldershaw et al. (2011) for a review). An analysis of how temperament influences social functioning could yield insight into interpersonal disruptions in AN and provide new avenues for intervention.

The purpose of the current investigation is to examine whether temperament mediates the relationship between disordered eating symptoms and social skill deficits in women with AN. To explore these possibilities, a cross-sectional, case-control design was employed. Women with a current diagnosis of AN (AN), weight-restored women with a prior diagnosis of AN (WR), and healthy control women (HC) who were matched for age, intellectual functioning, and race were recruited. Participants completed surveys to index their current symptoms, temperament, and social functioning. Consistent with prior research, it was hypothesized that (1) relative to HC, women with current or previous AN would show heightened HA paired with reduced NS; (2) that individual differences in these measures would be associated with poorer social skills; and (3) that differences in temperament would mediate the association between eating disorder symptoms and social dysfunction.

Method

Participants and procedure

The sample consisted of 52 female participants between the ages of 18 and 55 ($M = 27$ years; $SD = 9.2$ years). Participants were recruited through fliers posted at nearby universities, within outpatient, inpatient, and residential eating disorder treatment centres, via online advertisements, and through notices sent to mailing lists for local healthcare

providers. One hundred and sixty-four individuals responded to the advertisement. After excluding those who were male (this was part of a larger study of social cognition in which sex was a confound), had a history of psychosis, thought disorder, learning disability, or substance abuse, 95 underwent a structured clinical interview. Of these 95, 52 participants completed all three measures for the current study. Clinical participants had to currently meet (AN: $n = 17$) or previously have met (WR: $n = 17$) the criteria for AN as specified by the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5; American Psychiatric Association, 2013). WR participants had to have been weight restored for at least 6 months, and HC participants ($n = 20$) had to have no current or previous eating disorder symptoms. Each provided informed consent for a protocol approved by the Duke University School of Medicine (IRB#00008689). Refer to Supporting Information for demographics.

Survey measures

Autism spectrum quotient—(AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). The AQ is a 50-item scale that assesses autism-like traits in individuals with normal intelligence. Respondents indicate their answers using a four-point Likert scale, with higher scores reflecting more autism-like symptoms. The AQ demonstrates good test-retest reliability (Baron-Cohen et al., 2001) and moderate discriminant validity (Woodbury-Smith, Robinson, Wheelwright, & Baron-Cohen, 2005). Analyses in the current study utilized the three-factor structure reported by Austin (2005) to examine differences in the following factors: (1) social skill deficits (refer to Supporting Information); (2) details and pattern processing; and (3) communication and mindreading.

Eating Disorders Examination Questionnaire—(EDE-Q; Fairburn & Cooper, 1993). The EDE-Q is a 36-item questionnaire used to assess cognition and behaviour related to disordered eating over the past 28 days. The EDE-Q has four subscales: Restraint, Eating Concern, Shape Concern, and Weight Concern. A global EDE-Q score is computed by averaging scores across the four subscales. The EDE-Q demonstrates good psychometric properties (Luce & Crowther, 1999).

Temperament and character inventory—(TCI; Cloninger, Svrakic, & Wetzel, 1994). The TCI is a 240-item self-report scale used to assess personality and temperament. The TCI is broken into seven trait factors, four measuring temperament (HA, NS, reward dependence, and persistence), and three measuring character (self-directedness, self-transcendence, and cooperativeness). Each trait factor of the TCI is further broken down into four subscales. Given an a priori interest in NS and HA, group differences in the subscales of these two traits were also examined. The four subscales for NS include exploratory excitability (NS1), impulsiveness (NS2), extravagance (NS3), and disorderliness (NS4). The four subscales for HA include anticipatory worry (HA1), fear of uncertainty (HA2), shyness with strangers (HS3; refer to Supporting Information), and fatigability (HA4). The TCI demonstrates acceptable internal consistency (Cloninger et al., 1994). Only results from the NS and HA factors are reported.

Data analysis

All experimental variables were visually inspected, and measures were calculated to ensure a reasonable approximation of the normal distribution. All outcome variables demonstrated skewness and kurtosis values $<|2|$. Where participants failed to fill out all items of a questionnaire/subscale, their scores were removed from analysis of those measures. For group analyses, SAS 9.3 was used to perform an ordinary least squares ANOVA including a three-level variable for group (i.e. AN, WR, and HC). Where the overall model was significant, four follow-up contrasts were performed [AN vs. HC, AN vs. WR, WR vs. HC, and (AN + WR) vs. HC]. Two-step hierarchical regressions were used to explore whether NS or HA scores significantly improved estimates of participants' AQ social skill scores above and beyond clinical status alone.

The MBESS package developed for R was utilized (Kelley, 2010; Kelley, 2007a, 2007b; Preacher & Kelley, 2011) to examine whether temperament would mediate the relationship between social deficits and disordered eating. To ensure the appropriateness of mediation analysis, the interaction between the predictor and the mediator was tested. Where these interactions were non-significant, a non-parametric bootstrap analysis with 10 000 samples was performed. Statistically significant mediation was determined based on whether the bootstrapped 95% confidence interval contained 0 (Preacher & Hayes, 2004). The bootstrap mediation test—rather than the more commonly used Sobel test—was employed because of its superiority in dealing with power issues arising from nonnormality in the distribution of the indirect effect (refer to Preacher & Hayes, 2004), making bootstrapping more appropriate for our sample size.

Results

There was an effect of group membership on current body mass index ($F(2.47) = 17.01, p < 0.001$); however, our WR and HC participants did not differ on current body mass index ($p > 0.15$). For lowest body mass index, there was an overall effect of group ($F(2.46) = 47.28, p < 0.001$) and a significant difference between both clinical groups and HC. In contrast, the difference between WR and currently ill participants was not significant ($p > 0.76$). For the EDE-Q, all groups significantly differed on each subscale; refer to Table 1.

Hypothesis 1: Group differences in temperament

Analyses of HA indicated a significant overall effect of group ($F(2.49) = 8.92, R^2 = 0.267, p < 0.001$). Both clinical groups differed from HC [AN vs. HC: $F(1.49) = 16.96, p < 0.001$, WR vs. HC: $F(1.49) = 7.97, p < 0.01$, (AN + WR) vs. HC: $F(1.49) = 16.21, p < 0.001$] but did not differ from each other ($F(1.49) = 1.63, p > 0.2$). There was no significant effect of group for NS [$F(2.48) = 1.47, p > 0.24$]. The effect of group on overall AQ scores was also significant [$F(2.49) = 5.97, R^2 = 0.2, p < 0.006$]. In the contrasts, participants with current anorexia did not differ from WR participants [$F(1.49) = 1.67, p > 0.2$], but all other group comparisons were significant [AN vs. HC: $F(1.49) = 11.68, p < 0.002$, WR vs. HC: $F(1.49) = 4.44, p < 0.05$, (AN + WR) vs. HC: $F(1.49) = 10.28, p < 0.003$]. For the AQ social skill subscale, there was a significant effect of group [$F(2.49) = 4.16, R^2 = 0.15, p < 0.03$] with currently ill participants differing from HC [$F(1.49) = 8.32, p < 0.007$] and aggregated

clinical participants differing from HC [$F(1.49) = 6.05, p < 0.02$]. No group differences emerged for either of the other two AQ subscales; refer to Table 2.

Hypothesis 2: Association of temperament and social functioning

In our hierarchical regressions, clinical status was included [(AN +WR) vs. HC] as a dummy variable at Step 1 and HA or NS at Step 2. In *Hierarchical Model 1*, the effect of clinical status was significant [Full Model: $F(1.50) = 5.90, R^2 = 0.11, p < 0.02$]. The inclusion of HA scores significantly improved model predictions for AQ social skills [Full Model: $F(2.49) = 5.61, R^2 = 0.19, p < 0.007$]. A similar but negative effect was found for NS for *Hierarchical Model 2* [Step 1, Full Model: $F(1.49) = 5.44, R^2 = 0.1, p < 0.02$; Step 2, Full Model, $F(2.49) = 9.11, R^2 = 0.28, p < 0.001$]. Including both HA as well as NS also performed significantly better than clinical status alone [*Hierarchical Model 3*: Step 1, Full Model: $F(1.49) = 5.44, R^2 = 0.10, p < 0.03$, Step 2, Full Model: $F(3.47) = 7.63, R^2 = 0.33, p < 0.001$]; refer to Table 3.

Hypothesis 3: Mediating role of harm avoidance on disordered eating and social functioning

There was a direct effect of global EDE-Q on AQ social skills [path c: $b = 0.62, t(50) = 2.81, p < 0.008$] and an effect of EDE-Q on HA [path a: $b = 2.52, t(50) = 5.15, p < 0.001$]. When both HA and EDE-Q scores were included, there was a trend for HA to predict AQ social skills [path b: $b = 0.11, t(50) = 1.83, p > 0.07$], but the effect of EDE-Q on AQ social skill scores was no longer significant [path c': $b = 0.33, t(50) = 1.25, p > 0.2$]. The bootstrap analysis revealed a significant indirect effect of HA on AQ social skills [indirect effect (b) = 0.29, 95% confidence interval = (0.054, 0.582)], with HA mediating 46.4% of the total effect; refer to Figure 1.

Follow-up analyses were performed to examine whether any specific subscale of HA mediated the relationship between EDEQ scores and AQ social skills. Only shyness with strangers (HA3) was a significant mediator. There was an association between global EDE-Q and HA3 [path a: $b = -0.46, t(50) = 2.26, p < 0.004$] and between HA3 and AQ social skills [path b: $b = 0.55, t(50) = 4.11, p < 0.001$]. The inclusion of HA3 into the model reduced the relationship between global EDE-Q and AQ social skills to non-significance [path c: $b = 0.62, t(50) = 2.81, p < 0.008$; path c': $b = 0.37, t(50) = 1.82, p > 0.05$]. The indirect effect was significant [indirect effect (b) = 0.25, 95% confidence interval = (0.008, 0.503)], with HA3 mediating 40.7% of the total effect.

To confirm that HA3 mediated the relationship between EDEQ scores and social abilities specifically, items on the AQ social skill subscale were split into items that measured social motivation (Items 13, 15, 17, 34, 40, 44, and 47; example, 'I enjoy meeting new people') or social competency (Items 11, 22, 26, 38, and 50; example 'I find it hard to make new friends'). Mediation analysis was then performed separately for these two factors. There was a marginally significant effect of EDE-Q on social competence [path c: $b = 0.62, t(50) = 1.95, p = 0.057$]; however, HA3 mediated this relationship [path b: $b = 0.07, t(50) = 4.71, p < 0.001$, path c': $b = 0.018, t(50) = 0.78, p > 0.4$, indirect effect (b) = 0.03, 95% confidence interval = (0.0015, 0.06)], explaining 65% of the relationship between EDE-Q and

competence. No mediation effect was found for social motivation. Mediation analysis including NS as the mediator was not significant.

Discussion

The current study aimed to characterize the relationships amongst disordered eating, temperament, and social skills. HA generally, and shyness with strangers (HA3) specifically, mediated the relationship between current symptoms and social dysfunction. This effect was still significant even after only including items of the AQ that pertain to social competence, indicating a relationship between social withdrawal and social skills. Our result is important in that it clarifies exactly *which* element of HA is relevant to interpersonal functioning in AN, which could point towards novel interventions targeting social functioning. Furthermore, because our mediation analysis was performed across all participants, the treatment implications of our results can be extended to those meeting full diagnostic criteria as well as to those who experience sub-threshold psychopathology.

Why then might shyness be associated with social deficits in disordered eating? The experience of peer rejection associated with social inhibition (Nelson, Rubin, & Fox, 2005) may lead shy individuals to withdraw from social interaction, further interfering with the formation of social skills (refer to Rubin, Coplan, & Bowker (2009) for a detailed account of this perspective). Interestingly, social deficits that emerge by way of shyness may have other consequences that are relevant to the treatment of AN. Shyness has been associated with deficits in interpersonal fluency as well as in the ability to understand others, both of which are associated with a greater reticence to disclose information about the self (Matsushima, Shiomi, & Kuhlman, 2000). As self-disclosure is one of the cornerstones of psychotherapy, shyness-related deficits may interfere with patients' ability to benefit from treatment.

A potential criticism of our mediation model concerns our choice of predictor (EDE-Q) and mediator variables (HA). A plausible argument could be made for specifying HA as the predictor and eating disorder symptoms as the mediator. Indeed, several studies have indicated that social anxiety is evident in individuals who developed AN prior to the onset of disordered eating (Godart, Flament, Lecrubier, & Jeammet, 2000; Kaye, Bulik, Thornton, Barbarich, & Masters, 2004). Yet other evidence is supportive of our own model. In the Minnesota Semi-Starvation Experiment—in which the caloric intake of healthy males was dramatically reduced—many participants began to exhibit socially avoidant behaviour not present prior to the study (Keys, Brozek, Henschel, Mickelson, & Taylor, 1950). This suggests that restriction itself brought about social withdrawal. It is also possible that the relationship between eating disorder symptoms and social HA is bidirectional. That is, shy or socially anxious individuals may be more likely to develop disordered patterns of eating, which further exacerbate social inhibition, leading to poor social skills. More research is necessary to clarify the causal direction of this relationship.

Because of our small sample size, results of the current study should be interpreted with caution. A recent analysis of the sample sizes necessary to reach 0.8 power estimated that for effects of the magnitude reported here, a sample size between 36 and 78 is needed for a bootstrap mediation (Fritz & Mackinnon, 2007). Thus, while our sample does fall within the

appropriate range, future studies should be performed to ensure that this effect replicates in larger samples.

In sum, disordered eating, differences in temperament, and social difficulty are all characteristics of AN. Our results suggest, as a recent review also argues (Kaye et al., 2015), that temperament could be a fruitful target for intervention. Additional research should explore how such interventions could improve both disordered eating as well as social outcomes in AN.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

We would like to thank members of Scott Huettel's laboratory for their helpful feedback on analysis design.

This research was funded by the NIMH and NIDDK grants awarded to Dr. Nancy Zucker (R01-MH-078211-01, RCI-MH-088678, and K23-MH-070418).

REFERENCES

- American Psychiatric Association. Diagnostic and statistical manual. fifth. Washington, DC: American Psychiatric Press, Inc.; 2013.
- Baron-Cohen S, Wheelwright S, Skinner R, Martin J, Clubley E. The autism-spectrum quotient (AQ): Evidence from Asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders*. 2001; 31:5–17. [PubMed: 11439754]
- Bulik CM, Sullivan PF, Fear JL, Pickering A. Outcome of anorexia nervosa: Eating attitudes, personality, and parental bonding. *Int. J. Eat. Disord*. 2000; 28:139–147. [PubMed: 10897075]
- Cloninger CR. A unified bisocial theory of personality and its role in the development of anxiety states. *Psychiatric Developments*. 1986; 3:167–226.
- Cloninger, CR., Svrakic, DM., Wetzel, RD. The temperament and character inventory (TCI): A guide to its development and use. S. Louis, MO: Washington University, Center for Psychobiology of Personality; 1994.
- Cunha AI, Relvas AP, Soares I. Anorexia nervosa and family relationships: Perceived family functioning, coping strategies, beliefs, and attachment to parents and peers. *International Journal of Clinical and Health Psychology*. 2009; 9:229–240.
- Fairburn, CG., Cooper, Z. Binge eating: Nature, assessment, and treatment. In: Fairburn, C., Wilson, G., editors. 1993. p. 317-360.
- Frank GKW, Roblek T, Shott ME, Jappe LM, Rollin MDH, Hagman JO, et al. Heightened fear of uncertainty in anorexia and bulimia nervosa. *International Journal of Eating Disorders*. 2012; 45:227–232. [PubMed: 21495057]
- Friederich HC, Kumari V, Uher R, Riga M, Schmidt U, Campbell IC, et al. Differential motivational responses to food and pleasurable cues in anorexia and bulimia nervosa: A startle reflex paradigm. *Psychological Medicine*. 2006; 36:1327–1335. [PubMed: 16790080]
- Fritz MS, Mackinnon DP. Required sample size to detect the mediated effect. *Psychological Science*. 2007; 18:233–239. [PubMed: 17444920]
- Godart NT, Flament MF, Lecrubier Y, Jeammet P. Anxiety disorders in anorexia nervosa and bulimia nervosa: Comorbidity and chronology of appearance. *European Psychiatry: The Journal of the Association of European Psychiatrists*. 2000; 15:38–45. [PubMed: 10713801]
- Harrison A, O'Brien N, Lopez C, Treasure J. Sensitivity to reward and punishment in eating disorders. *Psychiatry Research*. 2010; 177:1–11. [PubMed: 20381877]

- Harrison A, Tchanturia K, Treasure J. Attentional bias, emotion recognition, and emotion regulation in anorexia: State or trait? *Biological Psychiatry*. 2010; 68:755–761. [PubMed: 20591417]
- Kaye WH, Bulik CM, Thornton L, Barbarich N, Masters K. Comorbidity of anxiety disorders with anorexia and bulimia nervosa. *The American Journal of Psychiatry*. 2004; 161:2215–2221. [PubMed: 15569892]
- Kaye WH, Wierenga CE, Bailer UF, Simmons AN, Bischoff-Grethe A. Nothing tastes as good as skinny feels: The neurobiology of anorexia nervosa. *Trends in Neurosciences*. 2013; 36:110–120. <http://doi.org/10.1016/j.tins.2013.01.003>. [PubMed: 23333342]
- Kaye WH, Wierenga CE, Knatz S, Liang J, Boutelle K, Hill L, Eisler I. Temperament-based treatment for anorexia nervosa. *European Eating Disorders Review: The Journal of the Eating Disorders Association*. 2015; 23:12–18. <http://doi.org/10.1002/erv.2330>. [PubMed: 25377622]
- Kelley K. Confidence intervals for standardized effect sizes. 2007a; 20(8)
- Kelley K. Methods for the behavioral, educational, and social sciences: An R package. *Behavior Research Methods*. 2007b; 39:979–984. [PubMed: 18183915]
- Kelley K. MBESS: An R package. 2010
- Keys, A., Brozek, J., Henschel, A., Mickelson, O., Taylor, HL. *The biology of human starvation*. England: University of Minnesota Press; 1950.
- Luce KH, Crowther JH. The reliability of the Eating Disorder Examination-Self-Report Questionnaire Version (EDE-Q). *International Journal of Eating Disorders*. 1999; 25:349–351. [PubMed: 10192002]
- Matsushima R, Shiomi K, Kuhlman DM. Shyness in self-disclosure mediated by social skill. *Psychological Reports*. 2000; 86:333–338. [PubMed: 10778288]
- Nelson LJ, Rubin KH, Fox NA. Social withdrawal, observed peer acceptance, and the development of self-perceptions in children ages 4 to 7 years. *Early Childhood Research Quarterly*. 2005; 20:185–200.
- Oldershaw A, Hambrook D, Stahl D, Tchanturia K, Treasure J, Schmidt U. The socio-emotional processing stream in anorexia nervosa. *Neuroscience and Biobehavioral Reviews*. 2011; 35:970–988. [PubMed: 21070808]
- Otani K, Suzuki A, Ishii G, Matsumoto Y, Kamata M. Relationship of interpersonal sensitivity with dimensions of the temperament and character inventory in healthy subjects. *Comprehensive Psychiatry*. 2008; 49:184–187. [PubMed: 18243892]
- Preacher KJ, Hayes AF. SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers: A Journal of the Psychonomic Society, Inc.* 2004; 36:717–731.
- Preacher KJ, Kelley K. Effect size measures for mediation models: Quantitative strategies for communicating indirect effects. *Psychological Methods*. 2011; 16:93–115. [PubMed: 21500915]
- Quinton S. Processing of five types of “threat” information in anorexic and bulimic women. *European Eating Disorders Review*. 2004; 12:184–189.
- Rubin KH, Coplan RJ, Bowker JC. Social withdrawal in childhood. *Annual Review of Psychology*. 2009; 60:141–171.
- Steinglass JE, Figner B, Berkowitz S, Simpson HB, Weber EU, Walsh BT. Increased capacity to delay reward in anorexia nervosa. *Journal of the International Neuropsychological Society: JINS*. 2012; 18:773–780. [PubMed: 22591835]
- Tyrka AR, Wier LM, Anderson GM, Wilkinson CW, Price LH, Carpenter LL. Temperament and response to the Trier Social Stress Test. *Acta Psychiatrica Scandinavica*. 2007; 115:395–402. [PubMed: 17430418]
- Watson KK, Werling DM, Zucker NL, Platt ML. Altered social reward and attention in anorexia nervosa. *Frontiers in Psychology*. 2010 Sep.1:36. [PubMed: 21887145]
- Woodbury-Smith MR, Robinson J, Wheelwright S, Baron-Cohen S. Screening adults for Asperger syndrome using the AQ: A preliminary study of its diagnostic validity in clinical practice. *Journal of Autism and Developmental Disorders*. 2005; 35:331–335. [PubMed: 16119474]

Figure 1. Harm avoidance mediates the relationship between Eating Disorders Examination Questionnaire (EDE-Q) global scores and social skill deficits in the Autism Spectrum Quotient (AQ)

Global scores on the EDE-Q are significantly related to social skill deficits as measured by the AQ; however, the inclusion of harm avoidance scores mediates the relationship between EDE-Q Global scores and AQ social skill scores. Note: * denotes significance and b corresponds to the unstandardized coefficients

EDE-Q (Eating Disorders Examination Questionnaire) scores and BMI (body mass index): Results from group ANOVA

Table 1

	AN		WR		HC		<i>a</i>		<i>b</i>		<i>c</i>		<i>d</i>	
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>	<i>F</i>	<i>p</i>
BMI-Current	17.63 (1.28)	21.67 (2.12)	23.12 (2.12)	23.12 (2.12)	32.12**	15.07**	2.09	16.88**						
BMI-Lowest	14.85 (1.72)	15.08 (1.76)	20.66 (2.30)	20.66 (2.30)	70.60**	0.01	67.65**	94.54**						
Restraint	4.21 (1.22)	2.19 (1.17)	0.97 (0.96)	0.97 (0.96)	73.41**	27.75**	10.40*	46.80*						
Eating Concern	4.94 (2.61)	3.59 (2.65)	2.39 (2.59)	2.39 (2.59)	86.33**	33.77**	11.55*	54.19**						
Shape Concern	4.89 (0.84)	2.63 (1.17)	1.38 (0.92)	1.38 (0.92)	109.62**	43.93**	14.05**	68.03**						
Weight Concern	4.58 (0.92)	2.60 (1.27)	0.98 (0.73)	0.98 (0.73)	114.29**	33.52**	23.22**	80.96**						
Global	4.33 (0.76)	2.23 (1.08)	0.90 (0.66)	0.90 (0.66)	142.73**	51.86**	21.56**	92.63**						

Note: AN, currently-ill participants; WR, weight-restored participants; HC, healthy participants; *SD*, standard deviation. *a*, AN vs. HC; *b*, AN vs. WR; *c*, WR vs. HC; *d*, (AN + WR) vs. HC.

* $p < 0.01$.

** $p < 0.001$.

Table 2

Temperament and character inventory (TCI) scores and Autism Spectrum Quotient (AQ) scores by group:
Results of group ANOVA

	AN	WR	HC	Total
	Mean (<i>SD</i>)	Mean (<i>SD</i>)	Mean (<i>SD</i>)	Mean (<i>SD</i>)
TCI				
Harm Avoidance	21.94 (6.63)	19.24 (5.80)	13.33 (6.09)	18.08 (7.08) <i>a,c,d</i>
Novelty Seeking	17.82 (7.98)	17.29 (5.96)	20.88 (5.56)	18.67 (6.64)
AQ				
Total Score	23.00 (5.83)	20.53 (6.06)	16.56 (4.79)	19.96 (6.09) <i>a,c,d</i>
Social Skills	4.94 (2.61)	3.59 (2.65)	2.39 (2.59)	3.62 (2.77) <i>a,d</i>
Details/ Patterns	5.06 (2.33)	5.12 (1.83)	4.33 (2.30)	4.83 (2.16)
Communication/ Mind Reading	1.76 (1.30)	2.00 (1.37)	1.28 (1.13)	1.67 (1.28)

Note: AN, currently-ill participants; WR, weight-restored participants; HC, healthy participants; *SD*, standard deviation. Significance tests ($p < 0.05$): *a*, AN vs. HC; *b*, AN vs. WR; *c*, WR vs. HC; *d*, (AN + WR) vs. HC.

Table 3

Hierarchical models: Effect of clinical status, harm avoidance, and novelty seeking on Autism Quotient (AQ) social skill deficits

	Unstandardized estimate (SE)	Standardized estimate (SE)	t-value
<i>Hierarchical Model 1</i>			
Step 1			
Intercept	2.41 (0.65)	0	3.83 *
Clinical Status	1.88 (0.77)	0.33	2.43 *
Step 2			
Intercept	3.00 (0.66)	0	4.53 *
Clinical Status	0.95 (0.85)	0.16	1.11
Harm	0.12 (0.06)	0.33	2.20 *
Avoidance			
$R^2 = 0.08$ $F = 4.86$ $p = 0.03$			
<i>Hierarchical Model 2</i>			
Step 1			
Intercept	2.41 (0.65)	0	3.72 *
Clinical Status	1.85 (0.79)	0.32	2.33 *
Step 2			
Intercept	2.81 (0.60)	0	4.69 *
Intercept	1.25 (0.74)	0.21	1.69
Clinical Status	-0.18 (0.05)	-0.43	-3.41 *
Novelty Seeking			
$R^2 = 0.18$ $F = 11.62$ $p = 0.001$			
<i>Hierarchical Model 3</i>			
Step 1			
Intercept	2.41 (0.65)	0	3.72 *
Intercept	1.85 (0.79)	0.32	2.33 *
Clinical Status			
Step 2			
Intercept	3.31 (0.64)	0	5.18 *
Clinical Status	0.51 (0.82)	0.09	0.62
Harm	0.10 (0.05)	0.27	1.91
Avoidance			
Novelty Seeking	-0.17 (0.05)	-0.39	-3.17 *
$R^2 = 0.23$ $F = 7.96$ $p = 0.01$			

* $p < 0.05$.