

Title: Modeling the impact of social problem-solving deficits on depressive vulnerability in the broader autism phenotype

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Abstract

The social communication and interaction deficits associated with the autism phenotype can have serious emotional consequences for individuals on the autism spectrum. This can be particularly true during young-adulthood, a period of increased social demands and expectations. The current study investigated the specific role of social problem-solving deficits as a mediator in the relationship between autism phenotype severity and depressive symptomology in young-adults. A sample of 230 university students (48% male) ranging in age from 18-30 ($M=21.30$, $SD=2.48$) were assessed on autism phenotype expression (Autism-Spectrum Quotient), social problem-solving ability (Social Problem-Solving Inventory, Revised) and depressive symptomology (Beck's Depression Inventory). Results indicated that deficient social problem-solving skills account for a significant portion of the depressive symptomology associated with increased autism phenotype expression. Path model analysis output suggested that increased expression of the social components of the autism phenotype are associated with both ineffective social problem-solving styles and attitudes, while increased detail orientation discourages the use of an impulsive problem-solving style. The findings of this investigation provide preliminary evidence suggesting that programs designed to improve social problem-solving skills could be beneficial in the reduction of depressive vulnerability for young-adults on the autism spectrum.

Keywords

Autism-Spectrum Quotient (AQ); autism phenotype expression; social problem solving; depression; university students; path model analysis

Introduction

Based on current diagnostic criteria, Autism Spectrum Disorder (ASD) is characterized by a duo of core impairments: (i) deficits in social communication and social interaction, and (ii) restricted and repetitive behaviors, interests, and activities (American Psychological Association, 2013). Evidence suggests that beyond these core areas of deficit, approximately 65% - 80% of individuals with ASD are additionally diagnosed with at least one coexisting psychiatric condition (Sterling, Dawson, Estes, & Greenson, 2008). Investigations into this topic have found a variety of conditions to be commonly associated with an ASD diagnosis, including Mood Disorders, Anxiety Disorders, Specific Phobias, Obsessive Compulsive Disorder, and Attention Deficit Hyperactivity Disorder (Leyfer et al., 2006; Lugnegård, Hallerbäck, & Gillberg, 2011). The presence of these coexisting conditions can cause additional impairment for the individual, and have serious detrimental effects on the quality of life for themselves and their loved ones (Gillberg & Billstedt, 2000; Matson & Nebel-Schwalm, 2007).

Among the psychiatric concerns afflicting individuals with ASD, studies suggest the most commonly presented condition to be depression (Ghaziuddin, Ghaziuddin, & Greden, 2002; Lugnegård et al., 2011). However, as a result of assessment difficulties stemming from the emotional processing and communication deficiencies common to this population (Leyfer et al., 2006), as well as the overlap in some typical behavioral markers (i.e. social withdrawal) for depression and ASD related characteristics (Matson & Nebel-Schwalm, 2007) reported prevalence rates have been inconsistent across studies, ranging anywhere from 5% - 82% (Shtayermman, 2007). While investigations into the etiology of depression have produced

myriad factors that can explain why an individual may become susceptible to a depressive episode (genetic, biological, environmental etc.), little information is currently available regarding why individuals with ASD appear to be particularly vulnerable to experiencing these episodes.

Available evidence on the presentation of depressive symptomology in ASD indicates that prevalence rates are highest among individuals with average or above-average levels of intelligence, a cohort referred to as having High-Functioning Autism Spectrum Disorder (HFASD) as well as among young adults (Ghaziuddin et al., 2002). In a recent study by Lugnegård et al. (2011), it was found that in a sample of 54 young-adults with HFASD, 70% had experienced at least one episode of major depression, and 50% suffered from reoccurring episodes. It is possible that distress resulting from struggles with the development and maintenance of social relationships during this age-span may be an important contributing factor to this pattern of increased incidence of depression (Figure 1).

In discussing the apparent increased vulnerability to depression during this age-span for individuals with HFASD, Sterling et al. (2008) note that young-adulthood represents a period of increased personal and societal expectations to establish significant relationships with others; and while individuals with HFASD are likely to have the motivation to meet these expectations, they may lack some of the key social skills needed to do so and/or the insight necessary to appropriately modify their social strategies when they are unsuccessful. Resulting discrepancies (perceived or actual) between the quality or quantity of significant relationships held by the individual with HFASD and their neurotypical peers, can result in emotional distress by contributing to perceptions of personal and social inequality or inadequacy. In one of the earliest studies to address the topic of depression in young-adults with HFASD, Wing (1981) suggested

that this population's increased susceptibility seemed to be the result of "a painful awareness of handicap and difference from other people" (p.118). The association between negative social comparisons and depression has long been recognized in neurotypical populations (Furnham & Brewin, 1988), but these perceptions of inequality have the potential to be particularly demoralizing for individuals with HFASD who can struggle to distinguish between their self-perception and their intrinsic worth (Hedley & Young, 2006; Tantam, 2000). Of additional concern are the findings relating these depressive struggles to elevated rates of suicide ideation and attempts in adults with HFASD. Though the literature on this subject is limited, recent examinations of this topic in clinical samples of adults with HFASD have reported prevalence rates of suicidal ideation at 66% and suicidal plans or attempts at 35% (Cassidy, Bradley, Robinson, Allison, McHugh, Baron-Cohen, 2014; Paquette-Smith, Weiss, & Lunsky, 2014). Across these studies, and others exploring this topic in children with ASD (e.g. Mayes, Gorman, Hillwig-Garcia, & Syed, 2013), a history of depression was one of the strongest predictors of suicide attempts, suggesting that efforts to reduce depressive vulnerability could help to alleviate this serious issue within the ASD population as well.

It has been suggested that psychosocial interventions could be of particular use for reducing the depressive vulnerability in this population resulting from poor social outcomes and comparisons (Ghaziuddin et al., 2002). However, further research is still needed to identify specific components of these social struggles in order to provide targets for focused treatments. One such component of daily social interaction that is worthy of further exploration as a potential area of target for interventions is social problem-solving.

Nezu and Ronan (1988) define social problem-solving as the cognitive and behavioral processes by which individuals develop and select effective strategies in response to problematic interpersonal situations encountered in their day-to-day life. The first studies to identify the key role that social problem-solving deficits play in depression occurred in the mid-to-late 1970's (Marx, Williams, & Claridge, 1992). Since that time, poor social problem-solving skills have consistently been shown to be a strong predictor of depression in a number of populations, including: adolescents (Becker-Weidman, Jacobs, Reinecke, Silva, & March, 2010), university students (Anderson, Goddard, & Powell, 2009), general psychiatric patients (D'Zurilla, Chang, Nottingham, & Faccini, 1998), individuals with anxiety disorder (Marx et al., 1992), and clinically depressed patients (Argus & Thompson, 2008). Additionally, depression treatment outcome studies have found that the presence of poor social problem-solving skills at baseline predicted poorer treatment response (Joiner, Gencoz, Faruk, & Rudd, 2001) and poorer prognosis at 3 and 6 month follow-ups (Garland, Harrington, House, & Scott, 2000), suggesting that these problem-solving deficiencies may leave individuals more vulnerable to relapse as well.

Studies exploring social problem-solving skills in individuals with HFASD have found that when presented with social problem scenarios, participants with HFASD demonstrate poorer memory for the details of the scenario, generate less effective and less detailed solutions, and have more difficulty making judgments on the appropriateness of solutions compared to matched controls (Channon, Charman, Heap, Crawford, & Rios, 2001; Goddard, Howlin, Dritschel, & Patel, 2007). Despite these findings, and the well-documented association between social problem-solving deficits and depression, the extent to which these deficiencies could account for

some of the increased vulnerability to depressive episodes in individuals with HFASD has yet to be thoroughly examined.

A preliminary step for understanding the potential role of social problem-solving deficits in HFASD specific depressive vulnerability was taken by Rosbrook & Whittingham (2010). In lieu of a clinical sample, Rosbrook & Whittingham explored this topic by examining ASD phenotype severity in a large (n=231) neurotypical university sample. The results of their study indicated that deficits in social problem-solving played the role of a partial mediator, accounting for a significant ($p<0.05$) amount of the depressive symptoms initially predicted by ASD phenotype expression levels.

There is growing evidence that ASD represents the extreme end of a phenotypical continuum that is expressed to varying levels in both clinically identified and neurotypical populations (Best, Moffat, Power, Owens, & Johnstone, 2008). Additionally, studies exploring subthreshold expression of ASD phenotype traits have not only shown that the cognitive and behavioral characteristics associated with ASD are not confined to those with a diagnosis, but individuals who express elevated levels of these traits are also more susceptible to milder versions of a number of the psychiatric and psychosocial difficulties found in individuals with ASD as well (Best et al., 2008; Kanne, Christ, & Reiersen, 2009). It has been proposed (Kanne, et al., 2009; Kunihiro, Senju, Dairoku, Wakabayashi, & Hasegawa, 2006) that these findings provide evidence to support the feasibility and utility of examining subthreshold expression of the traits associated with the ASD phenotype in neurotypical samples as a proxy for individuals with an ASD. Specifically, it is suggested these analogue studies could prove to be particularly useful for research aimed at producing relationship models, as this would allow access to a larger sample base with a broader range of symptom presentation. Thus, the Rosbrook & Whittingham

(2010) finding that social problem-solving deficits significantly mediate the relationship between ASD phenotype expression and depressive symptomology offers a valuable first step for providing insight into the potential role of social problem-solving in the depressive vulnerability of young-adults with HFASD. However, one important limitation to the findings from that study was the fact that social problem-solving was only examined as a singular variable, thus not assessing the individual contributions of the different components of this social functioning process.

Social problem-solving is generally described as being comprised of two main components: *problem-solving orientation*, one's attitude and beliefs about the problem and their ability to resolve it, and *problem-solving style*, the cognitive and behavioural actions one takes to resolve the problem (Nezu, 2004). Additionally, both of these components can be further detailed into their negative (ineffective, maladaptive) or positive (effective, adaptive) manifestations. While a positive problem-solving orientation will entail seeing the situation as a challenge with an obtainable resolution, a negative problem-solving orientation involves viewing the situation as a threat that one is unlikely to be capable of resolving. Similarly, while positive problem-solving styles incorporate rational, processed, and well thought out responses to problematic situations, negative problem-solving styles are characterized by impulsive and careless, and/or avoidant and passive responses (D'Zurilla et al., 1998; Nezu 2004).

Studies that have explored the unique impacts of these components on the association between social problem-solving ability and depressive susceptibility, have suggested that they are differentially important with regard to their influence in this relationship. Researchers have noted that it is an individual's use of ineffective (negative) aspects of the problem-solving

orientation and style components that typically influences the expression of depressive symptomology (e.g. Anderson, Goddard, & Powell, 2011; D'Zurilla et al., 1998; Reinecke, DuBois, & Shultz, 2001), with the utilization of a negative problem-solving orientation often emerging as the component with the most significant impact (e.g. Anderson et al., 2011; Bray, Barrowclough, & Lobban, 2007; Kant et al., 1997; McMurrin & Christopher, 2009). When taking into consideration the findings from the broader ASD literature, it seems likely that persons with autism may be particularly predisposed to adopting a variety of negative social problem-solving attributes (negative orientation, problem avoidance, and impulsive / careless responding).

Social functioning literature suggests that ASD social impairments can result in perceptions of social inadequacy and poor self-efficacy (Sterling et al., 2008; Vickerstaff, Heriot, Wong, Lopes, & Dossetor, 2007), issues which are defining components of, and strong predictors for the adoption of a negative problem-solving orientation when faced with problematic situations. Further, findings from the decision-making literature suggest that individuals with ASD are more strongly motivated by risk-avoidance, than reward-seeking (Luke, Clare, Ring, Redley, & Watson, 2012; South et al., 2014). As the confrontation of any social problem inherently involves the risk that if handled poorly it can escalate the problem or cause new ones to emerge, this might imply that individuals with ASD are likely to demonstrate an increased reliance on an avoidant problem-solving style. Reliance on this type of problem-solving style might be further encouraged as a result of the high rates of social anxiety in ASD (Dickerson-Mayes, Calhoun, Murray, Zahid, 2011), and the negative association between social anxiety and assertive social skills (Bellini, 2004). Finally, the common co-occurrence of ADHD symptoms in individuals with ASD (Leyfer et al., 2006; Sinzig, Morsch, Bruning, Schmidt, &

Lehmkuhl, 2008), and in particular the high rates of expression of features associated with ADHD inhibition/impulsivity (Ames & White, 2011), could suggest that while not a direct result of the ASD phenotype, individuals with ASD might be predisposed to utilise an impulsive or careless problem-solving style.

Obtaining comprehensive knowledge regarding how the traits associated with the ASD phenotype relate to the utilization of ineffective social problem-solving processes, and additionally establishing the relative contributions of these different processes on the expression of depressive symptoms will allow for a more detailed understanding of the partial mediation relationship reported by Rosbrook & Whittingham (2010). Moreover, such details could provide invaluable information for the development of targeted therapeutic interventions, and thus further investigation is warranted.

The aims of the current study are: (i) to confirm that deficient social problem-solving is a significant mediator in the relationship between ASD phenotype expression and depressive symptomology, and (ii) to conduct a path model analysis exploring the associations of these variables at a subcomponent level. It is hypothesized that the findings from this study will support those of Rosbrook & Whittingham (2010) that social problem-solving mediates the relationship between ASD phenotype expression and depressive symptomology. Furthermore, it is anticipated that the results of the modeling analysis will expand upon that finding by providing a theoretical account of how specific aspects of the autism phenotype, ineffective social problem-solving processes, and depressive symptomology interact; offering potential insight for interventions aimed at improving social problem-solving skills in individuals with HFASD.

1. Methods

1.1 Participants

The participants for this study were 230 young-adult students recruited from the University of St Andrews in Scotland. The sample included 111 men (48%) and 119 women (52%) with a mean age of 21.30 years old (SD=2.48, range: 18-30). All participants gave informed consent and the study received ethical approval from the University Teaching and Ethical Committee.

1.2 Materials

1.2.1 ASD Phenotype Expression: Autism-Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001).

The AQ is designed to assess the expression of traits associated with the ASD phenotype in adults with average or above-average levels of intelligence. The questionnaire consists of 50 statements developed to address five key domains of the ASD phenotype: Attention Switching (e.g. It does not upset me if my daily routine is disturbed), Attention to Detail (e.g. I usually notice car number plates or similar strings of information), Social Skills (e.g. I find it hard to make new friends), Communication (e.g. I enjoy social chit-chat), and Imagination (e.g. I find making up stories easy). Participants respond to whether they believe the statements describe them on a 4-point continuous (Likert-type) scale ranging from “Strongly Disagree” to “Strongly Agree.” Scores for the AQ range from 0-50 (higher scores indicating increased levels of ASD phenotype expression) with a score of 32 established as a useful cut-off for clinically significant trait expression.

While the psychometric properties of the overall scores produced by the AQ have consistently been shown to be reasonably good (Baron-Cohen et al., 2001; Hoekstra, Bartels,

Cath, & Boomsma, 2008; Kurita and Koyoma, 2006; Wakabayashi, Baron-Cohen, Wheelwright, and Tojo, 2006), a number of studies have raised concerns regarding the internal consistencies of the five domains detailed in the initial model by Baron-Cohen et al. Based on the results of subsequent factor analyses, it has been suggested that, alternatively, the AQ could be more accurately defined by a four- (Stewart & Austin, 2009), three- (Hurst, Mitchell, Kimbrel, Kwapil, & Nelson-Gray, 2007), or two-domain model (Hoekstra et al., 2008). This study utilized the Hoekstra et al. (2008) two-domain model comprised of the original 'Attention to Details' factor, and a higher-order factor of 'Social Interaction', which encompasses the Social Skills, Communication, Attention Switching, and Imagination domains from the original Baron-Cohen et al. (2001) model. This model was chosen as it was not only tested in a large (n=961) student sample and then confirmed in a large (n=302) general population sample, but it was also independently replicated in a latter principal component analysis performed by Valla et al., 2010. Additionally, as this model retained use of all 50 items from the AQ, it allowed for the assessment of a wider variety of the phenotypical characteristics of ASD. Internal consistency results produced for this two-domain model were good for the higher-order Social Interaction factor ($\alpha = 0.71$ and 0.81) and moderate for the Attention to Details factor ($\alpha = 0.63$ and 0.68) for both the general population and student samples, respectively (Hoekstra et al., 2008).

1.2.2 Depressive Symptomology: Beck's Depression Inventory, Second Edition (BDI-II; Beck, Steer, & Brown, 1996).

The BDI-II is one of the most widely utilized self-report assessments for symptoms of depression. The questionnaire consists of 21 groups of statements, each related to a different

symptom of depressive episodes (e.g. Sadness, Loss of Pleasure, Guilty Feeling, Loss of Energy, Changes in Sleeping Pattern). Each group of statements has a set of at least four possible answer choices, ranging in intensity (e.g. I do not feel sad, I feel sad much of the time, I am sad all the time, I am so sad or unhappy that I can't stand it). Participants are instructed to pick the answer choice that best describes the way they have been feeling over the preceding two weeks. Scores for this assessment range from 0-63, with high scores indicating the presence of high levels of depressive symptoms.

1.2.3 Social Problem-Solving: Social Problem-Solving Inventory – Revised (SPSI-R; D Zurilla, Nezu, & Maydeu-Olivares, 2002).

The SPSI-R is used to assess an individual's strengths and deficits in social problem solving attitudes and skills. This assessment consists of 52 statements describing social situations (e.g. When I have a problem with another person in my life, I put off trying to solve it for as long as possible.) that participants' rate on a 5-point continuous (Likert-type) scale ranging from "Not at all true of me" to "Extremely true of me." The SPSI-R consists of three subscales assessing negative or maladaptive components of social problem-solving: Negative Problem Orientation (viewing problems as frustrating events, that are a threat to one's well-being, and doubting one's ability to successfully resolve them), Avoidance Style (passivity, procrastination, or inaction when faced with a problem), and Impulsive/Carelessness Style (utilizing hurried and incomplete solutions when faced with a problem). Higher scores for each of the subscales represent a

stronger utilization of that social problem-solving style or orientation. Total scores for the SPSI-R range from 0 - 20, with higher scores indicating stronger social problem solving abilities.

1.3 Procedure

The study sample was recruited through a university research participation website, and advertisements posted on department message boards and in university wide student email notices. Participants were randomly administered the measures as a series of pencil and paper questionnaires in one of two orders during a single session. Based on concerns that focusing on social problem-solving situations, and/or the lengthy process of the study could affect a participant's mood state, it was decided that each sequence of questionnaires would begin with the BDI-II. Following the BDI-II the remaining two assessments (the AQ and SPSI-R) were administered in random order to complete the series, thus creating two sequences.

1.4 Statistical Analysis

Statistical analyses were conducted using SPSS version 19. Path model analysis was assessed using structural equation modeling via Analysis of Moment Structure (AMOS) version 22. Following previously established guidelines (Browne & Cudek, 1993; Tabachnik & Fidell, 1996), the path analysis model was evaluated with the subsequent criteria: chi-squared (χ^2) p -value being greater than 0.05; the comparative fit index (CFI) and goodness of fit index (GFI) being greater than 0.95; and the root mean square error of approximation (RMSEA) being less than 0.06.

2. Results

2.1 Descriptive Statistics

Across all participants, mean scores for the assessment totals were: AQ=18.18 (SD=6.54, range: 2-38), SPSI-R=12.69 (SD=2.75, range: 4.89-18.53), and BDI-II=9.92 (SD=7.82, range: 0-40). Post-hoc analysis revealed no significant difference in scores between genders for either social problem solving abilities [$F(1,228)=1.53$, $p=0.22$] or depressive symptoms [$F(1,228)=0.49$, $p=0.49$].

In the initial report for the AQ (Baron-Cohen et al., 2001), it was noted that male students on average scored significantly higher than female students, representative of the increased prevalence rates of ASD in males. Additionally, students studying in Science fields were found to have scored, on average, significantly higher than those studying in Non-Science fields (Humanities and Social Sciences), representative of the disproportionate rates of students with ASD studying in Science fields (Wei, Yu, Shattuck, McCracken, & Blackorby, 2013), and suggestive of an association between ASD characteristics and math/science skills. Differences in both gender and field of study (based on Baron-Cohen et al., 2001 specifications) were examined in the current sample for AQ total, Social Interaction, and Attention to Details scores (Table 1). The only differences that reached statistical significance were found in the gender comparison, with male participants, on average, scoring higher on the AQ Total and Social Interaction scales, compared to female participants.

2.2 Mediation Analysis

Linear and hierarchical regression analyses were conducted to examine the mediating role of social problem-solving. Results found that the total effect of ASD phenotype expression on depressive symptomology was initially able to account for 12% of the variance in BDI-II scores. However, when indirect effects via the shared relationship between these variables and social problem-solving ability were controlled for, the amount of variance predicted by the

remaining direct effect of ASD phenotype expression on depressive symptomology was attenuated to 5% (Figure 2). As the relationship between ASD phenotype expression and depressive symptomology was not reduced to zero as a result of controlling for social problem-solving ability, this would suggest a partial mediation. The significance of social problem-solving's partial mediation role was examined with the bootstrapping method (Preacher & Hayes, 2008; bootstrap resamples=2000), as well as the more conservative Sobel Test (Baron & Kenny, 1986; Sobel, 1982). Results of both the bootstrapping method (standardized indirect effect = 0.11; 95% bias corrected confidence intervals = 0.06 to 0.18) and the Sobel Test ($Z=3.41$, $SE=0.04$) support the significance of this partial mediation beyond the 0.05 level.

2.3 Path Analysis

To explore this mediated relationship on a more detailed level, a path model utilizing the assessed ASD phenotype domains (Social Interaction and Attention to Details) and maladaptive social problem-solving components (Avoidance, Impulsive/Carelessness Style, and Negative Problem Orientation) was developed and evaluated for quality of fit (intercorrelations of all variables used in the model can be found in Table 2). The tested path model included intercorrelations between the two ASD domains (as a weak correlation was found in Hoekstra et al., 2008, but not confirmed by Valla et al., 2010) and the three social problem-solving components (as ineffective problem-solving styles can result in, or be furthered by a poor problem-solving orientation). Direct paths were included from Social Interaction to all three social problem-solving components (as deficient social and communicative proficiency, comfort, and perceived self-efficacy will effect both the styles with which individuals react to social problems, as well as their confidence in their ability to resolve them) and depressive symptoms (as this domain will likely reflect mood-affecting social struggles outside of the scope of social

problem-solving). A recent theory proposed by Baron-Cohen and colleagues (Baron-Cohen, 2008; Baron-Cohen, Ashwin, Ashwin, Tavassoli, & Chakrabarti, 2009) suggest that the heightened attention to detail found in ASD is associated with a process referred to as *hyper-systemizing*. This theory postulates that extreme detail orientation is a highly purposeful and adaptive quality used for the recognition of patterns in systems (including social ones) and deriving if/then rules based on these observations to facilitate understanding how these systems are governed. With this in consideration, direct paths were included from Attention to Details to both Avoidance and Impulsive / Careless Style (as elevated levels of this quality will likely promote the recognition and systemizing of patterns of negative outcomes resulting from the use of these ineffective styles, and thus reduce the probability of continued utilization in subsequent problematic situations), but were not included to Negative Problem Orientation or depressive symptoms (as there was no theoretical basis for those connections). Finally, direct paths were included from all three maladaptive social problem-solving components to depressive symptoms (as the social consequences caused by any of these ineffective problem-solving strategies/orientation could theoretically result in emotional distress). Path model analysis output (Figure 3) found the valence of all included pathways to match expectations, however, not all reached significant levels. All criteria examined to evaluate the fit of the model were met ($\chi^2=2.48$, $p=0.29$, $df=2$; CFI=1.00; GFI=1.00; RMSEA=0.03), suggesting that this theorized model offers an acceptable representation of the relationships between these variables.

3. Discussion

Previous research has established that individuals with ASD are highly vulnerable to episodes of depression (Ghaziuddin et al., 2002). Furthermore, it has been suggested that

individuals with HFASD are especially susceptible to these episodes, particularly during young adulthood when struggles to meet rising social expectations can lead to increased incidences of loneliness (Whitehouse, Durkin, Jaquet, & Ziatas, 2009), and perceptions of inequality between themselves and their neurotypical peers (Hedley & Young, 2006; Sterling et al., 2008). Examining ASD phenotype expression in a large, young-adult student sample, the current study aimed to confirm the Rosbrook & Whittingham (2010) finding regarding the role of social problem-solving in this increased susceptibility, and produce a detailed theoretical model describing the specific components of the ASD phenotype and the social problem-solving process at work in this relationship.

3.1 ASD phenotype expression and sample demographics

Observed patterns in gender and field of study differences for total AQ scores, as well as the Social Interaction and Attention to Details domains were in line with expectations, however, not all detected differences reached statistical significance. As found in previous studies (Baron-Cohen et al., 2001; Hoekstra et al., 2008) males scored, on average, higher than females on both the total AQ score and the Social Interaction domain, while females scored, on average, higher than males on the Attention to Details domain. While these differences were found to be significant for both the AQ Total and the Social Interaction scores, no significant difference was found between the Attention to Details scores.

The field of study comparison produced results in the direction of expectations, with participants studying in Science fields scoring, on average, higher than those studying in Humanities/Social Science fields on total AQ, Social Interaction and Attention to Details. However, all of these differences failed to reach statistical significance. This may be a reflection of the university's intensive research focus across all disciplines, considering the means scores

for the Science students were similar to those produced in previous studies (i.e. Baron-Cohen et al., 2001), but mean scores for the students studying in 'Non-Science' fields were well above those found previously.

3.2 Social problem-solving as a mediator

A significant positive association was found between ASD phenotype expression and depressive symptoms, while a significant negative association was found between ASD phenotype expression and social problem-solving abilities. These findings align with expectations and suggest that individuals who express higher levels of the traits associated with the ASD phenotype are likely to have poorer social problem-solving abilities, and are more susceptible to depressive symptoms. Additionally, a strong negative association was found between social problem-solving ability and depressive symptoms, supporting the well-established relationship of individuals with poor social problem-solving abilities expressing increased levels of depressive symptoms. Results of mediation analyses supported the findings of Rosbrook and Whittingham (2010) that social problem-solving deficits are a significant partial mediator in the relationship between ASD phenotype expression and depressive symptomology. Specifically, it was found that deficits in social problem-solving accounted for approximately 57% of the variance in depressive symptoms initially predicted by ASD phenotype expression.

3.3 Insights from path model analysis

Further understanding regarding how ineffective social problem-solving processes mediate the relationship between characteristics of the ASD phenotype and depressive symptoms was achieved through the examination of a theorized path model. Results of the model

evaluation criteria suggest that the examined model provided an acceptable representation of the variable relationships.

As anticipated, results produced by the path model analysis output suggest that deficits assessed by the Social Interaction domain of the AQ were positively, and significantly related to all measured aspects of ineffective social problem-solving abilities. Specifically, it was found that increases in deficits associated with this component of the ASD phenotype (social / communicative comfort, and competence) result in the adoption of an attitude that social problems are threats to one's well-being that are unlikely to be resolved (Negative Problem Orientation), and tendencies to respond to these conflict scenarios ineffectively, either in an impulsive manner (Impulsive / Careless Style) or by avoiding confronting them altogether (Avoidance). These findings are in support of, and draw connections between other areas of research in ASD. Specifically the association with a negative problem-solving orientation mirrors findings from other domains of social functioning that report significant impacts of ASD social impairments on feelings of social inadequacy and poor self-efficacy (e.g. Sterling et al., 2008). The strong relationship with an avoidant problem-solving style is demonstrative of findings in the decision-making literature that motivational drives in ASD are influenced more strongly by the avoidance of risk and potential failure, than by seeking potential positive outcomes or reward (e.g. South et al., 2014). Finally the significantly increased likelihood of responding to social problems in an impulsive or careless manner provide support to findings of high rates of co-occurrence of ADHD inhibitory and impulse control symptoms found in individuals with ASD (Ames & White, 2011).

In line with predictions, negative relationships were produced between the Attention to Details domain and both ineffective problem-solving styles. This finding lends supports to the

hyper-systemizing hypothesis (Baron-Cohen, 2008; Baron-Cohen et al., 2009) that the pattern detection and rule construction associated with ASD related detail orientation can act to discourage the repeated use of such strategies as a result of the recognition of resultant negative consequence patterns. However, while the discouraging nature of this detail orientation against the continued adoption of maladaptive problem-solving styles reached significance for Impulsive / Careless Style, it did not for Avoidance. This is perhaps a reflection of the increased difficulty inherent in recognizing that the avoidance of a social problem can be the antecedent to resultant consequences, as these outcomes will be delayed; as opposed to the more immediate consequences that are likely to occur following impulsive or careless reactions. Additionally a recent study in children with ASD (Pouw, Rieffe, Stockmann, & Godow, 2013) found that avoidant responses to stressful situations can have immediate benefits as an adaptive emotion regulation strategy. Thus, this preliminary positive impact from utilizing an avoidant social problem-solving style may complicate the recognition of the eventual negative consequences that can occur as a result of this strategy. Finally, there was no significant intercorrelation between the two ASD domains of Social Interaction and Attention to Details. This finding was in line with Valla et al. (2010) and suggests a lack of overlap between the social and non-social components of the ASD phenotype assessed by these subscales.

With regard to impact on depression, of the three social problem-solving components, the only one to produce a significant direct relationship with depressive symptoms was Negative Problem Orientation. This result supports previous findings from the depression literature (e.g. Kant et al., 1997; McMurrin & Christopher, 2009), and suggests that the mindset with which one addresses social problems is the most influential component of the social problem-solving process with regard to resultant emotional states. Moreover, as predicted, a significant direct path

was also produced from the Social Interaction domain to depressive symptoms. This supports the partial mediation findings of the regression analyses, and suggests that there are aspects of the social and communicative struggles associated with the ASD phenotype beyond social problem-solving deficits that can affect an individual's vulnerability to depressive episodes as well; such as difficulties developing / maintaining friendships due to struggles with the nuances of social interaction, perceived social awkwardness, and/or social anxiety, resulting in isolation and loneliness.

3.4 Implications

The primary implication of this study is that the development of positive social problem-solving skills may prove to be a beneficial psychosocial target for interventions designed to reduce depressive vulnerability in individuals with HFASD or those with elevated, yet subthreshold expression of the ASD phenotype. The usefulness of focused problem-solving training for the purpose of behavior modification, is a topic that was originally introduced by D'Zurilla and Goldfried in 1971; and more recently has been given specific attention for its use in the reduction of depressive symptomatology. In 2009, Bell and D'Zurilla performed a meta-analysis of outcome studies on the efficacy of problem-solving therapy (PST) to reduce the symptoms of depressed mood. In their paper, Bell and D'Zurilla define PST as a "cognitive-behavioral intervention that focuses on training in adaptive problem-solving attitudes and skills" (p.348) with the aim of increasing personal well-being and reducing psychopathology by helping individuals maintain healthy relationships and cope with stressful social conflict scenarios. The findings of their analysis indicated that PST was an equally effective treatment option for the

reduction of depressive symptoms as compared to other psychosocial therapies and pharmacological treatments. Recently, the first study to explore the feasibility of utilizing PST in a small cohort of young-adults with HFASD was published by Pugliese & White (2014). This pilot study produced encouraging results, with high rates of treatment adherence, and good participant satisfaction, however, considering the small sample size of the study, any implications of these results must be considered carefully. Interestingly, of the participants that completed at least eight of the nine sessions (n=4), the two who did not exhibit marked improvement both had co-occurring depressive and anxious symptomology. These findings would appear to highlight the importance of taking into account the interrelationship between social problem-solving and depressive or anxious symptomology when developing a PST program for this population, as the presence of these aspects of emotional distress have the potential to play an obstructive role in the effectiveness of the intervention.

3.5 Limitations

The current study is not without limitations. Though a young-adult sample was a specific target of this study, all participants additionally fell within the further categorization of university students. Thus, the generalizability of the results from this study must be limited to a similar demographic population. Additionally, while our range of AQ scores did include eight individuals who presented with scores that met or exceeded the ASD clinical threshold of 32 (Baron-Cohen et al., 2001; Woodbury-Smith, Robinson, Wheelwright, & Baron-Cohen, 2005), the absence of participants with a formal ASD diagnosis makes it difficult to say with any certainty, whether or how these patterns will persist into populations with a clinical diagnosis.

This study would have additionally benefitted from the inclusion of a measure of anxiety. As the features of depression and anxiety are both highly prevalent in ASD (Lugnegård et al.,

2011), have both been found to be associated with deficits in social problem-solving (e.g. McMurran & Christopher, 2009), and often occur simultaneously (Dickerson-Mayes et al., 2011), the findings of the current study regarding the association between social problem-solving deficits and increases in depressive symptomology would have been strengthened if anxious symptomology could have been controlled for as a potential confound.

Finally, when examining social problem-solving abilities, there are two major categories of assessments that can be utilized by researchers: (i) *process measures* and (ii) *outcome measures* (D’Zurilla & Maydeu-Olivares, 1995; D’Zurilla et al., 1998). Process measures assess the behavioral and cognitive attributes that promote or inhibit the development of adaptive or effective solutions to social problems (i.e. the SPSI-R). Meanwhile, outcome measures assess an individual’s performance, or their ability to appropriately apply their social problem-solving skills when confronted with a specific problem scenario (D’Zurilla & Maydeu-Olivares, 1995). The sole use of a process measure may have limited the ability of the current study to completely assess, and thus analyze, the full role social problem-solving plays as a mediator in the relationship between the ASD phenotype and depressive symptomology.

3.6 General conclusions

The findings from the current study provide further support to the emotional impact that the social struggles associated with ASD can result in, and suggests a theoretical model for the specific role of social problem-solving deficits in depressive vulnerability. Moreover, the identification of specific social problem-solving response and orientation pitfalls associated with the ASD phenotype, and an understanding of how they relate to depressive symptoms will hopefully help to inform future attempts to adopt PST programs for individuals with HFASD.

Specifically, these findings suggest clear problems with increased incidence of avoidant and impulsive problem-solving styles as well as a negative problem-solving orientation resulting from the social impairments associated with the ASD phenotype. While all of these maladaptive social problem-solving processes were found to be associated with one another, it was the negative problem orientation that emerged as the most influential component in the expression of depressive symptoms. This would suggest that any attempts to reduce depressed mood in individuals with HFASD through the development of social problem-solving abilities should dedicate a substantial amount of time on addressing this component.

Additionally the significant negative association between enhanced detail orientation and an impulsive problem-solving style, if taken as support for the hyper-systemizing theory of Baron-Cohen and associates (Baron-Cohen, 2008; Baron-Cohen et al., 2009), could provide further insight for effective development of social problem-solving abilities in ASD. Specifically, the hyper-systemizing theory predicts that given enough time and opportunity to observe and test a system, an individual with ASD can acquire an excellent understanding of how that system operates. As such, the elevated and continued reliance on avoidance strategies being noted in this study, can be viewed as limiting the opportunity to observe the social problem-solving system in action and thus reducing chances for improved understanding and stunting the potential for effective skill development. Therefore, additional emphasis on the positive aspects of confronting social problems should be incorporated in any interventions for this population, and the inclusion of opportunities to test differing problem-solving approaches and observing their outcomes could prove highly beneficial.

Finally, as subthreshold expression of ASD traits in the current neurotypical sample were found to be associated with areas of known social functioning deficits (social problem-solving)

and psychiatric susceptibility (depressive symptomology), these results lend further support to the dimensional (continuum) view of ASD, and the utility of analogue studies for research in this field. With that being said, despite the promising and insightful findings produced from the current study, it is important to exercise some restraint from interpreting their implication with regard to clinical applications for adults with HFASD. Without the inclusion of a clinical sample, consideration of these findings should be limited to that of a suggestive and theoretical guide to the role of social problem-solving deficits in HFASD depressive vulnerability. To further assess the validity of the findings and models produced by this study it will be necessary to further explore these issues in a sample that includes those with a HFASD diagnosis, so that it can be determined if and how the variable associations noted in this study persist in a clinical population.

Based on the promising findings of this study, it is suggested that future research should continue to investigate the role of social problem-solving skills in the depressive susceptibility of individuals with ASD, with particular emphasis on confirming these findings in a clinical sample. Follow-up work should additionally incorporate examinations of traits of anxiety, not only as a potential confound, but to examine how the presence of these traits might result from, or encourage the use of maladaptive social problem-solving attributes. Should the findings from the current study be replicated in individuals with HFASD, it is recommended that further effort should be made to adopt and explore the potential of PST programs to reduce depressive vulnerability for individuals with HFASD. Finally, continued attention should also be paid to the vulnerabilities of individuals who express elevated, yet sub-threshold levels of the ASD phenotype as it is becoming more apparent that they are susceptible to many of the same problems as diagnosed populations, and may benefit from similarly targeted treatments.

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Figure 1:

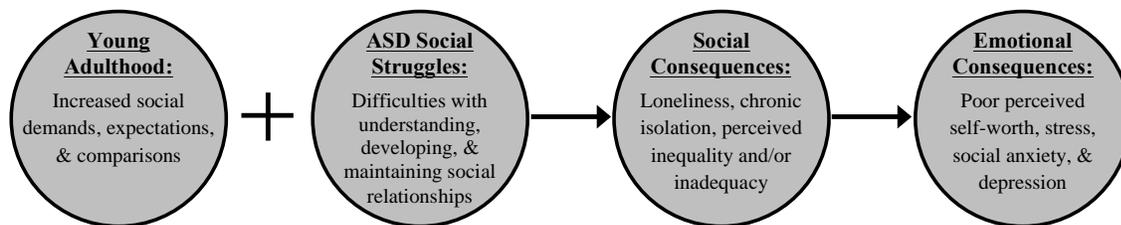


Figure Caption: Increased social demands of young adulthood may provide some of the answers to why this age-span is associated with increased susceptibility to depressive episodes for individuals with HFASD.

Table 1

AQ Total, Social Interaction, and Attention to Detail gender and field of study comparisons.

	N	μ -score	S.D.	F (1,228)	<i>p</i>
<i>Male (Female):</i>	111 (119)				
AQ Total		19.08 (17.34)	6.07 (6.87)	4.14	<0.05
Social Interaction		14.03 (11.68)	5.52 (6.18)	9.16	<0.01
Attention to Details		5.27 (5.65)	2.09 (2.54)	1.50	0.22
<i>Science (Non-Science):</i>	108 (122)				
AQ Total		18.46 (17.93)	6.86 (6.26)	0.39	0.51
Social Interaction		12.90 (12.74)	6.22 (5.79)	0.04	0.84
Attention to Details		5.56 (5.39)	2.29 (2.38)	0.30	0.58

note: statistically significant differences in bold; AQ = Autism-Spectrum Quotient

Figure 2:

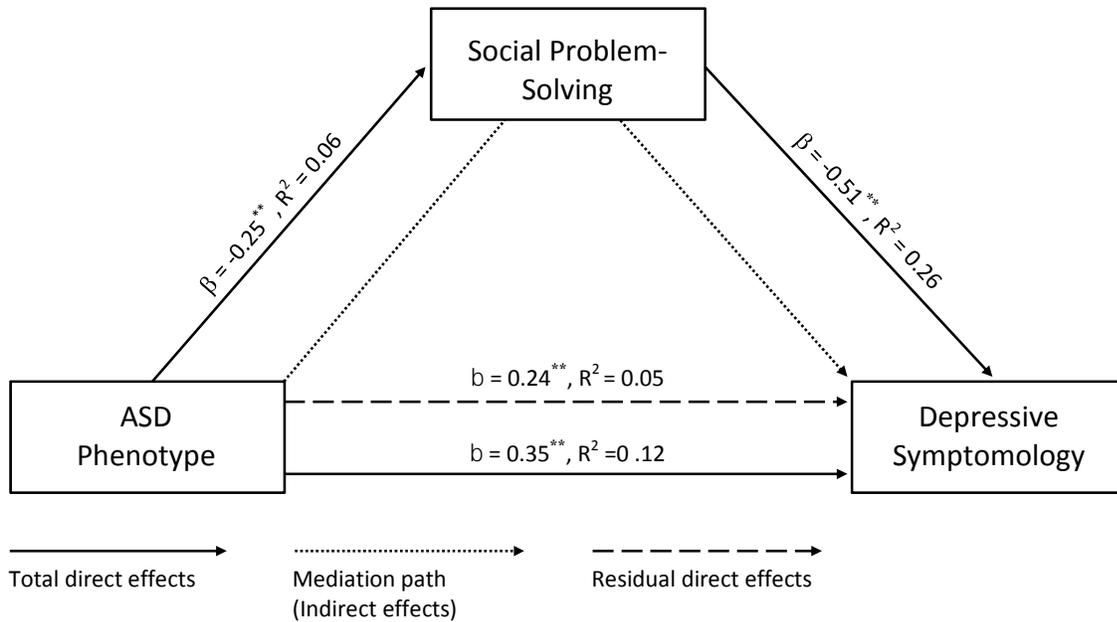


Figure Caption: Linear and hierarchical regression analyses of the relationship between ASD phenotype expression and depressive symptomology as mediated by social problem-solving ability. $** p < .01$

Table 2

Pearson product intercorrelations of path model analysis variables

	2.	3.	4.	5.	6.	7.	8.
1. AQ Total	0.90**	0.40**	-0.25**	0.24**	0.07	0.37**	0.35**
2. Social Interaction	1.00	0.03	-0.33**	0.26**	0.18**	0.40**	0.34**
3. Attention to Details		1.00	0.15*	-0.06	-0.16*	0.01	0.08
4. SPSI-R Total			1.00	-0.78**	-0.58**	-0.79**	-0.51**
5. Avoidance				1.00	0.38**	0.65**	0.41**
6. Impulsiveness/Carelessness					1.00	0.35**	0.25**
7. Negative Problem Orientation						1.00	0.55**
8. BDI-II							1.00

note: AQ = Autism-Spectrum Quotient, SPSI-R = Social Problem Solving Inventory, BDI-II = Beck's Depression Inventory; * p < .05, ** p < .01

Figure 3:

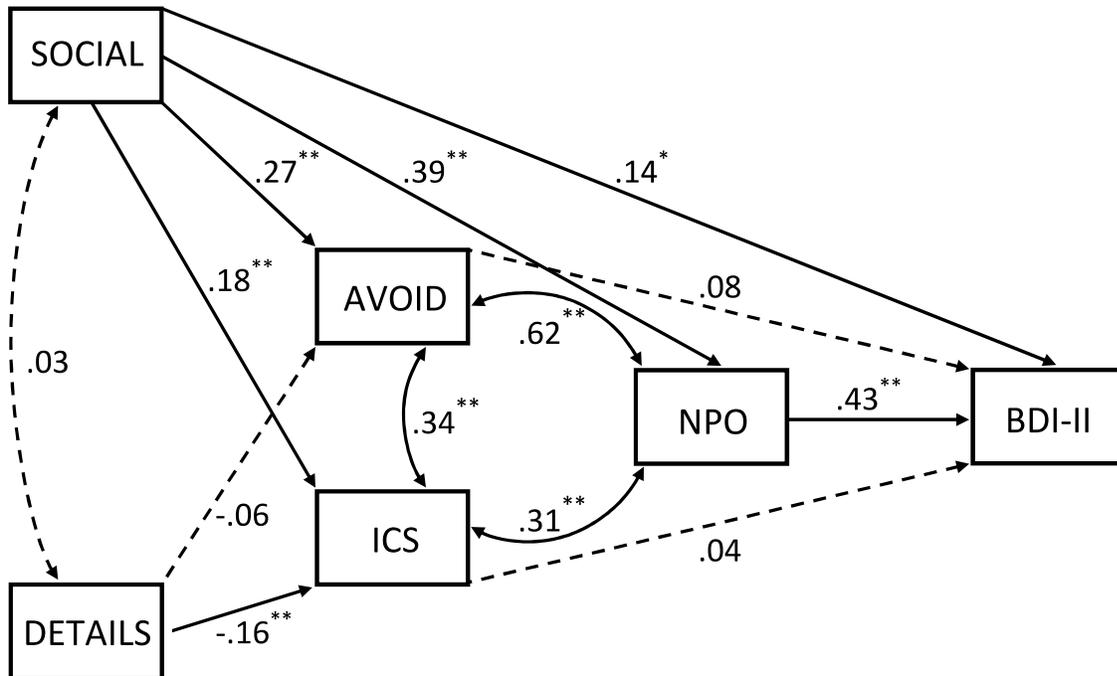


Figure Caption: Path model analysis output. AQ scales: SOCIAL = Social Interaction, DETAILS = Attention to Details; SPSI-R scales: AVOID = Avoidance, ICS = Impulsive/Carelessness Style, NPO = Negative Problem Orientation; BDI-II = depressive symptoms. Dashed lines represent non-significant paths. * $p < .05$, ** $p < .01$.