Title

The salience of the self: Self-referential processing and internalizing problems in children and adolescents with autism spectrum disorder

Journal

Autism Research, 10(5)

ISSN

1939-3792

Authors

Burrows, Catherine A
Usher, Lauren V
Mundy, Peter C
et al.

Publication Date

2017-05-01

DOI

10.1002/aur.1727

Peer reviewed

HHS Public Access

Author manuscript

Autism Res. Author manuscript; available in PMC 2018 May 01.

Published in final edited form as:

Autism Res. 2017 May ; 10(5): 949–960. doi:10.1002/aur.1727.

The Salience of the Self: Self-referential Processing and Internalizing Problems in Children and Adolescents with Autism Spectrum Disorder

Catherine A. Burrows[1], **Lauren V. Usher**[1], **Peter C. Mundy**[2], and **Heather A. Henderson**[3]

[1]Department of Psychology, University of Miami, Coral Gables, Florida, USA

[2]UC-Davis MIND Institute, Sacramento, California, USA

[3]Department of Psychology, University of Waterloo, Waterloo, Ontario, Canada

Abstract

Scientific Abstract—Children and adolescents with autism spectrum disorder (ASD) demonstrate atypical processing of, and memory for, self-referenced information, which may contribute to the heightened rates of co-occurring internalizing problems. We assessed affective and cognitive aspects of self-referential processing in verbally-fluent children with ASD (N=79), and an age-matched comparison sample (COM, N=73) of children without an autism diagnosis. We examined group differences in these two aspects of the self-system, and their joint contributions to individual differnces in internalizing problems. Using a self-referenced memory (SRM) task, participants indicated whether a series of positive and negative trait adjectives described themselves and a well-known fictional character. Participants were then surprised with a recognition memory test on the same adjectives. Overall, individuals with ASD showed a reduction in the extent to which they preferentially endorsed positive over negative trait adjectives about themselves, and a reduction in their preferential memory for self- over other-referenced information. Across the full sample, these two aspects of self-referential processing jointly predicted self-reported internalizing problems. Specifically, self-evaluations were strongly and inversely associated with internalizing problems but only for children with relatively high self-referenced memory. These findings suggest that the salience of the self influences the extent to which affective self-evaluations impact emotional functioning for youth both with and without ASD. Implications for basic (e.g., developmental) and translational (e.g., intervention) research are discussed.

Lay Abstract—Children with autism spectrum disorder (ASD) think about themselves differently than typically developing children do. Specifically, children with ASD think less positively of themselves than is typical, which can lead to anxiety and depression. Their system for remembering information about themselves is also altered. Usually, individuals relate new information to things they know about themselves to aid memory. However, individuals with ASD do not show better memory when they think about themselves, compared to when they think about

Corresponding authors: Catherine Burrows cburrows@umiami.edu; (305)205-4991; Department of Psychology, University of Miami, Coral Gables, FL 33146 or Heather Henderson hhenderson@uwaterloo.ca; +1(519)888-4567, ext. 31597; Department of Psychology, University of Waterloo, Waterloo, ON, Canada N2L 3G1.

another person, which is called preferential self-referenced memory (SRM). We examined what children with ASD (N=79), and an age-matched comparison sample (COM, N=73) think of themselves, and how well they remember information about themselves. Participants answered whether trait adjectives described themselves, and later were surprised with a memory test on those same adjectives. Overall, youth with ASD viewed themselves less positively than COM participants. Children with ASD also remembered fewer self-relevant relative to other-relevant adjectives. For all children, having strong memory for self-referenced information meant that positive self-evaluations were highly protective against symptoms of anxiety and depression. Self-referenced memory might tell us how much an individual focuses on what they think of themselves, for better or for worse. These differences could influence social skills and mental health in children with ASD. Differences in how individuals with ASD think about themselves may be important to address in treatment.

Keywords

Autism spectrum disorder; self-referenced processing; self-evaluations; memory

From an early age, individuals with autism spectrum disorder (ASD) demonstrate atypical representations of themselves, which may alter the developmental course of their intra- and inter-personal functioning (Mundy & Van Hecke, 2008). Many individuals with ASD receive direct and indirect negative feedback from the environment due to their poor social skills (Schroeder, Cappadocia, Bebko, Pepler, & Weiss, 2014; Usher, Burrows, Schwartz, & Henderson, 2015). If individuals possess insight into these difficulties and integrate them into their self-concept, they may develop internalizing problems (Attwood, 2000; Gotham, Bishop, Brunwasser, & Lord, 2014). Examinations of how individuals with ASD process information about themselves may provide insight into socio-cognitive processes underlying comorbid conditions. Here, we examine affective and cognitive aspects of self-referential processing – self-positivity biases and self-referenced memory (SRM), respectively – which develop throughout childhood and serve adaptive social functions (Heine et al., 1999; Symons & Johnson, 1997; Uddin, 2011). Given the great heterogeneity insight into social difficulties in ASD, we also examined their joint contributions to individual differences in internalizing problems in a sample of youth with ASD and a comparison sample of youth without autism (COM).

Self-Positivity Bias

Favoring positive rather than negative information about oneself is normative and adaptive for personal well-being, as individuals are motivated to construct and retain positive self-evaluations (Baumeister, 1998). This self-positivity bias provides individuals with confidence in themselves, even in new or difficult situations, which may buffer against low self-esteem and internalizing problems (Goldstein, Hayden, & Klein, 2015; Mezulis, Abramson, Hyde, & Hankin, 2004). Reduced positive self-evaluations are evident across many forms of psychopathology, including internalizing problems (e.g., anxiety, depression), externalizing problems (e.g., ADHD) and ASD (Gotlib & Joormann, 2010; Mezulis et al., 2004; Williamson, Craig, & Slinger, 2008), although few of these studies examine whether effects are specific to self evaluations by comparing to other-referenced

evaluations. In ASD, children and adolescents report lower global self-worth (Capps, Sigman, & Yirmiya, 1995) and endorse fewer positive traits about themselves, compared to typically developing children (Pfeifer et al., 2013). However, little research has examined the functional outcomes of negative self-perceptions in ASD.

Self-Referenced Memory

Individuals know and understand themselves, including their own personality traits, emotions, and actions, better than anyone else (Baumeister, 1998; Damon & Hart, 1982). Because of this, the self provides a unique cognitive structure that supports preferential attention, processing, organization and memory for incoming information (Klein & Kihlstrom, 1986; Klein & Loftus, 1988). Memory for self-referential information is stronger than memory for information processed regarding others, or encoded in reference to semantic or orthographic features (e.g., adjective valence or word length; Rogers, Kuiper, & Kirker, 1977; Symons & Johnson, 1997), which is typically assessed using the SRM task (Symons & Johnson, 1997). During this task, individuals encode positively- and negatively-valenced trait adjectives under various processing conditions (i.e. “Does this word describe [yourself, another person, or a positive personality trait]?”), and are later surprised with a recognition memory task for the same adjectives (Rogers et al., 1977). Individuals as young as eight years of age consistently demonstrate enhanced memory for self-referenced words relative to the other conditions (Halpin, Puff, Mason, & Marston, 1984; Hammen & Zupan, 1984). The degree of preferential memory for self- over other-referenced words is thought to index the integrity of the self-system (Klein & Loftus, 1988), which acts as an important tool for learning and memory, particularly for social experiences. Developmentally, this tendency to preferentially encode and retrieve self-referential information is thought to serve an adaptive purpose, by providing a prototype from which to understand the experiences of others (Henderson & Mundy, 2012; Hobson et al., 2006).

Children and adults with ASD typically fail to *preferentially* remember self- over other-referenced information (Henderson et al., 2009; Lombardo et al., 2007) and semantically-encoded information (Toichi et al., 2002; Yoshimura & Toichi, 2014). Individual differences in the degree of preferential SRM are consistently associated with emotion recognition, theory of mind, and autistic traits in individuals with and without ASD (Henderson et al., 2009; Lombardo et al., 2007; Yoshimura & Toichi, 2014). Reductions in SRM in ASD may hinder the development of intra- and interpersonal functioning by limiting the ability to understand the intentions, reactions and motivations of others. However, no study to date has examined whether memory performance differs as a function of adjective valence.

Associations with Internalizing Problems

Internalizing problems constitute one of the highest comorbid conditions with ASD, with approximately 40% of individuals meeting clinical criteria for co-occurring internalizing problems (Mayes, Calhoun, Murray, & Zahid, 2011; van Steensel, Bögels, & Perrin, 2011). However, there is great variability in the presentation and level of impairment caused by internalizing symptoms in individuals with ASD, which may be influenced by atypical affective and cognitive self-referential processing. Negative self-evaluations in conjunction

with heightened self-focused attention have been identified as a cognitive vulnerability factor for internalizing problems broadly (Ehring & Watkins, 2008). The perseverative thinking style that is often present in ASD (Lopez, Lincoln, Ozonoff, & Lai, 2005), combined with negative self-focused thoughts could contribute to symptoms of anxiety and depression, including worry in social situations, feelings of sadness and hopelessness, and lack of motivation (Gotham et al., 2014; McEvoy & Mahoney, 2013; Nejad, Fossati, & Lemogne, 2013). In contrast, elaborate processing of positive self-referenced information could protect from such internalizing problems. Furthermore, for individuals whose sense of self is not salient, self-perceptions may not impact internal well-being. Examining the combined influences of both affective and cognitive aspects of self-referential processing may uncover specific mechanisms underlying variability in the expression of internalizing problems in youth with and without ASD.

Present Study

The goal of this study was to examine group differences in self-postivity biases and SRM, as well as their unique and joint contributions to internalizing problems in children with and without ASD. This may help to identify socio-cognitive mechanisms to comorbidity, and ways to improve well-being in individuals with ASD, particularly in childhood when one's sense of self is developing and interventions can be maximally effective.

This study had three aims. First, self- and other-evaluations were compared between ASD and COM groups on the endorsement phase of the SRM task. We hypothesized that individuals with ASD would demonstrate a reduced self-positivity bias relative to COM individuals, but comparable other-positivity biases. The second aim was to replicate previous reports of reduced preferential self-referenced memory and examine whether adjective valence influences later memory performance in the self or other condition, as no studies have examined memory differences by valence in ASD. Finally, inter-relations among self-positivity biases and self-referenced memory, as well as their associations with self-reports of internalizing problems were examined. We hypothesized that children with high SRM would show stronger inverse associations between self-positivity biases and internalizing problems, due to the heightened salience of their self-system.

Method

Participants

Participants were 152 youth aged 8–16 years ($N_{ASD=}$79 ASD, 68 males; N_{COM}=73, 53 males) who participated in a study of social-emotional adjustment. Data from a subsample of current participants were analyzed in a previous paper on SRM and theory of mind in children with ASD by Henderson and colleagues (2009; N=50). However, the current study incorporates additional participants (i.e., replication sample, N=102), and examines and relates both phases of the SRM task with internalizing problems. Primary findings of reduced preferential SRM from Henderson (2009) were replicated (see supplementary materials). Novel analyses were conducted using the full combined sample in order to maximize power.

Participants with ASD were recruited through a letter mailed to parents of verbally-fluent children with ASD from the Center for Autism and Related Disabilities at the University of Miami (UM). All participants in the ASD group had diagnoses from community mental health professionals using DSM-IV criteria. The comparison sample was recruited via letters sent home from school for students in the Miami-Dade County Public School system.

To be eligible for the study, participants in the ASD sample had to meet criteria on the Autism Diagnostic Observation Schedule (ADOS) and on at least one out of two parent-reported diagnostic measures. COM participants were excluded if they exceeded cutoff criteria on the ADOS, or if they exceeded cutoff criteria for more than one of the parent-reported ASD diagnostic measures. However, COM participants were not excluded if their parents reported that they experienced a learning disorder (N=2), ADHD (N=5), or an anxiety or mood disorder (N=1). Participants were excluded from either group if their parents reported that they were affected by a neurological disorder, severe syndromes other than ASD (e.g., schizophrenia), or psychotic symptoms. In addition, participants were excluded if they were not fluent in English, per parent report, or if their verbal IQ was below 70. Sample socio-economic factors are presented in supplementary materials.

There were no significant differences between ASD and COM groups on age (M_{ASD}=12.55; M_{COM}=13.23). However, the ASD and COM groups differed significantly on verbal IQ, with the ASD group (M=101.51) demonstrating lower verbal IQ than the COM group (M=109.73). Groups also differed on gender, with a greater proportion of males in the ASD (86.1%) than COM (72.6%) group (see Table 1).

Procedure

All study procedures were approved by the Institutional Review Board at UM. Interested families took part in two laboratory visits that included diagnostic confirmation testing, a cognitive assessment, and additional psychophysiological and behavioral assessments. Parental informed consent and child assent were obtained. Families were compensated $40 for participation in each visit.

Measures

Social Communication Questionnaire (SCQ; Berument et al., 1999)—The SCQ is a brief parent-report instrument for the valid screening or verification of lifetime symptoms of ASD. It was developed from the 40 critical items of the Autism Diagnostic Interview, and has a criterion score of 12 which discriminates likely presence of ASD.

High-functioning Autism Spectrum Screening Questionnaire (ASSQ; Ehlers, Gillberg, & Wing, 1999)—The ASSQ is a 27-item parent-report checklist that was designed as a brief screening device to identify current symptoms associated with ASD in children and adolescents. Parents rated their children's symptoms on a three-point scale: "not true" (0), "somewhat true" (1), or "true" (2). A cutoff score of 13 was used to capture clinically-significant symptoms of ASD (Ehlers et al., 1999).

Autism Diagnostic Observation Schedule - Generic (ADOS-G; Lord et al., 2000)—The ADOS is a semi-structured standardized observational assessment of ASD. It measures communication, social interaction, play and the imaginative use of materials in a series of structured activities. The ADOS has 4 modules appropriate to children and adults of varying developmental linguistic levels. Module 3 or 4 was administered to all participants by trained, reliable researchers. A cutoff score of 7 on the social communication domain was used to verify community diagnoses of ASD (Lord et al., 2000).

Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV; Wechsler, 2003)—To obtain an index of verbal intelligence, selected subtests (Similarities, Vocabulary) from the WISC-IV were administered. These subtests load most strongly onto VIQ, demonstrate strong test-retest reliability, and allow for a calculation of VIQ with minimal testing burden to the participant (Williams, Weiss, & Rolfhus, 2003).

Behavior Assessment System for Children, Self-report of Personality, Second Edition (BASC-2; Reynolds, 2010)—The BASC-2 assesses a range of social and emotional functioning. Two versions are available depending on the youth's age: child (ages 6–11) and adolescent (ages 12–21), and assess comparable domains of functioning across 139–179 questions. Questions are answered or on a scale from 'never' to 'almost always'. Responses are aggregated into age-adjusted T-scores (M=50, SD=10). Of interest in the current study was the Internalizing Problems domain.

Self-Referenced Memory Task—This task involves two phases: 1) Endorsement and 2) Recognition.

Endorsement Phase: In the endorsement phase, 3 lists of personality traits, each containing 14 adjectives (7 positive, 7 negative) were presented to participants. Adjectives were capped at a 3rd grade reading level. One of three types of processing condition questions was presented before each list: self-referent ('Does this word describe something about you?'), other-referent ('Does this word describe something about Harry Potter?'), and structural ('Does this word contain seven or more letters?'). Participants were seated 70 cm from the presentation screen (NANAO FlexScan 550i 17-inch monitor). Adjectives were presented on the screen for 2 seconds each, followed by 1.5 additional seconds fixation, providing the participants 3.5 seconds to respond 'yes' or 'no' by button press (two-button press box). Adjectives within a list were always presented in the same order, but list and condition order were counterbalanced across all participants. For participants unfamiliar with Harry Potter, Spiderman was used as the referent in the 'other' condition. Participants verbally confirmed that they were familiar enough with the 'other' referent to answer questions about that character.

Endorsement rates were calculated for each combination of valence and condition. Participants' data for a given list were excluded if they did not respond to at least half (4) of the items within that list (i.e., insufficient responding), ensuring a representative endorsement value. Adjusted rates of endorsement were computed as the number of yes responses, divided by the total number of items responded to, and multiplied by 7 (the possible number of items for each condition). This procedure corrected for missed

responses, while still allowing for meaningful interpretation of the score. Self- and other-positivity bias were computed as the difference between the endorsement rates for positive and negative adjectives in each condition. See Table 2 for a description of primary variables. Data were missing for 3 participants due to insufficient responding (n=1) or data recording errors (n=2).

Recognition Phase: Immediately following the presentation of all adjectives, an unexpected (to the participant) recognition phase was administered. Participants were presented with a sheet containing all 42 previously-viewed adjectives, interspersed with 84 novel distracter words, with an equal number of positive and negative adjectives. Over the next 5 minutes, participants were instructed to circle all adjectives judged as 'old' (i.e., previously viewed). Measures of memory sensitivity (i.e., d′) were calculated for each participant's recognition performance (Macmillan & Creelman, 2004). The d′ measure was computed as the standardized probability of correctly remembering the number of words identified minus the standardized probability of false alarms (i.e. distracter words incorrectly identified as 'old'). The recognition sheets were unavailable for several participants (n=18) after their recognition scores had been entered by condition. Thus, recognition scores by condition were available, but memory performance *by valence* could not be calculated. These participants did not differ from the larger sample on any demographic variables, diagnostic group, or primary dependent variables, all *p*'s > .05.

Results

Preliminary Analyses

Zero-order correlations (Table 3) were conducted separately by diagnostic group to determine covariates. Age correlated with most measures of memory sensitivity in the ASD group, and therefore was included as a covariate in Aim 2 for between-group comparisons. Due to group differences in verbal IQ and gender composition, they were included as covariates in all between-group analyses. Results are also presented without covariates in the supplementary materials.

The assumption of parallel regression slopes was tested for Aim 1 and 2 models to ensure that covariates did not interact with diagnostic group to influence results. The interaction terms were not significant for either of the ANCOVA models, all *p*'s>.05. Thus, the assumption of parallel regression slopes was met, and the interaction terms of covariates with group status were not included in hypothesis testing.

Hypothesis Testing

Endorsement Phase—We hypothesized that individuals with ASD would demonstrate a reduced self-positivity bias. To test the full factorial model, a 2 (Group: ASD, COM) by 2 (Condition: Self, Other) by 2 (Valence: Positive, Negative) repeated measures ANCOVA was conducted, controlling for verbal IQ and gender (Tables 4–5). Consistent with our hypothesis, the three-way interaction approached significance (Figure 1). Exploratory analyses were conducted to determine whether the three-way interaction was in the expected direction. Univariate ANCOVAs were conducted on the positivity bias score in each

condition (Self; Other), controlling for verbal abilities and gender. The self-positivity bias was significantly lower for the ASD (M_{adj}=3.22, SE=.26) than for the COM group (M_{adj}=4.22, SE = .26). This effect was specific to the Self Condition, with no group differences in the other-positivity bias scores (ASD M_{adj}=3.90, SE=.26; COM M_{adj}=3.96, SE=.27). Full results from the ANCOVA are described in supplementary materials.

Recognition Phase—For the second aim, we examined the recognition data to determine whether the reduced preferential SRM in the ASD group was modulated by adjective valence. A 2 (Group: ASD, COM) by 2 (Condition: Self, Other) by 2 (Valence: Positive, Negative) repeated measures ANCOVA was conducted on participants' recognition (memory sensitivity: d′) data, controlling for verbal IQ, gender, and age (Table 6). As expected, a Group by Condition interaction emerged, indicating that the difference between memory performance in the Self and Other conditions differed by group. Preferential SRM was significantly lower for participants with ASD (M_{adj}=.13, SE=.08), than for COM participants, (M_{adj}=.63, SE=.08; Figure 2). In addition, individuals with ASD tended to remember fewer self-relevant and more other-relevant adjectives. No other main effects or interactions emerged. The Levene's test for homogeneity of variances indicated that the groups differed in their variance on their Self-Positive, $F(1, 131)=7.05$, $p=.009$, and Self-Negative, $F(1, 131)=4.19$, $p=.04$, memory performance but not in either Other condition. The ASD group exhibited greater variability in performance in both the Self-Positive (SD_{ASD}=0.95; SD_{COM}=.69) and the Self-Negative condition (SD_{ASD}=1.02; SD_{COM}=.72), than did the COM group.

Correlations between Endorsement and Recognition—The third aim of this study was to examine the interrelations among endorsement and memory performance for those same adjectives within each diagnostic group (Table 3). We used Fisher's r to z transformation to test whether the strength of the correlation between self-positivity biases and preferential SRM differed by group. The self-positivity bias was predictive of preferential SRM in the COM group, but not the ASD group (Figure 3). The difference between correlation values between groups was significant at a trend level, $z=-1.75$, $p=0.08$, indicating that the association between self-positivity biases and preferential SRM tended to be stronger in the COM group than the ASD group.

Associations with Internalizing Problems—To examine the joint contributions of affective and cognitive aspects of self-referential processing to internalizing problems, a moderation analysis was conducted using hierarchical regression to test whether SRM (d′self) moderated the association between self-positivity biases and internalizing problems, and whether this effect differed by diagnostic group (Table 7, see supplementary materials). Across the full sample, there was a main effect of self-positivity biases such that higher self-positivity bias scores were associated with lower levels of internalizing problems. However, this effect was moderated by SRM, such that individuals with high (1SD above the mean) d′self showed stronger inverse associations between self-positivity biases and internalizing problems, b=−0.44, p=.002, compared to those with low d′self (1SD below the mean), where the association was not significant, b=0.01, p=.97. This moderation effect did not differ by group. See Figure 4 and Table 7.

Discussion

This was the first study to simultaneoulsy assess affective and cognitive aspects of self-referential processing in a large sample of youth with ASD and a comparison group. Individuals with ASD endorsed less positive views of themselves, and showed reduced preferential SRM. In addition, children with ASD tended to show compartmentalized self-systems, where positive self-endorsements did not predict later memory for the same information, as was the case for the comparison sample. For all children, self-positivity biases were protective against internalizing problems; however this effect was strongest for children who displayed enhanced memory for self-relevant information. Examination of the joint influences of affective and cognitive aspects of self-referential processing on internalizing problems provides novel insights into the social cognitive mechansims underlying the heterogeneity in this prevalent comorbidity.

Many individuals with ASD are aware of the social difficulties they face, and the negative evaluations that others may make about them in social situations (Attwood, 2000; Bellini, 2004), which together may contribute to reduced self-positivity biases. Past studies suggest that reduced self-positivity biases are common across developmental conditions characterized by social difficulties including ADHD, anxiety and depression (Mezulis et al., 2004). Our data suggest that individuals with lower evaluations of themselves, compounded with increased self-focused attention showed the highest internalizing problems in both groups. Future studies should examine directions of effects across disorders to identify whether the pathways to reduced self-positivity are shared across disorders.

Biased preferential SRM is believed to be adaptive, providing a strong structure on which to consolidate and elaborate memories (Klein & Kihlstrom, 1986). Across our full sample, and both the original sample from Henderson and colleagues (2009), and the new replication sample, youth with ASD demonstrated reduced preferential SRM compared to COM children who showed significantly enhanced memory for self- relative to other-referenced information. This atypical memory performance did not differ by valence of the adjectives encoded, indicating that individuals with ASD show a global difficulty in preferential memory allocation to self-referenced information. Converging evidence demonstrates that memory for several types of personally-relevant information is impaired in ASD, where adults with ASD show reduced preferential memory for owned items (over other-owned items), compared to neurotypical adults (Grisdale, Lind, Eacott, & Williams, 2014). Goddard and colleagues (2014) also reported reduced cued autobiographical memory in children with ASD compared to controls. Reduced attention and memory for self-relevant objects and information appears to reflect a global deficit in ASD across development that may explain variability in socio-cognitive abilities, social interactions and comorbid conditions.

Interestingly, memory performance was positively associated with age in the ASD group, but not the COM group, with older individuals with ASD demonstrating better memory performance for adjectives of both positive and negative valence and in both the self and other conditions. Previous research by Ray and colleagues (2009) demonstrated that memory performance in the self condition on the same task increased with age in typically-

developing children aged 7–13. Given that our sample was older, on average, than the Ray sample, the developmental trend in the ASD group may reflect a developmental *lag* in this population. Perhaps the adaptive organization of the self-system into different domains (e.g. social competence, academic competence; Harter, 1982) that typically occurs in middle childhood occur at later ages for children with ASD. Future studies should extend this research longitudinally in individuals with ASD to determine at what point in development this age-related effect levels off.

Individuals with ASD also exhibited more within-group variability in their memory for self-referenced information than did COM participants. There may be individuals with HFA who exhibit comparable SRM to the COM group, while others show dramatic reductions in SRM. Individual differences in SRM moderated the well-established association between self-positivity biases and internalizing problems (Goldstein et al., 2015; Gotlib & Joormann, 2010). This is consistent with previous research demonstrating that repetitive negative self-focused thinking acts as a cognitive vulnerability factor for internalizing problems (Ehring & Watkins, 2008; McEvoy, Mahoney, & Moulds, 2010). High SRM may index the salience of self-evaluations to internal functioning, where negative evaluations of one's self are particularly detrimental, but positive evaluations are protective. Importantly, this moderation held in both the COM and ASD groups, suggesting a preserved *mechanism* of risk for internalizing problems across groups. Future studies should examine the joint contributions of affective and cognitive aspects of self-referential processing in other clinical groups, including individuals with anxiety and depression, as well as across development.

Assessing both affective and cognitive aspects of self-referential processing may prove helpful in clinical settings. Current interventions for ASD are aimed at ameliorating individuals' understanding of others (White, Keonig, & Scahill, 2007). Children with differing combinations of self-evaluations and salience of these evaluations may benefit from different types of interventions. For example, children who prioritize self-referential information but endorse negative self-perceptions may benefit most from interventions targeting improving self-esteem, and training attention to positive environmental cues (e.g., attention-bias modification training; Hakamata et al., 2010). However, treatments for children with low SRM could target the organization of self-referential memory processes. For example, asking a child with ASD to describe how he looks and feels when he is angry, *and* linking these descriptions to a previous frustrating situation with another peer may help integrate these facets of self, rather than focusing on either of those skills separately.

Limitations and Future Directions

This study had several limitations. First, all of the primary self-referenced processing variables were assessed during a single task with some missing data, and associations with internalizing problems were assessed cross-sectionally. This limits our ability to assess directionality of influence. We interpret our moderation analyses as self-perceptions preceding internalizing problems, but it may be that internalizing problems affect the processing of self-relevant information. Future research should examine how positive endorsements of the self relate to preferential memory of self-referential information across different types of tasks over the course of development. Given that memory performance

varied as a function of age in the ASD group, associations between the two phases of the task and associations with internalizing problems may change as individuals grow older.

Atypical self-referential processing in individuals with ASD may be reflected in the neural processes involved in thinking about oneself and others. The default mode network is thought to support self- and other-referential processing (Murray, Schaer, & Debbané, 2012; Raichle et al., 2001) and consistently shows atypical activity and connectivity in ASD (Burrows, Laird, & Uddin, 2016; Kennedy & Courchesne, 2008; Washington et al., 2014; Ypma et al., 2016). Most research has focused on differences in either affective or cognitive aspects of self-referential processing. However, our behavioral findings suggest that there may also be differences in the coordination between affective and cognitive aspects of self-referential processing that warrant future exploration.

Conclusions

This was the first study to examine self-evaluations and SRM and their unique and joint associations with social difficulties and internalizing problems in individuals with ASD. We found robust diagnostic group differences in the mean levels and associations between both aspects of the self-system. Despite these differences, a similar pattern of associations with internalizing problems was evident in both the ASD and COM group. SRM may be an important moderator to consider when examining predictors of internal functioning in all children.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Grant sponsor National Institutes of Health; Grant number R01 MH71273.

References

Attwood T. Strategies for Improving the Social Integration of Children with Asperger Syndrome. Autism. 2000; 4(1):85–100. DOI: 10.1177/1362361300004001006

Baumeister RF. The Self. Handbook of social psychology (4th). 1998; 1:680–740.

Bellini S. Social Skill Deficits and Anxiety in High-Functioning Adolescents With Autism Spectrum Disorders. Focus on Autism and Other Developmental Disabilities. 2004; 19(2):78–86. DOI: 10.1177/10883576040190020201

Berument SK, Rutter M, Lord C, Pickles A, Bailey A. Autism screening questionnaire: diagnostic validity. The British Journal of Psychiatry. 1999; 175(5):444–451. [PubMed: 10789276]

Burrows CA, Laird AR, Uddin LQ. Functional connectivity of brain regions for self- and other-evaluation in children, adolescents and adults with autism. Developmental science. 2016

Capps L, Sigman M, Yirmiya N. Self-competence and emotional understanding in high-functioning children with autism. Development and Psychopathology. 1995; 7(01):137–149.

Damon W, Hart D. The Development of Self-Understanding from Infancy Through Adolescence. Child Development. 1982; 53(4):841–864. DOI: 10.2307/1129122

Ehlers S, Gillberg C, Wing L. A screening questionnaire for Asperger syndrome and other high-functioning autism spectrum disorders in school age children. Journal of autism and developmental disorders. 1999; 29(2):129–141. DOI: 10.1023/A:1023040610384 [PubMed: 10382133]

Ehring T, Watkins ER. Repetitive Negative Thinking as a Transdiagnostic Process. International Journal of Cognitive Therapy. 2008; 1(3):192–205. DOI: 10.1521/ijct.2008.1.3.192

Goldstein BL, Hayden EP, Klein DN. Stability of self-referent encoding task performance and associations with change in depressive symptoms from early to middle childhood. Cognition and Emotion. 2015; 29(8):1445–1455. DOI: 10.1080/02699931.2014.990358 [PubMed: 25530070]

Gotham K, Bishop SL, Brunwasser S, Lord C. Rumination and Perceived Impairment Associated With Depressive Symptoms in a Verbal Adolescent–Adult ASD Sample. Autism Research. 2014; 7(3): 381–391. DOI: 10.1002/aur.1377 [PubMed: 24802136]

Gotlib IH, Joormann J. Cognition and Depression: Current Status and Future Directions. Annual Review of Clinical Psychology. 2010; 6:285–312. DOI: 10.1146/annurev.clinpsy.121208.131305

Grisdale E, Lind SE, Eacott MJ, Williams DM. Self-referential memory in autism spectrum disorder and typical development: Exploring the ownership effect. Consciousness and cognition. 2014; 30:133–141. http://dx.doi.org/10.1016/j.concog.2014.08.023. [PubMed: 25286242]

Hakamata Y, Lissek S, Bar-Haim Y, Britton JC, Fox NA, Leibenluft E, Pine DS. Attention Bias Modification Treatment: A Meta-Analysis Toward the Establishment of Novel Treatment for Anxiety. Biological psychiatry. 2010; 68(11):982–990. http://dx.doi.org/10.1016/j.biopsych.2010.07.021. [PubMed: 20887977]

Halpin J, Puff CR, Mason H, Marston S. Self-reference encoding and incidental recall by children. Bulletin of the Psychonomic Society. 1984; 22(2):87–89. DOI: 10.3758/BF03333770

Hammen C, Zupan BA. Self-schemas, depression, and the processing of personal information in children. Journal of Experimental Child Psychology. 1984; 37(3):598–608. http://dx.doi.org/10.1016/0022-0965(84)90079-1. [PubMed: 6747551]

Harter S. The Perceived Competence Scale for Children. Child Development. 1982; 53(1):87–97. DOI: 10.2307/1129640

Heine SJ, Lehman DR, Markus HR, Kitayama S. Is there a universal need for positive self-regard? Psychological Review. 1999; 106(4):766–794. DOI: 10.1037/0033-295X.106.4.766 [PubMed: 10560328]

Henderson HA, Mundy PC. The Integration of Self and Other in the Development of Self-Regulation. Handbook of self-regulatory processes in development: New directions and international perspectives. 2012; 113

Henderson HA, Zahka NE, Kojkowski NM, Inge AP, Schwartz CB, Hileman CM, Mundy PC. Self-referenced memory, social cognition, and symptom presentation in autism. Journal of Child Psychology and Psychiatry. 2009; 50(7):853–861. [PubMed: 19298471]

Hobson RP, Chidambi G, Lee A, Meyer J, Müller U, Carpendale J, Racine T. Foundations for self-awareness: An exploration through autism. Monographs of the Society for Research in Child Development. 2006:i-166.

Kennedy DP, Courchesne E. Functional abnormalities of the default network during self-and other-reflection in autism. Social Cognitive and Affective Neuroscience. 2008; 3(2):177–190. [PubMed: 19015108]

Klein SB, Kihlstrom JF. Elaboration, organization, and the self-reference effect in memory. Journal of Experimental Psychology: General. 1986; 115(1):26. [PubMed: 2937872]

Klein SB, Loftus J. The nature of self-referent encoding: The contributions of elaborative and organizational processes. Journal of Personality and Social Psychology. 1988; 55(1):5.

Lombardo MV, Barnes JL, Wheelwright SJ, Baron-Cohen S. Self-referential cognition and empathy in autism. PLoS ONE. 2007; 2(9):e883. [PubMed: 17849012]

Lopez BR, Lincoln AJ, Ozonoff S, Lai Z. Examining the Relationship between Executive Functions and Restricted, Repetitive Symptoms of Autistic Disorder. Journal of autism and developmental disorders. 2005; 35(4):445–460. DOI: 10.1007/s10803-005-5035-x [PubMed: 16134030]

Lord C, Risi S, Lambrecht L, Cook EH Jr, Leventhal BL, DiLavore PC, Rutter M. The Autism Diagnostic Observation Schedule—Generic: A standard measure of social and communication deficits associated with the spectrum of autism. Journal of autism and developmental disorders. 2000; 30(3):205–223. DOI: 10.1023/A:1005592401947 [PubMed: 11055457]

Macmillan, NA., Creelman, CD. Detection theory: A user's guide. Psychology press; 2004.

Mayes SD, Calhoun SL, Murray MJ, Zahid J. Variables Associated with Anxiety and Depression in Children with Autism. Journal of Developmental and Physical Disabilities. 2011; 23(4):325–337. DOI: 10.1007/s10882-011-9231-7

McEvoy PM, Mahoney AEJ. Intolerance of uncertainty and negative metacognitive beliefs as transdiagnostic mediators of repetitive negative thinking in a clinical sample with anxiety disorders. Journal of Anxiety Disorders. 2013; 27(2):216–224. http://dx.doi.org/10.1016/j.janxdis.2013.01.006. [PubMed: 23474912]

McEvoy PM, Mahoney AEJ, Moulds ML. Are worry, rumination, and post-event processing one and the same?: Development of the repetitive thinking questionnaire. Journal of Anxiety Disorders. 2010; 24(5):509–519. http://dx.doi.org/10.1016/j.janxdis.2010.03.008. [PubMed: 20409676]

Mezulis AH, Abramson LY, Hyde JS, Hankin BL. Is There a Universal Positivity Bias in Attributions? A Meta-Analytic Review of Individual, Developmental, and Cultural Differences in the Self-Serving Attributional Bias. Psychological bulletin. 2004; 130(5):711–747. DOI: 10.1037/0033-2909.130.5.711 [PubMed: 15367078]

Mundy, P., Van Hecke, A. Neural systems, gaze following, and the development of joint attention. In: Nelson, CA.Luciana, M.Nelson, CA., Luciana, M., editors. Handbook of developmental cognitive neuroscience. 2nd. Cambridge, MA, US: MIT Press; 2008. p. 819-837.

Murray RJ, Schaer M, Debbané M. Degrees of separation: A quantitative neuroimaging meta-analysis investigating self-specificity and shared neural activation between self- and other-reflection. Neuroscience & Biobehavioral Reviews. 2012; 36(3):1043–1059. http://dx.doi.org/10.1016/j.neubiorev.2011.12.013. [PubMed: 22230705]

Nejad AB, Fossati P, Lemogne C. Self-Referential Processing, Rumination, and Cortical Midline Structures in Major Depression. Frontiers in Human Neuroscience. 2013; 7:666.doi: 10.3389/fnhum.2013.00666 [PubMed: 24124416]

Pfeifer JH, Merchant JS, Colich NL, Hernandez LM, Rudie JD, Dapretto M. Neural and behavioral responses during self-evaluative processes differ in youth with and without autism. Journal of autism and developmental disorders. 2013; 43(2):272–285. [PubMed: 22760337]

Raichle ME, MacLeod AM, Snyder AZ, Powers WJ, Gusnard DA, Shulman GL. A default mode of brain function. Proceedings of the National Academy of Sciences. 2001; 98(2):676–682. DOI: 10.1073/pnas.98.2.676

Ray RD, Shelton AL, Hollon NG, Michel BD, Frankel CB, Gross JJ, Gabrieli JD. Cognitive and Neural Development of Individuated Self-Representation in Children. Child Development. 2009; 80(4):1232–1242. [PubMed: 19630904]

Reynolds, CR. The Corsini Encyclopedia of Psychology. John Wiley & Sons, Inc; 2010. Behavior Assessment System for Children.

Rogers TB, Kuiper NA, Kirker WS. Self-reference and the encoding of personal information. Journal of Personality and Social Psychology. 1977; 35(9):677. [PubMed: 909043]

Schroeder JH, Cappadocia MC, Bebko JM, Pepler DJ, Weiss JA. Shedding Light on a Pervasive Problem: A Review of Research on Bullying Experiences Among Children with Autism Spectrum Disorders. Journal of autism and developmental disorders. 2014; 44(7):1520–1534. DOI: 10.1007/s10803-013-2011-8 [PubMed: 24464616]

Symons CS, Johnson BT. The self-reference effect in memory: A meta-analysis. Psychological bulletin. 1997; 121(3):371–394. DOI: 10.1037/0033-2909.121.3.371 [PubMed: 9136641]

Toichi M, Kamio Y, Okada T, Sakihama M, Youngstrom EA, Findling RL, Yamamoto K. A lack of self-consciousness in autism. The American Journal of Psychiatry. 2002; 159(8):1422–1424. DOI: 10.1176/appi.ajp.159.8.1422 [PubMed: 12153838]

Uddin LQ. The self in autism: An emerging view from neuroimaging. Neurocase. 2011; 17(3):201–208. [PubMed: 21207316]

Usher LV, Burrows CA, Schwartz CB, Henderson HA. Social competence with an unfamiliar peer in children and adolescents with high functioning autism: Measurement and individual differences. Research in Autism Spectrum Disorders. 2015; 17:25–39. http://dx.doi.org/10.1016/j.rasd.2015.05.005. [PubMed: 26161136]

van Steensel FJA, Bögels SM, Perrin S. Anxiety Disorders in Children and Adolescents with Autistic Spectrum Disorders: A Meta-Analysis. Clinical Child and Family Psychology Review. 2011; 14(3):302–317. DOI: 10.1007/s10567-011-0097-0 [PubMed: 21735077]

Washington SD, Gordon EM, Brar J, Warburton S, Sawyer AT, Wolfe A, VanMeter JW. Dysmaturation of the default mode network in autism. Human Brain Mapping. 2014; 35(4):1284–1296. DOI: 10.1002/hbm.22252 [PubMed: 23334984]

Wechsler, D. Wechsler intelligence scale for children–Fourth Edition (WISC-IV). San Antonio, TX: The Psychological Corporation; 2003.

White SW, Keonig K, Scahill L. Social skills development in children with autism spectrum disorders: A review of the intervention research. Journal of autism and developmental disorders. 2007; 37(10):1858–1868. [PubMed: 17195104]

Williams P, Weiss L, Rolfhus E. WISC-IV technical report# 2: Psychometric properties. The Psychological Corporation's WISC-IV Technical Manual. 2003; 2

Williamson S, Craig J, Slinger R. Exploring the relationship between measures of self-esteem and psychological adjustment among adolescents with Asperger Syndrome. Autism. 2008; 12(4):391–402. DOI: 10.1177/1362361308091652 [PubMed: 18579646]

Yoshimura S, Toichi M. A lack of self-consciousness in Asperger's disorder but not in PDDNOS: Implication for the clinical importance of ASD subtypes. Research in Autism Spectrum Disorders. 2014; 8(3):237–243. http://dx.doi.org/10.1016/j.rasd.2013.12.005.

Ypma RJF, Moseley RL, Holt RJ, Rughooputh N, Floris DL, Chura LR, Rubinov M. Default Mode Hypoconnectivity Underlies a Sex-Related Autism Spectrum. Biological Psychiatry: Cognitive Neuroscience and Neuroimaging. 2016; 1(4):364–371. http://dx.doi.org/10.1016/j.bpsc.2016.04.006. [PubMed: 27430030]

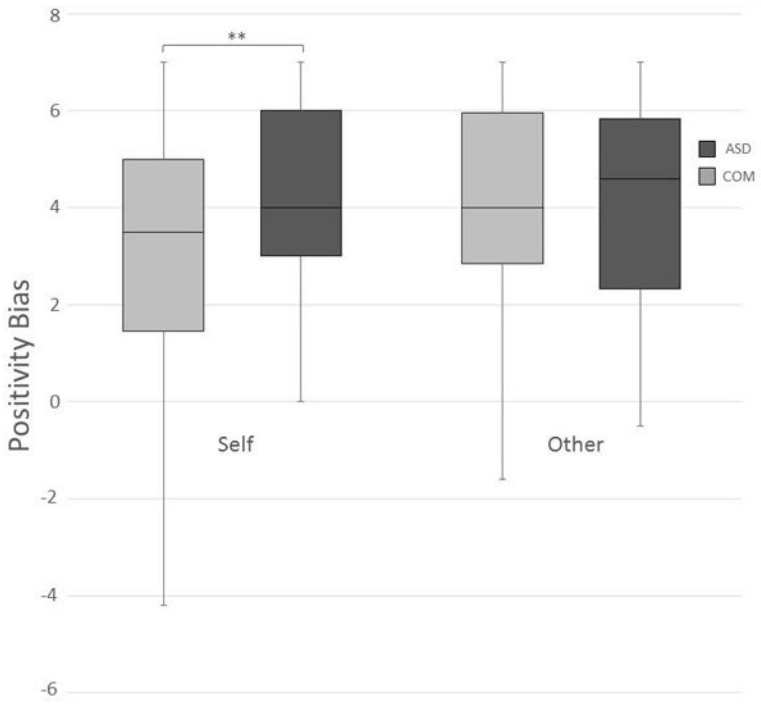

Figure 1.

In the Group by Valence by Condition interaction on endorsement data, the self-positivity bias was significantly lower for participants with ASD than COM participants. Groups did not differ in their other-positivity bias scores. Box-and-whisker plots denote the median (middle line), 25th and 75th percentiles (extension of boxes) and range (whiskers) of Positivity Bias scores for each group. *Note*. ASD = individuals with autism spectrum disorder, COM = comparison individuals without autism diagnosis; ** $p < .01$.

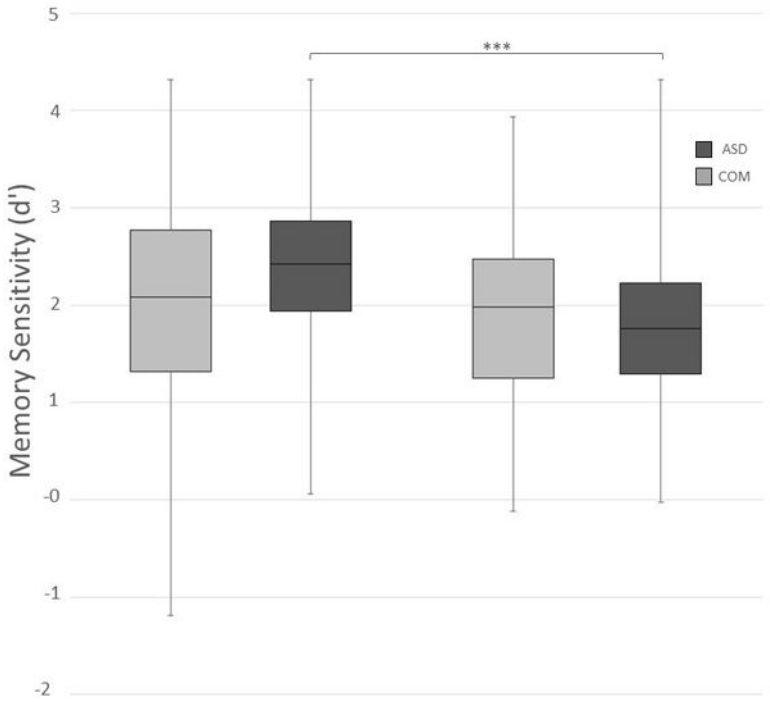

Figure 2.

Significant Group by Condition interaction on recognition data, where ASD participants demonstrate reduced preferential self-referenced memory (statistics for interaction can be found in Table 6). COM participants demonstrated the self-reference effect, showing a greater difference in memory for self- versus other-referenced information, controlling for age, gender and verbal IQ. Box-and-whisker plots denote the median (middle line), 25th and 75th percentiles (extension of boxes) and range (whiskers) of Positivity Bias scores for each group. *Note*. ASD = individuals with autism spectrum disorder, COM = comparison individuals without autism diagnosis; ** $p < .01$.

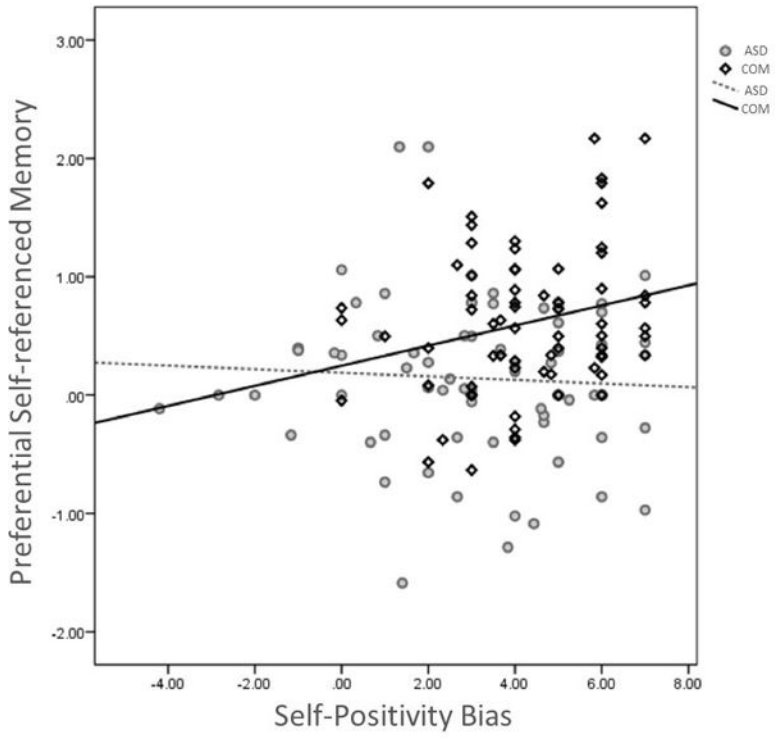

Figure 3.

Self positivity bias was associated with preferential self-referenced memory in the comparison sample but not in the participants with ASD. Statistical values can be found in Table 4. *Note*. ASD = individuals with autism spectrum disorder, COM = comparison individuals without autism diagnosis.

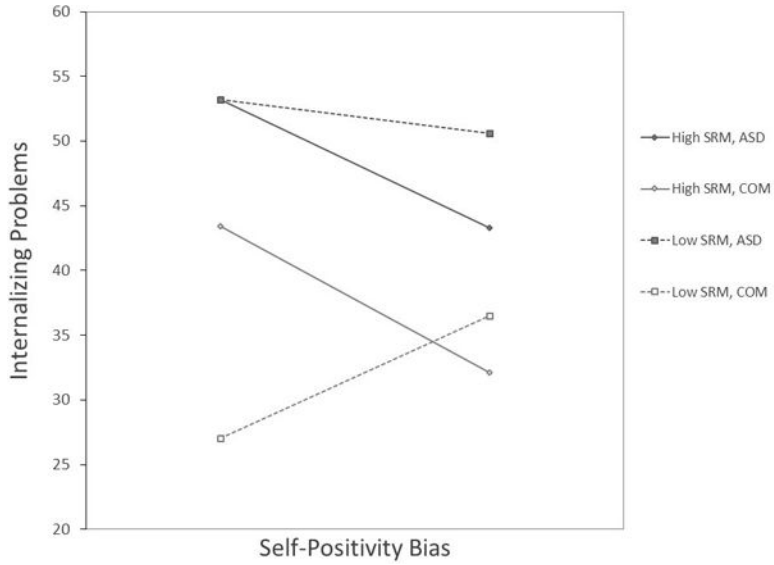

Figure 4.

Self-referenced memory (d′self) moderates the association between self-positivity bias and self-reported internalizing problems across the full sample. For children with high d′self, self-positivity biases are protective against internalizing problems, but the association is not significant for children with low d′self. This effect was not moderated by group status. Associations are represented at one standard deviation above (High SRM) and below (Low SRM) the mean of d′self. *Note*. ASD = individuals with autism spectrum disorder, COM = comparison individuals without autism diagnosis.

Table 1

Descriptive values for demographic and diagnostic information.

	Diagnostic Group				Group differences	
	ASD (n = 79)		COM (n = 73)			
	Mean (SD)	*Range*	*Mean (SD)*	*Range*	*t* value	*p* value
Gender	68 M, 11 F	–	53 M, 20 F		χ^2=4.70	0.03
Age in years	12.55 (2.57)	8.17 – 16.75	13.23 (2.18)	8.83 – 16.33	−1.76	0.09
Verbal IQ	101.51 (14.91)	75 – 140	109.73 (12.28)	81 – 146	−3.82	*<.001*
ADOS	12.39 (3.57)	7 – 22	1.58 (1.80)	0 – 6	23.85	*<.001*
SCQ	19.01 (6.30)	3 – 33	4.76 (3.47)	0 – 20	17.32	*<.001*
ASSQ	26.37 (8.64)	10 – 46	4.53 (4.55)	0 – 23	19.68	*<.001*
BASC Internalizing	54.18 (9.87)	29 – 77	44.97 (6.55)	36 – 64	6.62	*<.001*

Note. ADOS = Autism Diagnostic Observation Schedule, SCQ = Social Communication Questionnaire, ASSQ = Autism Spectrum Screening Questionnaire, BASC = Behavior Assessment Scale for Children, ASD = individuals with autism spectrum disorder, COM = comparison individuals without autism diagnosis.

Table 2

Description of primary study variables.

Variable Name	Description	Calculation	Conditions of Interest	Phase	Aim
Endorsement rate	Adjectives endorsed	# endorsed yes divided by total # endorsed	self-positive, self-negative, other-positive, other-negative	Endorsement	1
Positivity Bias	Positive concept of referent	Difference between endorsement of positive and negative adjectives	Self, Other	Endorsement	1, 3
Memory Sensitivity (d′)	Memory performance	Standardized probability of recognition minus standardized probability of false alarms	self-positive, self-negative, other-positive, other-negative, self, other	Recognition	2, 3
Preferential Self-Referenced Memory	Memory bias for self-referential information	d′Self - d′Other	N/A	Recognition	2, 3

Table 3

Correlations between primary variables and covariates of age, symptom severity, and verbal IQ. Correlations for participants with ASD are reported in the shaded region above the diagonal; correlations for COM participants are reported below the diagonal.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	–	.15	.07	−.14	.05	.02	.00	−.11	.44**	.36**	.35**	.34**	.05	−.02
2. Symptom Severity (ASSQ)	.11	–	.19	−.19	.14	.05	.05	−.19†	−.09	−.19	.00	.10	−.32**	.23*
3. Verbal IQ	−.10	.13	–	−.14	−.10	−.33**	−.12	−.01	.18	.05	.11	.10	.06	−.06
4. Endorsement: self-positive	−.10	.03	−.07	–	−.27*	.06	−.08	.72***	−.20†	−.11	−.24*	.01	.13	−.17
5. Endorsement: self-negative	.02	.12	−.14	.08	–	.06	.12	−.86***	.11	.03	.09	.07	−.02	.28*
6. Endorsement: other-positive	.13	.01	−.03	.20†	−.06	–	−.26*	−.01	−.23†	−.15	−.13	−.10	−.16	.01
7. Endorsement: other-negative	.21†	−.16	−.31**	.02	.42***	−.10	–	−.13	−.09	−.15	−.16	−.11	.00	.04
8. Self Positivity Bias	−.09	−.08	.07	.56***	−.78***	.17	−.33**	–	−.20	.08	−.19	−.05	−.06	−.28*
9. Recognition: self-positive	.24†	.14	−.16	.04	−.02	.01	−.03	.01	–	.75***	.79***	.60***	.44**	−.12
10. Recognition: self-negative	.15	.08	−.05	.10	−.07	.06	−.04	.11	.68***	–	.67***	.64***	.52**	−.14
11. Recognition: other-positive	.23†	.28*	−.10	−.04	.17	−.14	−.04	−.17	.64***	.41***	–	.63***	.01	.07
12. Recognition: other-negative	.06	.18	−.10	−.03	.10	−.15	−.02	−.11	.51***	.66***	.48***	–	−.17	.13
13. Preferential Self-referenced Memory	.01	−.05	−.10	.17	−.15	.19	−.02	.23*	.26*	.35**	−.37**	−.34**	–	−.09
14. BASC Internalizing Problems	−.09	.39**	.13	−.03	.32**	−.01	−.09	−.28*	−.01	−.05	.05	.22†	−.16	–

Note. ASSQ = Autism Spectrum Screening Questionnaire, BASC = Behavior Assessment Scale for Children, ASD = individuals with autism spectrum disorder, COM = comparison individuals without autism diagnosis;

† $p < .10$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 4

Endorsement and recognition values for each group and condition.

	Endorsement Phase				Recognition Phase			
	ASD		COM		ASD		COM	
	Mean (SD)	*Range*	*Mean (SD)*	*Range*	*Mean (SD)*	*Range*	*Mean (SD)*	*Range*
Self-Positive	5.44 (1.33)	2.33 – 7.00	5.70 (1.05)	3.50–7.00	1.83 (0.94)	−0.60 – 3.73	2.26 (0.69)	0.00 – 3.73
Self-Negative	2.22 (1.78)	0.00 – 7.00	1.46 (1.41)	0.00–7.00	2.04 (1.03)	−1.20 – 3.73	2.29 (0.71)	0.22 – 3.73
Other-Positive	5.29 (1.50)	1.17 – 7.00	5.59 (1.14)	2.00–7.00	1.80 (0.88)	−0.50 – 3.73	1.80 (0.75)	0.13 – 3.73
Other-Negative	1.44 (1.46)	0.00 – 5.6	1.58 (1.58)	0.00–7.00	1.89 (0.89)	−0.07 – 3.73	1.79 (0.86)	−0.50 – 3.73
Self	3.83 (0.95)	1.67 – 7.00	3.59 (0.90)	1.75–7.00	1.99 (1.01)	−0.74 – 4.33	2.41 (0.74)	0.05 – 4.32
Other	3.36 (0.89)	1.50 – 5.60	3.58 (0.93)	2.00–7.00	1.86 (0.91)	−0.12 – 3.94	1.79 (0.76)	−0.03 – 4.32
Positive	5.36 (1.03)	3.25 – 7.00	5.65 (0.86)	3.50–7.00	1.81 (0.86)	−0.40 – 3.73	2.03 (0.65)	0.07 – 3.73
Negative	1.85 (1.20)	0.00 – 5.6	1.51 (1.26)	0.00–7.00	1.97 (0.87)	−0.64 – 3.73	2.04 (0.72)	−0.03 – 3.73

Note. All values represent values on the endorsement and recognition portion of the self-referenced memory task. *Note.* ASD = individuals with autism spectrum disorder, COM = comparison individuals without autism diagnosis.

Table 5

Results from the Group by Condition by Valence ANCOVA on endorsement rates. All analyses control for Gender and Verbal IQ. Degrees of freedom for all contrasts were 1, 144.

	Factor	Wilks Λ	F Value	p value	Partial η2	Follow-up Contrast	Follow-up Contrast F Value	Follow-up Contrast p Value
Main Effects	Group	–	0.30	0.58	0.00	–	–	–
	Condition	0.98	2.57	0.11	0.02	–	–	–
	Valence	0.94	9.04	0.003	0.06	Positive > Negative	3.13	0.079
Interactions	Condition × Group	0.92	12.38	0.001	0.08	Self: ASD > COM	2.77	0.099
						Other: ASD < COM	7.64	0.006
	Valence × Group	0.97	4.06	0.046	0.03	Positive: ASD < COM	6.77	0.042
						Negative: ASD = COM	1.11	0.30
	Condition × Valence	1.00	0.00	0.95	0.00	–	–	–
	Group × Condition × Valence	0.98	3.63	0.059	0.03	Self positivity bias: ASD < COM	6.98	0.009
						Other positivity bias: ASD = COM	0.03	0.87

Note. ASD = individuals with autism spectrum disorder, COM = comparison individuals without autism diagnosis.

Table 6

Results from the Group by Condition by Valence ANCOVA on recognition rates. All analyses control for Gender, Verbal IQ, and age. Degrees of freedom for all contrasts were 1, 128.

	Factor	Wilks Λ	F Value	p value	Partial η^2	Follow-up Contrast	Follow-up Contrast F Value	Follow-up Contrast p Value
Main Effects	Group	–	1.00		0.00	–	–	
	Condition	1.00	0.02	0.90	0.00	–	–	
	Valence	0.99	2.00	0.13	0.02	–	–	
Interactions	Condition × Group	0.89	16.09	<.001	0.11	Self: ASD < COM	2.91	0.090
						Other: ASD > COM	3.18	0.077
	Valence × Group	0.99	0.37	0.54	0.00	–	–	
	Condition × Valence	1.00	0.00	0.96	0.00	–	–	
	Group × Condition × Valence	0.99	0.19	0.66	0.00	–	–	

Note. ASD = individuals with autism spectrum disorder, COM = comparison individuals without autism diagnosis.

Table 7

Results from the self-positivity bias (SPB) by d'self by group moderation on Internalizing problems. SRM moderated the association between SPB and internalizing problems, such that those with high d'self showed a stronger, significant relationship between SPB and internalizing problems. This effect was not moderated by group, indicating that the moderation was comparable in each group.

	Predictor	Step 1 b	Step 1 p value	Step 2 b	Step 2 p value	Step 3 b	Step 3 p value	Step 4 b	Step 4 p value
Step 1. R^2=.02	Gender	.02	.83	.13	.08	.12	.10	.12	.09
	Verbal IQ	−.14	.09	.02	.79	.04	.60	.03	.64
Step 2. R^2=.31	Group			.41	<.001	.40	<.001	.40	<.001
Δ R^2=.29	SPB			−.27	<.001	−.22	.10	−.19	.17
	d´Self			−.11	.17	.06	.63	.06	.61
Step 3. R^2=.37	Group × SPB					−.09	.47	−.11	.39
Δ R^2=.07	Group × d´Self					−.20	.10	−.20	.09
	SPB × d´Self					−.24	.001	−.41	.04
Step 4. R^2=.38 Δ R^2=.004	Group × SPB × d´Self							.18	.34

*Note: Standardized regression coefficients are presented, for the final model which includes all predictors. Degrees of freedom for all analyses are 1, 131.