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The Role of Valence in Self-referenced Memory in Children with and without Autism Spectrum Disorder

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UNIVERSITY OF MIAMI

THE ROLE OF VALENCE IN SELF-REFERENCED MEMORY IN CHILDREN
WITH AND WITHOUT AUTISM SPECTRUM DISORDER

By

Catherine Burrows

A THESIS

Submitted to the Faculty
of the University of Miami
in partial fulfillment of the requirements for
the degree of Master of Science

Coral Gables, Florida

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WITH AND WITHOUT AUTISM SPECTRUM DISORDER

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The Role of Valence in Self-referenced
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Individuals with autism have consistently demonstrated atypical processing of and memory for self-referenced information compared to their typically developing peers, yet the underlying cause of these differences remains unknown. The present study aims to explore a potential mechanism underlying atypical memory for self-referenced information in higher functioning individuals with autism (HFA) and a comparison group of individuals without an autism diagnosis (COM). Participants included 79 children and adolescents with an HFA diagnosis (68 males, 11 females) and 73 COM individuals (53 males, 20 females) who completed a self-referenced memory task. Diagnostic group differences were detected in endorsement and memory for positive and negative trait adjectives, as well as in the relations between performance in each phase of the task. Results from a mediation model indicated that the Self-Positivity Bias significantly mediated the diagnostic group differences in preferential self-referenced memory. Results will be discussed with reference to the structure of the self-system in children with HFA, and the role of preferential self-processing in supporting social skill development, and in terms of the implications for the development of interventions for children with autism.

TABLE OF CONTENTS

LIST OF TABLES	iv
LIST OF FIGURES	v
Chapter	
1 INTRODUCTION	1
The Self-Reference Effect	2
The Self-Reference Effect in ASDs	4
Role of Valence in Self-referenced Memory	6
Autism and Internalizing Disorders	7
Present Study	8
Specific Aims	9
2 METHOD	11
Participants.....	11
Procedure.....	12
Measures	12
3 RESULTS	16
Preliminary Analyses	16
Aim 1 – Group Differences in Endorsement Rates	16
Aim 2 – Group Differences in Recognition Rates.....	19
Aim 3 – Interrelations Among Endorsement and Recognition	21
Aim 4 – Mediation Model.....	21
4 DISCUSSION	23
Endorsement Differences	23
Recognition Differences	26
Relating Endorsement and Recognition	28
Mediation Analyses	29
Limitations and Future Directions	29
TABLES.....	32
FIGURES.....	35
REFERENCES.....	41

LIST OF TABLES

TABLE 1: Raw recognition statistics.....	31
TABLE 2: Descriptive Statistics	32
TABLE 3: Correlations between primary variables and covariates	33

LIST OF FIGURES

FIGURE 1	34
FIGURE 2	35
FIGURE 3	36
FIGURE 4	37
FIGURE 5	38
FIGURE 6	39

CHAPTER 1: INTRODUCTION

Much research in individuals with autism spectrum disorders has focused on *interpersonal* and social skill deficits (e.g., Mundy et al., 1986; Travis & Sigman, 1998; Church, Alisanski, & Amanullah 2000). For example, impairments in the ability to take another person's perspective are considered a core deficit of the disorder and inform our understanding of how individuals with autism function within a social context (Baron-Cohen, Leslie, & Frith, 1985). However, there has been a recent shift towards understanding the role of a strong sense of self as a developmental precursor for understanding others and for the development of social skills (Hobson et al., 2006; Lombardo et al., 2007, Lombardo & Baron-Cohen, 2011; Uddin, 2011). Specifically, recent research suggests that an intact sense of self as well as the perception of one's self being embedded within a social context are necessary, although not sufficient, for understanding the emotions, motivations, and behavior of others (Frith & Happé, 1999; Lee & Hobson, 1998; Henderson & Mundy, 2012). From an early age, individuals with autism demonstrate atypical representations of themselves, which may alter the developmental course of their interpersonal understanding and relationships (Mundy & Vaughan Van Hecke, 2008). In this way, examinations of the *intrapersonal* deficits, or the differences in the cognitive representation of one's self, may inform our understanding of the observed interpersonal deficits in individuals with autism.

Recent research has highlighted the differences in the abilities of individuals with autism, compared to their typically developing peers, to encode and retrieve self-relevant information (Lombardo et al., 2007; Henderson et al., 2009). In general, it appears that the representational system of individuals with autism does not efficiently scaffold

attention and memory for personally-relevant information. However, less is known regarding the *mechanisms* underlying these differences in self-representation. A possible explanation for the observed atypical representation of self is that individuals with autism process information of emotional valence differently than their typically developing peers. Given the elevated levels of internalizing disorders in many individuals with autism, and the known impact of these disorders on processing and memory for information of affective content (Kim et al., 2000; Muris and Field, 2008), individuals with autism may differ from their typically developing peers, who preferentially process positive self-relevant information from the environment. Thus, the goal of the present study is to examine whether the affective valence of trait adjectives impacts the processing of, and memory for, self-relevant information in individuals with autism.

The Self-Reference Effect

The self is a unique cognitive structure that supports enhanced memory organization and motivation for positive self-presentation (Klein & Kihlstrom, 1986; Klein & Loftus, 1988). For example, a significant body of research indicates that information is remembered preferentially when it is encoded in relation to the self – more so than any other referent (Rogers, Kuiper & Kirker, 1977; Symons & Johnson, 1998). This has been assessed using a paradigm where participants are asked to judge whether trait adjectives are characteristic of themselves (i.e., “Does this word describe you?”), characteristic of another person (i.e., “Does this word describe Harry Potter?”), or based on some structural feature of the word (i.e., “Does this word have more than 7 letters?”). Examples of adjectives include “joyful,” “nice,” “stubborn,” and “clever,” and typically represent an equal number of positively and negatively valenced adjectives. After a short

delay, typically of 5-30 minutes, participants are asked whether they recognize the adjectives from a list of the original words interspersed among additional novel adjectives. Typically developing children and adults consistently show more accurate recognition of adjectives encoded in relation to the self relative to adjectives encoded in relation to another person or in a structural way (Rogers, Kuiper & Kirker, 1977; Symons & Johnson, 1998). This well-replicated pattern of performance is known as the self-reference effect (SRE). The SRE is attributed to the fact that individuals have a strong, well-developed sense of self, which allows for scaffolding of new information, leading to preferential processing and later retrieval (Rogers, Kuiper & Kirker, 1977). This efficient processing of self-referential information appears to serve an adaptive purpose, where an understanding of the self provides a prototype for understanding the experience of other individuals (Henderson & Mundy, 2012).

Historically, the SRE has been thought to occur because referencing the self promotes natural elaboration and organization of information (Klein & Loftus, 1988). Elaborative processing involves forming multiple associations between a word and other specific details relevant to that word that were previously stored in memory. Thus, when information is retrieved, these multiple connections to relevant personal memories facilitate recall (Klein & Loftus, 1988; Rogers, Kuiper, & Kirker, 1977). The self-reference condition also promotes efficient organization of information (Klein & Kihlstrom, 1986), by referencing other semantically related words when encoding new information. In this way, the word of reference is not simply remembered on its own, but also via its associations with other words with which it is categorized. This perspective

provides a useful explanation of why the SRE is so strong, but gives little insight into the source of individual differences in self-referenced memory.

The Self-Reference Effect in ASDs

Examinations of the SRE in individuals with autism have consistently demonstrated a failure to *preferentially* encode self-relevant information over other types of social information when compared to their typically developing counterparts. Toichi et al. (2002) examined memory performance for self-referenced information in adults with autism compared to healthy control subjects. They found that individuals with autism demonstrated worse memory for self-relevant words, but better memory in the semantic condition (i.e. “Is the meaning of this word similar to ___?”) than individuals in the comparison group. They concluded that individuals with autism may attend more to the ‘shallow’ aspect of materials, rather than elaborating and preferentially organizing self-relevant materials.

Lombardo et al. (2007) also investigated the degree to which adults with autism remember information encoded with reference to the self. Memory performance in each condition, as well as the degree of *preferential* self- over other-referenced memory were calculated. Preferential self-reflection was computed as the difference in the number of words recalled after being processed in relation to the self versus in relation to a friend, or a familiar other (i.e., “Does this word describe Harry Potter?”). They found that the adults with autism demonstrated greater memory for adjectives encoded in the self condition relative to others, or in a semantic way, but that the magnitude of the memory bias, or degree of preference, for self-referential over other-referential information was diminished relative to control participants. Interestingly, individual differences in the

degree of preferential self-processing was positively associated with emotion recognition, and negatively associated with autism symptom severity in both individuals with autism and typically developing individuals.

Henderson et al. (2009) extended this work to examine the SRE in children with high-functioning autism compared to a group of typically developing children matched on age and IQ. Consistent with Lombardo et al. (2007), children with HFA did not differ from their typically developing peers on the mean number of self-relevant words recalled, but showed a smaller memory bias for words encoded relative to the self versus others. Similar to previous findings, a larger self-referenced memory bias was associated with reduced symptom severity. These findings suggest that the reduced self-reference effect in individuals with autism appears early in development, and that efficient and elaborated processing of self-referential information may support social behavior and adaptive functioning.

Together, these findings suggest that individuals with autism may utilize less elaboration and organization for self-relevant information, leading to lower preferential processing of self-relevant information. In turn, lower depth of processing of self-referential information may hinder the ability of individuals with autism to effectively learn and flexibly implement social skills. However, no study to date has examined differences in memory for positive versus negative adjectives, or the association between adjective endorsement and memory recognition in typically developing individuals or those with autism.

Role of Valence in Self-referenced Memory

Previous research has revealed that individuals with autism process self-relevant information differently than do typically developing children and adults, and that this may be an important factor influencing the social skills deficits that are hallmark of the autism diagnosis. However, little is known about why these differences in processing occur. One possibility could be that the valence of trait adjectives impacts the way individuals with autism attend to and process those adjectives. Differences in memory may originate, in part, from differences in the initial processing of self-relevant adjectives, which would be apparent by examining the rates of endorsement upon first presentation and the influence of endorsement rates on later recognition memory.

In typically developing individuals, memory for *positive* trait adjectives encoded in relation to the self may be particularly enhanced through extensive elaboration and organization, as individuals have a natural tendency to incorporate positive emotional information into their self-schemas (Welch-Ross, Fasig & Farrar, 1999). Thus, memory is likely to be enhanced when the incoming information is of positive valence *and* is encoded with reference to the self. This is supported by findings showing that the self-reference effect is particularly strong for positive trait adjectives in healthy adults (D'Argembeau, Comblain, & Van der Linden, 2005). In this study, the facilitative effect of positive valence on heightened memory was unique to the self-referenced condition. The positivity bias did not hold when participants encoded words relative to another person. Preferentially processing positive rather than negative information related to one's self may be adaptive for personal well-being, as individuals are motivated to construct and retain positive views of themselves (Baumeister, 1998).

The impact of valence on self-referenced processing has also been examined in relation to internalizing psychopathologies. For example, Bradley and Matthews (1988) examined the processing of emotional information with reference to the self, compared to an unfamiliar other, in currently depressed, remitted depressed and control participants. Currently depressed individuals endorsed fewer positive and more negative adjectives when referencing themselves, but not when referencing another person, whereas remitted depressed individuals displayed similar endorsement patterns to control participants, endorsing many positive and few negative adjectives across all processing conditions. Currently depressed individuals also demonstrated a negative bias in the later recall of self-referential information, remembering more negative than positive words in the free recall memory task. The recovered depressed individuals showed the same positive self-referential memory bias seen in never depressed control participants, remembering more positive than negative adjectives. However, this finding did not directly examine whether differential rates of endorsement were related to the differential rates of recall. However, these findings highlight the potential role of affective valence in altering the encoding and retrieval processes involved in self-representation among depressed individuals.

Autism and Internalizing Disorders

No study to date has examined the effect of valence on self-referenced memory in children either with or without autism. However, examining rates of endorsement and recognition memory by valence may be particularly important in individuals with autism, who experience elevated clinical and subclinical levels of internalizing problems (Kim et al. 2000; Sukhodolsky et al. 2008). Higher functioning children and adolescents with autism (HFA) are at a higher risk for anxiety and depressive disorders than the general

population (Kim et al. 2000; Sukhodolsky et al. 2008; Simonoff et al. 2008). A recent study found that over 40% of higher functioning children with autism met criteria for at least one anxiety disorder (Sukhodolsky et al. 2008). Thus, individuals with autism may exhibit some of the cognitive biases that are commonly associated with internalizing disorders, such as endorsing greater levels of negative affect, and ruminating on negative self-referential information (Muris & Field, 2008; Hughes & Kendall, 2009).

The endorsement phase of self-referenced memory tasks, where participants must judge whether positive and negative traits are true of them, is very similar to measures of self-esteem, which also assess participants' impressions of themselves. Children and adolescents with autism have lower self-esteem across multiple domains including their perceptions of social competence, physical competence, and global self-worth (Capps, Sigman, & Yirmiya, 1995). The combination of reduced self-esteem and heightened risk for internalizing disorders could influence the way individuals with autism process, encode and retrieve both positive and negative self-referential information from the environment.

Present Study

Individuals with autism have consistently demonstrated atypical memory for self-referenced information, which has been linked to deficits in their social abilities. Previous research has described differences in self-referenced memory task performance, but few studies have examined the mechanisms underlying atypical patterns of performance. The goal of the present study was to examine how affective content may influence the endorsement and recognition of self-referenced information in a group of individuals

with high-functioning autism (HFA) and a comparison group of children without autism (COM).

Specific Aims

There are four specific aims to the current study:

1. To examine the influence of affective valence (positive vs. negative), diagnostic group (HFA vs. COM), and reference condition (self vs. other) on rates of endorsement of trait adjectives in children. It was hypothesized that all participants would endorse more positive than negative adjectives regardless of group status or encoding condition. However, it was hypothesized that this main effect of valence would be qualified by an interaction with diagnostic group and encoding condition, such that individuals with autism would endorse fewer positive and more negative traits than children without autism, but that this difference will be specific to the self condition.
2. To examine the effects of affective valence (positive vs. negative), diagnostic group (HFA vs. COM), and reference condition (self vs. other) on recognition of previously encoded trait adjectives. Memory sensitivity (d'), an index of accuracy that controls for false alarm rates (i.e., distracter words incorrectly identified as 'old'), in each affective condition was the dependent variable of interest, and was calculated for positive and negative adjectives in the self and other conditions. It was hypothesized that memory sensitivity would be predicted by an interaction of diagnostic group, valence, and reference condition. Specifically, it was hypothesized that, relative to the COM group, the HFA group will show reduced memory for positive and enhanced memory for negative trait adjectives in the self condition, but that the groups will

demonstrate comparable levels of memory sensitivity in the other-referenced condition.

3. To examine the inter-relations among rates of endorsement and memory sensitivity, for adjectives of positive and negative valence. Endorsement rates were correlated with memory sensitivity within the self and other conditions. Analyses were run across the full sample as well as within each diagnostic group. It was hypothesized that higher positive and lower negative endorsements would correlate with better recognition in the self condition. Because the self is a salient referent thought to increase memory specificity, it was hypothesized that across both groups, and within each valence (positive and negative), correlations would be unique to the self condition.
4. A final mediation model was tested to integrate Aims 1 through 3. A mediation model was hypothesized in which (a) Diagnostic Group will predict Endorsement Bias (measured as the difference between rates of positive and negative adjective endorsement in the self condition), (b) Endorsement Bias will predict Preferential Self-referenced Memory (d' self – d' other), and (c) the association between Diagnostic Group and Preferential Self-referenced Memory would be at least partially mediated by the effect of Endorsement Bias (see Figure 1). Preferential self-referenced memory was the dependent variable of interest, as this is the domain that has demonstrated the largest diagnostic group differences between HFA and COM groups.

CHAPTER 2: METHOD

Participants

Participants in the current study were 152 children and adolescents (aged 8 to 16 years, 79 HFA, 73 COM) who participated in a study of social-emotional adjustment in high functioning children and adolescents with autism. Participants in the HFA group were recruited through a letter mailed to parents of children with Asperger Syndrome and/or high-functioning autism from the Center for Autism and Related Disabilities at the University of Miami. All HFA participants had diagnoses from community mental health professionals using DSM-IV criteria. For the comparison sample participants were recruited through letters sent home from school with students in the Miami-Dade County school system. The letters included an explanation of the study and contact information for families who were interested in participating. Interested families were invited to take part in two laboratory visits that included diagnostic confirmation testing, a cognitive assessment, and several additional psychophysiological and behavioral assessments.

To be eligible for the study, participants in the HFA sample had to meet criteria on the Autism Diagnostic Observation Schedule (ADOS) and one out of two parent-reported diagnostic measures. Measures included the Social Communication Questionnaire (SCQ), and the High-Functioning Autism Spectrum Screening Questionnaire (ASSQ). HFA participants were excluded if they were affected by a neurological disorder, syndromes other than autism, or psychotic symptoms. 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 autism diagnostic measures. Selected subtests from the Wechsler Intelligence Scale for Children-Fourth

Edition (WISC-IV; Wechsler, 2003), including the Vocabulary and Similarities subtests, were administered to all participants to obtain an index of verbal comprehension (VCI). To be eligible for the study, participants were required to have a verbal IQ greater than 70. Participants in the current study included 68 males and 11 females in the HFA group and 53 males and 20 females in the COM group.

Procedure

Families in the study participated in two visits to the Coral Gables campus of the University of Miami. Participants and their caregivers were given information regarding the study and 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 instrument for the valid screening or verification of autism spectrum disorder symptoms in children. It was developed from the 40 critical items of the Autism Diagnostic Interview, compiled into a parent report questionnaire, and has a criterion score of 12 or higher (Berument et al., 1999). The SCQ has demonstrated valid discrimination of ASD from non-ASD individuals.

Autism Spectrum Screening Questionnaire (ASSQ; Ehlers, Gillberg, & Wing, 1999). The ASSQ is a 27-item checklist that was designed as a brief screening device to identify symptoms associated with either Asperger Syndrome (AS), or other high-functioning autism spectrum disorders, in children and adolescents of normal intelligence

or mild mental retardation. A cutoff score of 13 was used to capture symptoms of ASDs while discriminating from children with social impairments (Ehlers et al. 1999).

Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000). The ADOS is a semi-structured standardized observational assessment of pervasive developmental disabilities (PDD). It measures communication, social interaction, play and the imaginative use of materials. The ADOS consists of a series of standard activities designed to allow the examiner to observe aspects of social, communicative, cognitive, and self-regulatory behavior that have been identified as important in the diagnosis of autism. The structured activities have been divided into 4 modules appropriate to children and adults of varying developmental linguistic levels. Only one module is administered to an individual. Module 3 was administered to all participants. Cut off scores of 7 for autism spectrum disorder designations have been established based on these subsets of items. The ADOS was administered by trained, reliable coders.

Self-Referenced Memory (Henderson et al., 2009).

Endorsement Phase. The self-referenced memory task involves an encoding phase, directly followed by a recognition test phase. In the learning phase, 42 adjectives (3 lists each containing 14 adjectives – 7 positive and 7 negative) concerning personality traits were presented to participants. One of three types of processing condition questions was presented before each list: Letter counting ('Does this word contain seven or more letters?'), other-referent ('Does this word describe something about Harry Potter?'), and self-referent ('Does this word describe something about you?'). A forced choice of 'yes' or 'no' was required in the 2 seconds following presentation of each word. List order and

condition order were counterbalanced across all participants. For participants who were unfamiliar with Harry Potter, Spiderman was used as the referent in the ‘other’ condition.

For the current analysis, endorsement rates were calculated for each valence and condition in the encoding phase: self-positive, self-negative, other-positive, and other-negative. Rates of endorsement were computed as the number of items a participant responded yes to, divided by the total number of items they responded to, correcting for missed responses. Participants’ data for a given list was excluded if they did not respond to at least half of the items within that list. Self positivity bias was also computed as the difference between the endorsement rates for positive and negative adjectives in the self condition. Data was missing from 3 participants for this phase of the task. One participant did not respond in the 2 seconds following the presentation of adjectives for the majority of the adjectives. Data recording for two participants did not specify which condition was presented for each list of adjectives. Thus, their data was also excluded.

Recognition Phase. Immediately after the presentation of all adjectives, an unexpected recognition phase was administered to the participants. Participants were presented with a sheet containing all 42 previously-viewed adjectives randomly interspersed with 84 novel distracter words, for a total of 126 adjectives. Over the next 5 minutes, participants were instructed to circle all adjectives judged as ‘old.’ The ‘self’ and ‘other’ conditions are of interest for the present study.

Measures of memory sensitivity, d' , were calculated for each participant’s recognition performance. The d' measure was computed as the standardized probability of correctly remembering that number of words minus the standardized probability of

false alarms (i.e. distracter words incorrectly identified as 'old'). See Table 1 for a representation of the mean number of hits, misses, and false alarms by group. Several measures of memory sensitivity were computed for various aims. First, memory sensitivity was computed for positive and negative adjectives in both the self and other conditions. In addition, preferential self-referenced memory, or the degree of self-over-other memory bias, was computed as the difference between d' self and d' other. All participants ($N = 62$) from the original Henderson et al. (2009) paper are included in the current study, as well as additional participants ($N = 90$) who have been recruited for the project since the publication of the 2009 paper. Several participants were missing data for the recognition task. Recognition sheets were missing for 18 participants, thus their memory performance by valence could not be calculated. However, their memory performance by condition (not split by valence) had been documented so their data was used for all measures of d' self and d' other, as well as preferential self-referenced memory.

CHAPTER 3: RESULTS

Preliminary Analyses

Group differences on gender, age and verbal IQ were examined to identify whether any of these variables should be included as covariates for between-group analyses (see Table 2). There were no significant group differences between HFA and COM participants on age, $t(148.99) = 1.75, p > .05$, or gender, $\chi^2(1) = 3.795, p > .05$. However, the HFA and COM groups differed significantly on verbal IQ, $t(150) = 3.69, p < .001$, such that the COM group had higher verbal IQ than the HFA group. Thus, verbal IQ was included as a covariate in all between group analyses.

Zero-order correlations (Table 3) were conducted separately by diagnostic group to determine whether demographic or diagnostic variables correlated with primary self-referenced memory variables. Because it correlated with most measures of memory sensitivity in the HFA group, age was included as a covariate in Aim 2 between-group comparisons.

Aim 1 – Group Differences in Endorsement Rates

To examine group differences in rates of endorsement of adjectives of differing valence and under different referent conditions, a 2 (Group: HFA, COM) X 2 (Condition: Self, Other) X 2 (Valence: Positive, Negative) repeated measures ANCOVA was conducted, controlling for verbal IQ. Results revealed a main-effect of Valence, Wilks's $\Lambda = .93, F(1, 145) = 10.95, p = .001, \eta^2_{\text{partial}} = .07$. However, this was qualified by a Group X Valence interaction, Wilks's $\Lambda = .97, F(1, 145) = 5.32, p = .02, \eta^2_{\text{partial}} = .04$, as well as a Group X Condition interaction, Wilks's $\Lambda = .95, F(1, 145) = 8.19, p = .001, \eta^2_{\text{partial}} = .05$. The hypothesized three-way interaction was significant at a trend level, Wilks's $\Lambda = .98, F(1, 145) = 2.92, p = .09, \eta^2_{\text{partial}} = .02$.

To examine the main effect of Valence, summary scores were computed for Positive and Negative endorsement adjectives by collapsing across the self and other conditions. As expected, all participants endorsed more positive ($M_{adj} = 5.50$, $SE = 0.08$) than negative adjectives ($M_{adj} = 1.69$, $SE = 0.10$), when controlling for verbal abilities, Wilks's $\Lambda = .95$, $F(1, 146) = 7.38$, $p = .01$, $\eta^2_{partial} = .05$ (See Figure 1). When examined by diagnostic group, this effect held true in the COM group, Wilks's $\Lambda = .12$, $F(1, 71) = 527.94$, $p < .001$, $\eta^2_{partial} = .88$, as well as in the HFA group, Wilks's $\Lambda = .20$, $F(1, 75) = 299.80$, $p < .001$, $\eta^2_{partial} = .80$.

To probe the significant Group x Valence interaction, a univariate ANCOVA was conducted on the difference score between overall Positive and Negative endorsements, controlling for verbal IQ. The dependent variable was the difference between overall endorsement of Positive and Negative adjectives. A positive score reflects greater endorsement of Positive adjectives relative to the number of Negative adjectives endorsed. A preliminary analysis evaluating the homogeneity-of-slopes assumption indicated that the relationship between VCI and endorsement rate differences by valence did not differ significantly by group, $F(1, 146) = 1.27$, $p > .05$. The overall difference between endorsement of Positive and Negative adjectives was significantly greater for COM participants, ($M_{adj} = 4.15$, $SE = .20$), than for HFA participants ($M_{adj} = 3.49$, $SE = .19$), $F(1, 145) = 5.32$, $p = .02$. Overall, COM participants endorsed more positive relative to negative adjectives than did HFA participants, regardless of condition (See Figure 2). Additional follow-ups were conducted to determine whether this group difference was driven by endorsement differences in the Positive or Negative condition. Group differences emerged in endorsement of positive adjectives, (HFA $M_{adj} = 5.32$, SE

= .11; COM $M_{adj} = 5.71$, SE = .11), $F(1, 146) = 5.97$, $p = .016$, but not negative adjectives, (HFA $M_{adj} = 1.85$, SE = .15; COM $M_{adj} = 1.68$, SE = .15), $F(1, 145) = 1.34$, $p > .05$. Overall, participants with HFA endorsed fewer positive adjectives than did COM participants, but they did not differ on their endorsement of negative adjectives. The strength of the relationship between Group and positive-negative endorsement differences was small, as assessed by a partial η^2 , with group membership accounting for 3.5% of the variance in the dependent variable, holding verbal IQ constant.

A similar univariate ANCOVA was conducted to follow up the significant Group x Condition interaction on endorsement rates. The dependent variable captures the difference in endorsement of self-relevant adjectives and other-relevant adjectives, regardless of valence. A positive score reflects greater endorsement of self-relevant adjectives relative to other-relevant adjectives. A preliminary analysis evaluating the homogeneity-of-slopes assumption indicated that the relationship between VCI and the Self-Other difference score did not differ significantly by group, $F(1, 146) = 1.78$, $p > .05$. The Self-Other difference score was significantly greater for HFA participants ($M_{adj} = .50$, SE = .14), than for COM participants, ($M_{adj} = -.02$, SE = .14), $F(1, 144) = 8.73$, $p = .01$, indicating that HFA participants endorsed more self-relevant relative to other-relevant adjectives than did their typically developing peers (See Figure 3). Additional follow-ups were conducted to determine whether this group difference was driven by endorsement differences in the Self or Other condition. Groups did not differ in their overall endorsement of self-relevant adjectives, (HFA $M_{adj} = 3.81$, SE = .10; COM $M_{adj} = 3.62$, SE = .11), $F(1, 146) = 1.26$, $p > .05$. However, HFA participants ($M_{adj} = 3.29$, SE = .10) endorsed fewer adjectives in the Other condition, than did COM participants ($M_{adj} =$

3.67, SE = .10), $F(1, 146) = 6.34, p = .01$. The strength of the relationship between Group and self-other endorsement differences was small, as assessed by a partial η^2 , with group membership accounting for 4.2% of the variance in the dependent variable, holding verbal IQ constant.

Univariate ANCOVA's were conducted on the Positivity Bias score in each condition (Self; Other) to probe the trend for a Group X Condition X Valence interaction, while controlling for verbal abilities. The dependent variable of Positivity Bias measures the difference positive and negative adjective endorsement rates, with high values reflecting a highly positive (and low negative) view of the referent (Self; Other). The Self Positivity Bias was significantly lower for HFA participants ($M_{adj} = 3.20, SE = .25$) than for COM participants ($M_{adj} = 4.24, SE = .26$), $F(1, 146) = 7.83, p = .006$, partial $\eta^2 = .05$. This effect was specific to the Self Condition, as groups did not differ in their Other Positivity Bias (HFA $M_{adj} = 3.83, SE = .26$; COM $M_{adj} = 4.03, SE = .26$), $F(1, 146) = .269, p > .05$, partial $\eta^2 = .002$.

Aim 2 – Group Differences in Recognition Rates

To test whether recognition memory performance differed by group, reference condition, and valence of the adjectives, a 2 (Group: HFA, COM) X 2 (Condition: Self, Other) X 2 (Valence: Positive, Negative) repeated measures ANCOVA was conducted on participants' recognition (memory sensitivity, d') data. Because age correlated with HFA participants' (but not COM participants') memory sensitivity, it was included as a covariate in all Aim 2 analyses. Interestingly, the Levene's test for homogeneity of variances indicated that the groups differed in their variance on their Self-Negative memory performance, $F(1, 131) = 5.54, p = .02$, but not in any other condition or valence

combination. Inspection of the data revealed that the HFA group exhibited greater variability in performance ($SD = 1.02$) in the Self-Negative condition than did the COM group ($SD = .72$). A Group x Condition interaction emerged, indicating that the difference between memory performance in the Self and Other conditions differed by group, Wilks's $\Lambda = .90$, $F(1, 129) = 14.35$, $p < .0001$, $\eta^2_{\text{partial}} = .10$. However, the hypothesized 3 way interaction was not significant, Wilks's $\Lambda = .99$, $F(1, 129) = 0.10$, $p > .05$, $\eta^2_{\text{partial}} = .001$.

To follow up the Group X Condition interaction, a univariate ANCOVA was conducted on the difference score between participants' memory performance in the Self and Other condition. The overall difference between recognition of adjectives encoded in the Self and Other conditions was significantly lower for HFA participants ($M_{\text{adj}} = .14$, $SE = .08$), than for COM participants, ($M_{\text{adj}} = .61$, $SE = .08$), when controlling for age and verbal IQ, $F(1, 145) = 18.11$, $p < .001$. COM participants demonstrated greater discrimination in memory performance between the Self and Other condition than did HFA participants (See Figure 4). The 95% confidence intervals for the adjusted mean difference scores, $[-.01, .29]$ did not include zero indicating that the HFA participants not only discriminated less than the COM participants, their memory performance did not distinguish significantly between the Self and Other conditions. Additional follow-ups were conducted to determine whether this difference in memory performance was driven by group differences in the Self or Other condition. The HFA and COM groups differed in their recognition of self-referential adjectives, (HFA $M_{\text{adj}} = 2.01$, $SE = .10$; COM $M_{\text{adj}} = 2.41$, $SE = .11$), $F(1, 147) = 7.61$, $p = .007$. However, the groups did not significantly differ in their memory for other-referential adjectives, (HFA $M_{\text{adj}} = 1.91$, $SE = .10$; COM

$M_{adj} = 1.75$, $SE = .10$), $F(1, 145) = 1.23$, $p > .05$. The strength of the relationship between Group and self-other recognition differences was small to medium, as assessed by a partial η^2 , with group membership accounting for 11.1% of the variance in the dependent variable, holding age and verbal IQ constant.

Aim 3 – Interrelations Among Endorsement and Recognition

The third aim of this study was to examine the interrelations among endorsement and memory performance for those same adjectives both within and between diagnostic groups. Bivariate correlations, presented in Table 3, were conducted across the full sample, as well as within each diagnostic group. Interestingly, the Self Positivity Bias, or the difference between self-positive and self-negative adjectives was predictive of Preferential Self-referenced Memory ($d'_{self} - d'_{other}$) in the COM group, $r(71) = .23$, $p = .05$, but not the HFA group, $r(75) = -.06$, $p > .05$. See Figure 5 for associated scatterplots. In addition, age was correlated with most measures of memory sensitivity in the HFA but not the COM group (See Table 3).

Aim 4 – Mediation Model

The final aim of this study was to examine whether differences in endorsement mediate the group differences in preferential self-referenced memory. The mediation model examined the following questions: (a) Does Diagnostic Group predict Self Positivity Bias (path α)? (b) Does Positivity Bias predict Preferential Self-referenced Memory (path β), and (c) Is the association between Diagnostic Group and Preferential Self-referenced Memory mediated by the effect of Self Positivity Bias (path c). Preferential self-referenced memory is the dependent variable of interest, as this is the

domain that has consistently demonstrated the largest diagnostic group differences between HFA and COM groups in the literature.

To test the significance of the mediated effect, asymmetric confidence intervals were calculated using RMediation (Tofighi & MacKinnon, 2011). The mediated effect was deemed statistically significant if the confidence intervals did not include zero. Age and verbal IQ were included as covariates in all analyses to obtain conservative estimates. There was a significant effect of diagnostic group (dummy coded as COM = 0, HFA = 1) on Self Positivity Bias ($\alpha = 1.101$, $SE(\alpha) = 0.373$). However, there was no significant relationship between Self Positivity Bias and Preferential Self-referenced Memory, when controlling for group membership ($\beta = 0.017$, $SE(\beta) = 0.025$). The RMediation test of mediation indicated that Positivity bias significantly mediate the relationship between Diagnostic Group and Preferential did not Self-referenced Memory (Mean value = -0.019), as the confidence intervals, [-0.084, .036], included zero (See Figure 6). Including the Self Positivity Bias as a mediator explained 4% of the variance in Preferential Self-referenced Memory that was accounted for by Dignostic Group.

CHAPTER 4: DISCUSSION

This is the first study to examine how affective content may influence the endorsement and later recognition of self-referenced information in a sample of high-functioning individuals with autism (HFA) and a comparison group of children without autism (COM). Diagnostic group differences were detected on both endorsement and recognition variables, as well as in the relationship between endorsement and recognition portions of the self-referenced memory task. Importantly, the Self Positivity Bias, or the difference between endorsement of positive and negative self-referenced adjectives, partially mediated the diagnostic group differences in preferential self-referenced memory. Thus, examining group differences in adjective endorsement may help explain some of the variability in memory performance, as documented here and in previous studies in children and adults with HFA (Lombardo et al., 2007; Henderson et al., 2009, Pfeiffer et al., 2013).

Endorsement Differences

As expected, all participants endorsed more positive than negative adjectives, regardless of condition. However, this main effect was qualified by several interactions, reflecting group differences in endorsement. Unexpectedly, results revealed that the HFA and COM groups differed in their overall patterns of adjective endorsement in the Self condition relative to Other condition. The participants with HFA were more likely to *endorse* Self-referenced adjectives (regardless of valence) relative to Other-referenced adjectives, whereas COM participants did not differentially endorse Self- versus Other-referenced adjectives. These group differences were driven by differences in overall endorsement of Other-referenced adjectives, with no group differences in the Self

condition. This interaction of Group and Condition was unexpected. However, the observed differences could be due to deficits in mentalizing ability, or the ability to understand and attribute mental states to others (Baron-Cohen, 1995). Previous research has consistently identified that individuals with HFA experience difficulty understanding mental states of and attributing characteristics to other individuals (Hobson et al., 2006; Lombardo & Baron-Cohen, 2011). It is also possible that the HFA participants were simply less familiar with Harry Potter and thus endorsed fewer traits (either positive or negative) to him. To avoid this possibility, participants were able to use another referent they were familiar with, such as Spiderman. Future studies should examine whether individuals with HFA display a similar pattern of endorsement for familiar others (such as a family member or friend), compared to the unfamiliar other (the fictional character Harry Potter) used in the current study.

In addition, the diagnostic group by valence interaction revealed that COM participants endorsed more positive relative to negative adjectives, regardless of condition. This effect was driven by group differences in endorsement of positive adjectives, such that COM participants endorsed more positive adjectives than did HFA participants. This positivity bias is typically seen in reference to the self, and is considered normative and adaptive in young children (Welsh-Ross Fasig, & Farrar 1999; Henderson & Mundy 2012). This difference in positivity bias suggests that HFA participants demonstrated a less positive response style while referencing themselves and a well-known other. Previous research has revealed that children and adolescents with autism endorse lower levels of self-esteem across multiple domains including their perceptions of social competence, physical competence, and global self-worth (Capps,

Sigman, & Yirmiya, 1995). The current study replicates and extends this research, suggesting that individuals with autism may display reduced overall positivity, or a less positive outlook, regardless of the referent.

Alternatively, the group by valence interaction may indicate that participants with HFA interpret these adjectives differently. For example, “trusting,” may carry more negative connotations for a child with HFA, or “smarty-pants” may be a more positive attribute. This would also lead to the observed group differences in the degree of positive relative to negative adjective endorsement. This explanation is consistent with previous research which found that children with HFA differed from typically developing children in their subjective ratings of ‘pleasantness’ of both positive and negative adjectives (Ben Shalom et al., 2006). However, in the present study the difference between endorsement of positive and negative adjectives did not correlate with verbal IQ within the HFA group, $r(74) = -.13, p > .05$. Thus, the fact that children with HFA differed in the relative endorsement of positive and negative adjectives is not likely due to verbal abilities. However, future studies would benefit from examining the understanding and interpretation of trait adjectives in individuals with HFA.

The hypothesized 3-way interaction (Group x Valence x Condition) was significant at a trend level, with differences in endorsement of adjectives of positive valence specific to the self condition. Group differences in positivity bias, or the difference between endorsement of positive and negative adjectives, were specific to the self condition. Consistent with previous research, children and adolescents with HFA endorsed a less positive view of themselves than did typically developing children. Reduced self-esteem in the HFA group, reflected by the lower Self Positivity Bias, may

be lead to socio-emotional difficulties, and could help explain the heightened rate of internalizing problems in children and adolescents with HFA. Results should be interpreted with caution, as this three-way interaction was significant only at the trend level. This effect may be slightly masked by the overarching differences in endorsement of positive and negative adjectives, as well as in the self and other conditions. Future research should work to tease apart these effects to determine differences that are specific to the self condition.

Recognition Differences

Examining group differences in memory performance by valence and condition revealed a Group by Condition effect, such that COM participants displayed better memory for adjectives encoded in reference to the self versus other condition, where participants with HFA did not. These results are consistent with previous research (Lombardo et al., 2007; Henderson et al., 2009), and demonstrate the self-reference effect, where typically developing individuals preferentially remember information encoded in reference to the self. This biased preferential self-referenced memory is believed to be “healthy” and adaptive, providing a strong structure on which to consolidate and elaborate memories (Klein & Kihlstrom, 1986; Klein & Loftus, 1988). Children and adolescents with HFA, however, did not differentiate between self and other in memory performance, as their difference scores ($d'_{\text{self}} - d'_{\text{other}}$) were not significantly different from 0.

Interestingly, individuals with HFA demonstrated significantly greater within-group variability in memory performance in the Negative-Self condition than their COM peers. Performance in this condition was negatively related to current symptoms of high-

functioning autism (assessed by parent report on the ASSQ). Children with less severe symptomatology exhibited better memory performance for negative self-referenced traits, but not positive self-referenced traits, or other-referenced traits. This specific relation between lower symptoms and better memory for negative self-referenced adjectives may not be adaptive, as it may indicate that the higher functioning individuals ruminate more on their negative traits. This measure is similar to assessments of ruminative tendencies and memory biases for negative information which are often seen in individuals with anxiety disorders (Muris & Field, 2008). These biases may also be present in children with HFA, particularly those who have less severe symptoms and may be more in tune with the negative social cues they receive from the environment (Capps Sigman, & Yirmiya 1995; Sukhodolsky et al., 2007). This negative information may be more salient them, leading to better memory for negative information.

Alternatively, the inverse relationship between symptoms of HFA and memory for negative self-referenced information may simply be reflecting the association between symptoms and self-referenced memory performance. The association between symptoms of HFA and *positive* self-referential information is in the same direction, though not significant. Thus, the greater variability in the negative-self condition may be contributing to the significant association. Consistent with this assumption, symptoms of HFA were strongly associated with *preferential* self-referenced memory. The association with negative self-referenced memory performance may simply be an artifact of that association. Future studies should tease apart the influences of autism symptom severity, anxiety symptoms and biased memory in individuals with autism.

Relating Endorsement and Recognition

Results revealed a developmental trend in the HFA group, with memory increasing with age for adjectives of both positive and negative valence and in both the Self and Other conditions. The same age-related associations were not present in the COM group. 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. The developmental trend in the HFA group in the present study may simply reflect a developmental lag in this population. Future studies should extend this research to later ages in individuals with HFA to determine at what point in childhood this effect levels off, or whether it continues into later adolescence and young adulthood.

When examining the relations between endorsement of adjectives and later recognition, a different pattern emerged for each group. Specifically, in the COM group, but not the HFA group, the Self Positivity Bias predicted Preferential Self-referenced Memory. Thus, having a positive view of yourself supports efficient and adaptive memory in typically developing children. The self-system provides an important structure around which individuals scaffold incoming information from the environment, creating a vast web of semantic connections (Klein & Kihlstrom, 1986; Klein & Loftus, 1988). In the current study, typically developing individuals exhibited a coherent self-system such that positive attributes of one's self led to more efficient recognition. Surprisingly, the same relationship did not exist in the HFA sample. Thus, the organizational self-system may be compartmentalized in individuals with HFA, with separate processing of evaluations of the self and memory for those evaluations.

Mediation Analyses

Mediation analyses were conducted to tie together the observed group differences across various portions of the self-referenced memory task. First, mediation results revealed that the groups differed in the magnitude of their Self Positivity Bias, with the HFA group endorsing a significantly less positive view of themselves. However, group differences in the Self Positivity Bias did not significantly mediate the relationship between Diagnostic Group and Preferential Self-referenced Memory. Because the Self Positivity Bias did not correlate with Preferential Self-referenced Memory across the full sample, the overall model was not significant. Consistent with our hypothesis, the Self Positivity Bias was linked to Preferential Self-referenced Memory in COM sample. However, for HFA participants, Self Positivity Bias was not linked to preferential memory for self-relevant information. Future studies should examine other factors that may mediate these group differences in preferential self-referenced memory. Other factors associated with the encoding phase of the task, such as reaction time, neural activation during the task, or attention biases, may help explain the observed group differences. Such findings will help identify areas in which to intervene to increase self-referential memory in children and adolescents with HFA.

Limitations and Future Directions

The present study has several limitations. First, all of the primary variables were assessed during a single task. The mediation model examined in this study assumes temporal precedence of the different phases of the self-referenced memory paradigm. Though the different phases of the task occur in chronological order, they are simply indexing constructs of self-concept and efficiency of recall for self-referential

information. Future research should tease apart the direction of effects by assessing both aspects of this task over the course of development. It may be that inefficient memory for self-referential information contributes to the observed differences in self-concept, rather than the direction implied in the present study. In addition, future studies should extend this research by examining the variables included in the present study in relation to other constructs, such as theory of mind abilities, cognitive biases, and internalizing problems. Understanding the complex relationship between ASD and anxiety symptoms, self-referenced memory and understanding others' mental states could better explain the cause of the unique difficulties faced by those with HFA.

The current study also only examines affective biases as the mediator of group differences in self-referenced memory. Recent research suggests that neural activations in midline cortical regions of the brain (including the medial prefrontal cortex, posterior cingulate cortex, and the precuneus) underlie self-referential processing (Raichle et al., 2001, Kelley et al., 2002, Heatherton et al. 2006). These areas appear to be under-activated at rest and during self-referential processing for individuals with autism (Kennedy & Courchesne, 2008, Lombardo et al., 2010, Pfeifer et al., 2013). Future research should examine both the affective biases and differences in neural activations as joint contributors to the observed differences in preferential self-referenced memory.

This was the first study to link the endorsement and recognition phase of the self-referenced memory task in a sample of typically developing children and those with HFA. Individuals with HFA endorsed a less positive view of themselves, as well as reduced preferential self-referenced memory. Participants with HFA also demonstrated divided processing between affect and cognition within the self-system relative to their

typically developing peers, who displayed a coherent self-system. This indicates the importance of interventions aimed at ameliorating coherent self-processing in individuals with HFA. Current interventions for children on the autism spectrum are aimed at ameliorating their understanding of other individuals (for a review, see White, Keonig & Scahill, 2007). However, this research suggests that treatments should target the child's affective understanding of themselves, as well as the organization of self-referential memory processes.

TABLES

Table 1. Raw recognition statistics

	Diagnostic Group			
	HFA (n = 70)		COM (n = 64)	
	<i>Mean (SD)</i>	<i>Range</i>	<i>Mean (SD)</i>	<i>Range</i>
Self – Positive	6.02 (1.16)	2 – 7	6.32 (0.96)	3 – 7
Self – Negative	5.67 (1.82)	0 – 7	5.92 (1.15)	2 – 7
Other - Positive	5.89 (1.31)	1 – 7	5.22 (1.37)	1 – 7
Other – Negative	5.33 (1.56)	1 – 7	4.71 (1.58)	0 – 7
Positive False Alarms	10.57 (9.47)	0 – 40	7.09 (6.19)	0 – 37
Negative False Alarms	6.84 (6.20)	0 – 31	5.42 (4.69)	0 – 20

52

Note. All values represent raw values correctly or incorrectly identified on the recognition portion of the self-referenced memory task.

Table 2. Descriptive statistics

	Diagnostic Group				Group differences <i>t</i> value
	HFA (n = 79)		COM (n = 73)		
	<i>Mean (SD)</i>	<i>Range</i>	<i>Mean (SD)</i>	<i>Range</i>	
Gender	68 M, 11 F	-	53 M, 20 F		-
Age in years	12.55 (2.57)	8.17 – 16.75	13.23 (2.18)	8.83 – 16.33	-1.76†
Verbal IQ	101.51 (14.91)	75 – 140	109.73 (12.28)	81 – 146	-3.82***
ADOS	12.39 (3.57)	7 – 22	1.58 (1.80)	0 – 6	23.85***
SCQ	19.01 (6.30)	3 – 33	4.76 (3.47)	0 – 20	17.32***
ASSQ	26.37 (8.64)	10 – 46	4.53 (4.55)	0 – 23	19.68***

Note. ADOS = Autism Diagnostic Observation Schedule, SCQ = Social Communication Questionnaire, ASSQ = Autism Spectrum Screening Questionnaire.

† $p < .10$. * $p < .05$. *** $p < .001$.

Table 3. Correlations between primary variables and covariates of age, symptom severity, and verbal IQ

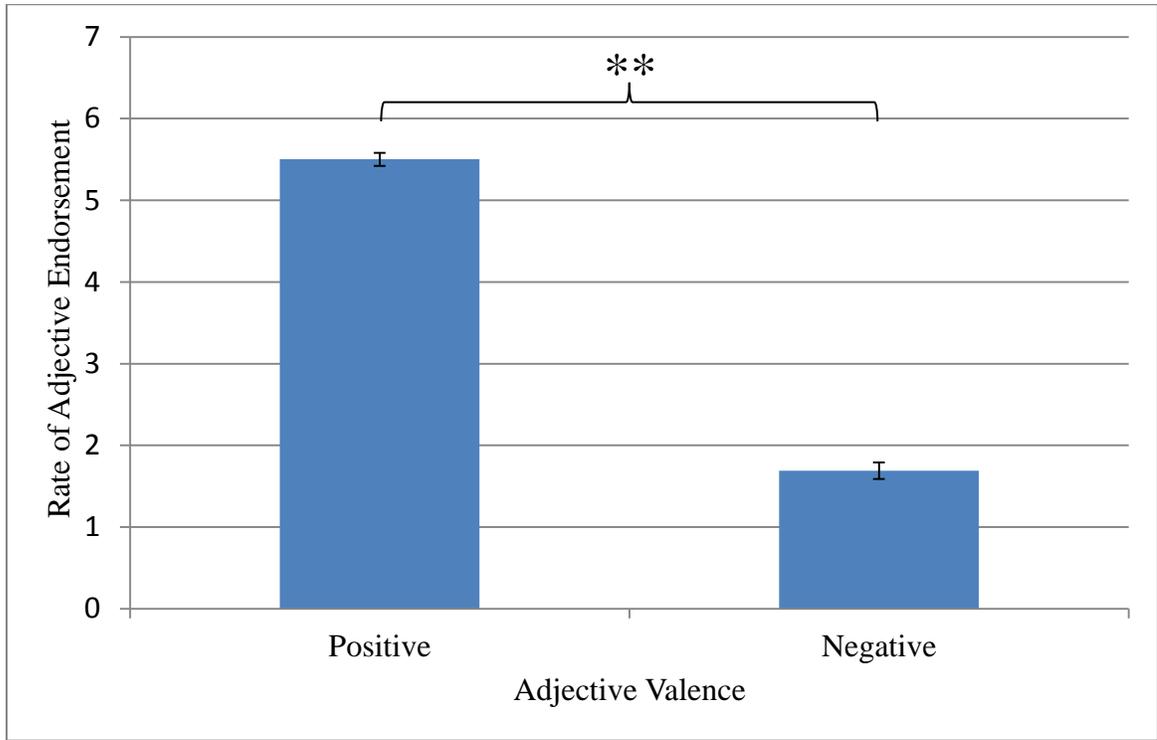
	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age	-	.15	.07	-.14	.05	.02	.00	-.11	.44**	.36**	.35**	.34**	.05
2. Symptom Severity (ASSQ)	.11	-	.19	-.19	.14	.05	.05	-.19 [†]	-.09	-.19	.00	.10	-.32**
3. Verbal IQ	-.10	.13	-	-.14	-.10	-.33**	-.12	-.01	.18	.05	.11	.10	.06
4. Endorsement: self-positive	-.10	.03	-.07	-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

Note. Correlations for HFA participants are reported in the shaded region above the diagonal; correlations for COM participants are reported below the diagonal.

[†] $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

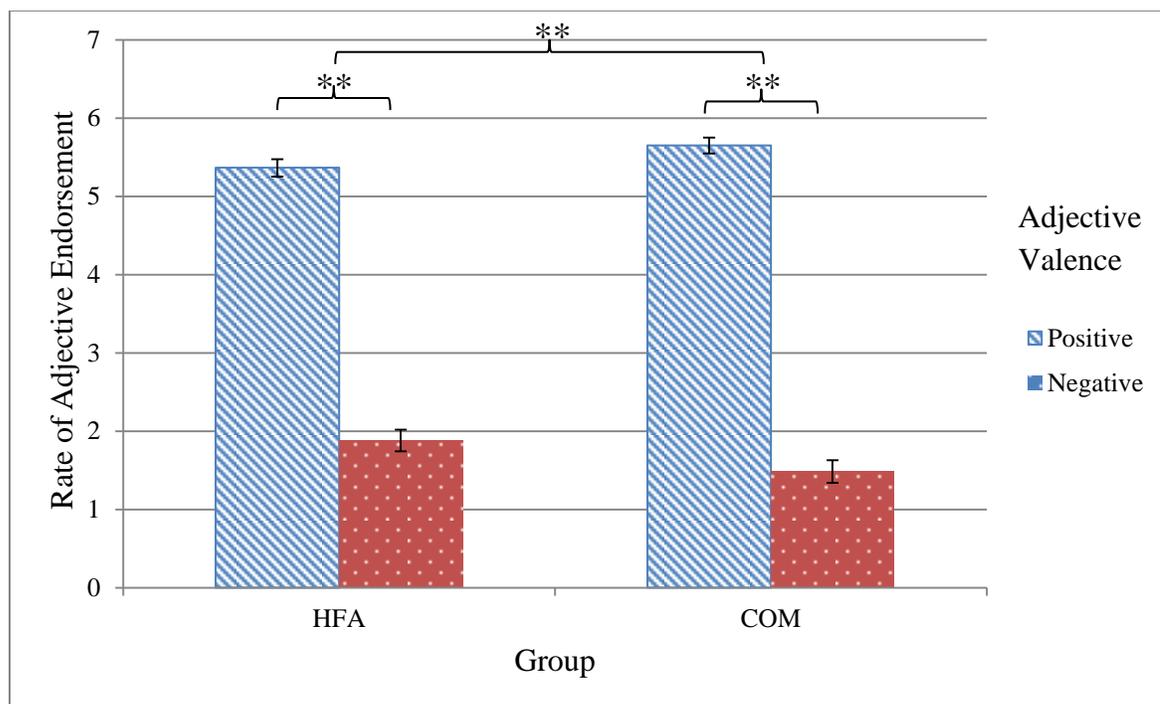
FIGURES

Figure 1. Aim 1 Main Effect of Valence



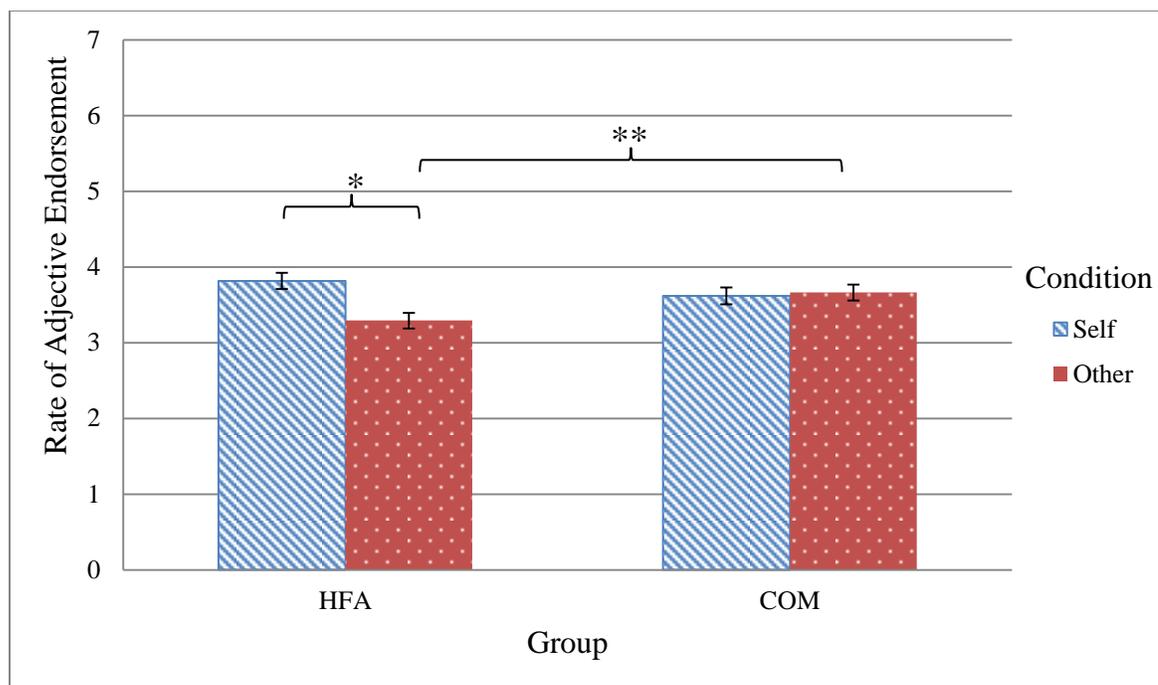
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Figure 2. Aim 1 Group \times Valence Interaction



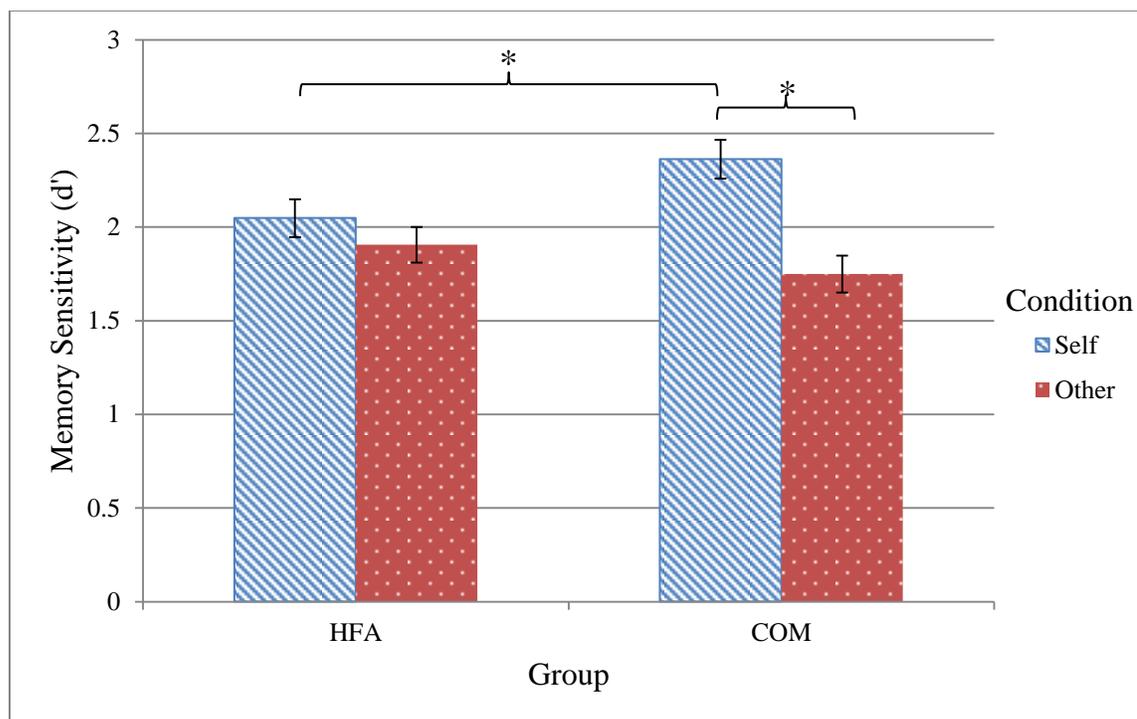
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Figure 3. Aim 1 Group x Condition Interaction



† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Figure 4. Aim 2 Group x Condition Interaction on Recognition data.



† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Figure 5. Relation between Self Positivity Bias and Preferential Self-referenced Memory for each diagnostic group.

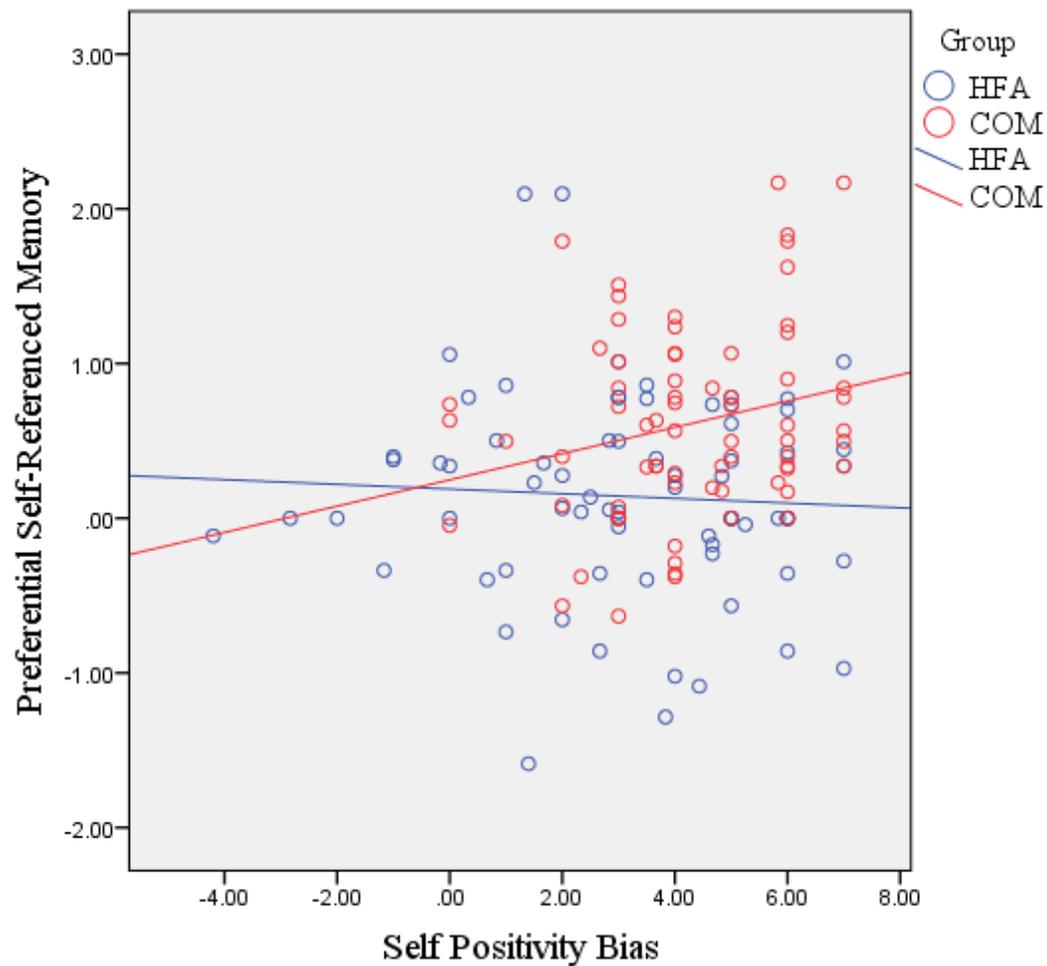
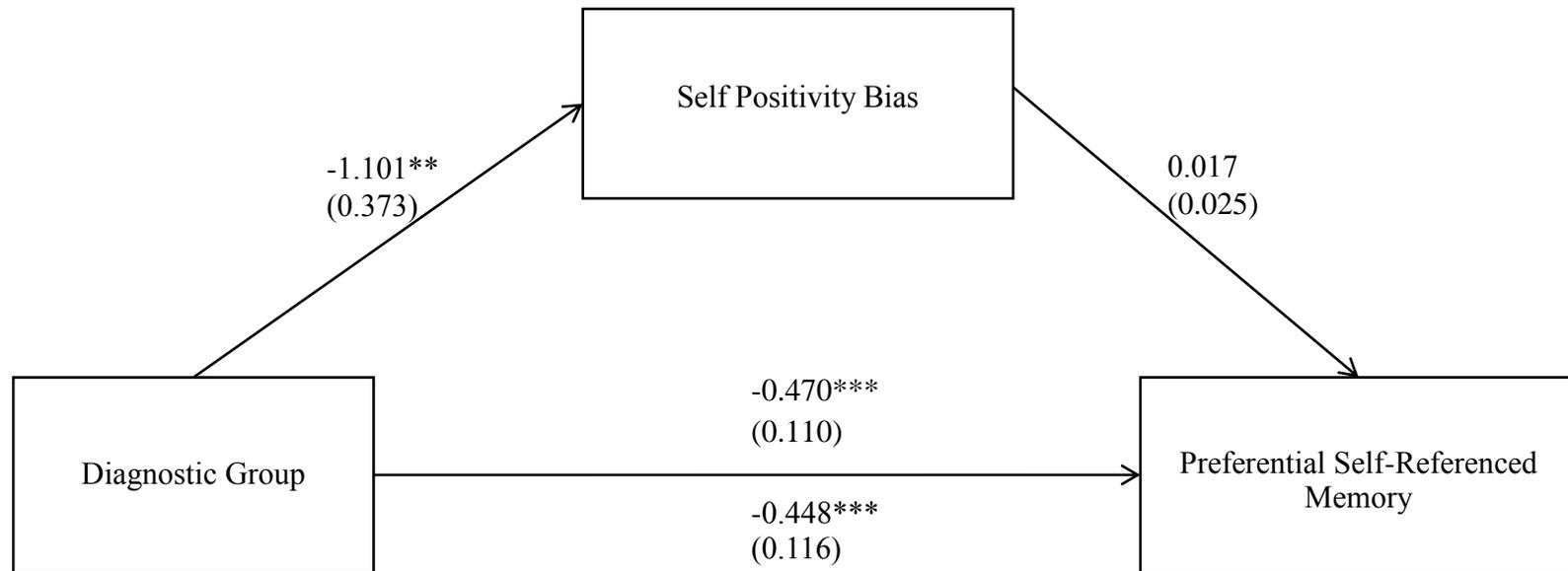


Figure 6. Mediation model: mediating effect of endorsement.



Note: Self Positivity Bias (the difference between positively and negatively valenced self-referential traits endorsed) as a mediator of the relationship between Diagnostic Group (Dummy Coded as COM = 0, HFA =1) and Preferential Self-Referenced Memory (d' self-d' other). † $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

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