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**Illusory memories of emotionally charged words in Autism Spectrum
Disorder: Further evidence for atypical emotion processing outside the
social domain**

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Running Head: Emotional modulation of illusory memories in ASD

Abstract

Recent evidence suggests that individuals with ASD may not accumulate distinct representations of emotional information throughout development. On the basis of this observation we predicted that such individuals would not be any less likely to falsely remember emotionally significant as compared to neutral words when such *illusory memories* are induced by asking participants to study lists of words that are orthographically associated to these words. Our findings showed that typical participants are far less likely to experience illusory memories of emotionally charged as compared to neutral words. Individuals with ASD, on the other hand, did not exhibit this emotional modulation of false memories. We discuss this finding in relation to the role of emotional processing atypicalities in ASD.

Key Words: **Autism Spectrum Disorder, Memory, Orthographic associations, Emotional processing, Illusory memories.**

Illusory memories of emotionally charged words in Autism Spectrum Disorder: Further evidence for atypical emotion processing outside the social domain

Research over the past four decades has firmly established that individuals from across the autism spectrum are severely compromised in various aspects of affectively patterned communication (e.g., Corona, Dissanayake, Arbelle, Wellington & Sigman, 1998; Hobson, Ouston & Lee, 1988, Joseph & Tager-Flusberg, 1997; Kasari, Sigman, Mundy & Yirmiya, 1990; Loveland, 2003; Moore, Hobson & Lee, 1997; Sigman, Kasari, Kwon & Yirmiya, 1993). Although these atypicalities are widely accepted to constitute a diagnostically sensitive manifestation of Autism Spectrum Disorder (ASD) (Lord, Rutter, Goode, Heemsbergen, Jordan, Mawhood & Schopler, 1989; Lord, Rutter & Le Couteur, 1994; Magyar & Pandolfi, 2007; Robins, Fein, Barton & Green, 2001), their causes remain the matter of debate. Some authors maintain that the emotional disturbances associated with ASD are the result of abnormalities in the development of socio-cognitive capacities such as face processing or 'Theory of Mind' understanding (e.g., Baron-Cohen, 1995; Baron-Cohen, Ring, Bullmore Wheelwright, Ashwin & Williams, 2000; Frith, 2003; Leslie & Frith, 1990; Schultz, 2005). Others, by contrast, suggest that abnormal affective development lies at the root of the interpersonal abnormalities characterising the condition (e.g., Hobson, 2002; Loveland, 2005, Mundy & Sigman, 1989). The major difficulty in resolving this debate rests with the fact that most of the relevant evidence for it to

date, stems from studies assessing how individuals with ASD understand and react to the emotional signals of others. As such, the evidence can be accommodated by both theoretical accounts. In order to advance our understanding of the role of affective disturbances in ASD, it is therefore important to broaden the focus of research and assess how the emotional significance of stimuli impacts on processes that are not primarily of a social nature. Studies of memory are ideally suited for this purpose because the influence of emotional factors in this domain are well established and understood (see Reisberg & Hertel, 2004 and Uttl, Ohta & Siegenthaler, 2006 for a collection of extensive reviews).

One of the most reliable findings in the typical memory literature is that emotionally significant information is better remembered than neutral information (Bradley, Greenwald, Petry & Lang, 1992; Cahill & McGaugh, 1998; Heuer & Reisberg, 1990; Kensinger & Corkin; 2003). To date only four studies have investigated this phenomenon in individuals with ASD. The first, was conducted by Beversdorf and colleagues (Beversdorf, Anderson, Manning, Anderson, Dordgren, Felopulos, Nadeau, Heilman & Bauman, 1998) who presented a group of 10 ASD and 13 typically developed adults with an audiotape of 10 emotionally salient statements (e.g., Carl shot his gun at someone) and 10 emotionally neutral statements (e.g., Mike is talking on the phone). After each block of statements participants were asked to write down as many of them as possible. Results indicated that only typically developed adults, and not those with a

diagnosis of ASD, recalled significantly more of the emotionally salient statements. In direct contrast to this finding, South and colleagues (South, Ozonoff, Suchy, Kesner, McMahon & Lainhart, 2008) reported no differences in memory for emotional material between a group of 36 adults with a diagnosis of ASD and 38 typically developed adults. In their experiment, participants were asked to study a random sequence of emotionally salient and neutral words for a subsequent recognition memory test. This time both groups of participants were found to exhibit superior memory for the emotionally salient material. Whilst the findings from these two studies are clearly at odds, a study from our own laboratory (Gaigg & Bowler, 2008) may help to resolve this inconsistency. Similar to South et al. (2008) we also presented participants with a random sequence of emotionally charged and neutral words and also found no group differences in memory for the emotional material between ASD and typically developed adults on an immediate test of memory. When assessing participants' memory again after 1 hour and once more after 1 day, however, the memory advantage for emotional words increased for typical participants whilst it diminished for those with a diagnosis of ASD. Importantly, we had included a set of semantically related but neutral words (i.e. names of fruit) in our materials, allowing us to determine to what extent the memory superiority for emotional words may be accounted for in terms of the semantic similarity between them. In this respect our results showed that neither group of participants exhibited enhanced memory for emotionally charged over semantically related neutral words on the immediate free recall test. This emotion-specific enhancement of memory only emerged on

the 1 hour and 1 day delay tests, and it only emerged for typical but not ASD participants. Together, this pattern of findings suggests that individuals with ASD may exhibit a quantitative enhancement in memory for emotionally charged as compared to neutral information over short periods of time because of semantic aspects of the stimuli rather than their emotional quality *per se*. In the Beversdorf et al. (1998) study the blocked presentation and use of statements rather than single words may not have rendered semantic aspects of the emotional material salient enough to facilitate such a 'semantic modulation' of memory in ASD, whereas in the South et al. (2008) study such semantic influences on memory may explain why these authors failed to observe differences between ASD and typical participants. The evidence from the verbal domain, therefore, suggests that the emotional quality of verbal information does not impact on memory in ASD in the same qualitatively distinct fashion as in typical individuals and this conclusion has recently received additional support from the non-verbal domain. More specifically, Deruelle, Hubert, Santos and Wicker (2008) found that, unlike typical individuals who exhibit a memory advantage for negative as compared to positive and neutral pictures, participants with ASD demonstrated no such memory advantage (if anything they tended to remember neutral images more than positive and negative ones).

Considering the available evidence, one might expect that memories of emotional material in individuals with ASD are qualitatively no different (or only minimally so) from their memories of non-emotional information. Over a lifetime, this would

mean that individuals with ASD would accumulate representations of emotional information that are qualitatively indistinct from representations of non-emotional information. One way to test this contention is through a memory illusion paradigm developed by Pesta, Murphy and Sanders (2001). In their experiment, participants were presented with a list of words comprising blocks of orthographically associated words (e.g., Book, Nook, Cook, Look,...Cape, Tape, Shape, Nape,...) that participants were instructed to try to remember for a subsequent recognition memory test. Unbeknownst to the participants, this recognition test included a number of words that were orthographically very similar to the words that had been on the studied list, but which participants had not actually seen. Half of these so-called Target Lures were neutral (e.g., Hook) and half of them were emotionally charged (e.g., 'Rape'). Pesta et al. (2001) found that typical individuals were extremely unlikely to falsely identify the emotionally charged Target Lures as having been on the original study list whilst their false recognition rates of neutral Target Lures was far above chance. In other words, whilst the orthographic similarity between the studied words and the Target Lures gave rise to illusory memories of certain neutral words, the distinctive nature of the emotional words attenuated such illusory memories.

In the current experiment we replicated one of Pesta et al's. (2001) experiments in order to test the hypothesis that individuals with ASD would be as likely to succumb to illusory memories of emotionally charged as neutral words. In addition, we were interested in whether individuals with ASD would generally be

as susceptible to the illusory memory phenomenon as typically developed individuals. To date, most studies investigating this phenomenon in ASD (Beversdorf, Smith, Crucian, Anderson, Keillor, Barrett, Hughes, Felopulos, Bauman, Nadeau & Heilman, 2000; Bowler, Gardiner, Grice & Saavalainen, 2000; Hillier, Campbell, Keillor, Phillips & Beversdorf, 2007) have employed a paradigm developed by Deese (1959) and Roediger and McDermott (1995), in which participants study groups of semantically rather than orthographically associated words (e.g., bed, dream, pillow,...) before memory is tested for some of these words together with semantically associated Target Lures (e.g., sleep). Overall the evidence suggests that individuals with ASD are susceptible to such semantically induced memory illusions, even if they may sometimes be less susceptible to them than typical comparison individuals (Beversdorf et al., 2000). Interestingly, Hillier et al. (2007) found that individuals with ASD were less susceptible to illusory memories of abstract visual patterns that were induced by asking participants to study sets of similar visual patterns despite the fact that groups did not differ on a standard semantic memory illusion paradigm. This pattern of results is informative in relation to the 'Weak Central Coherence' (WCC) (e.g. Shah & Frith, 1993) and 'Enhanced Perceptual Functioning' (EPF) accounts of ASD (Mottron & Burack, 2001; Mottron, Dawson, Soulières, Hubert & Burack, 2006). The former suggests that individuals with ASD are impaired in processing globally constituted and conceptual meaning, which seems at odds with the finding that individuals with ASD are subject to semantically induced memory illusions. The EPF account, on the other hand, predicts superior

perceptual processing in ASD and this account seems to be in line with the patterning of findings in the memory illusion literature. To date, no study has assessed memory illusions in ASD in the verbal domain that are induced by structural (i.e. orthography) rather than semantic associations between words. Given the evidence so far, one might expect individuals with ASD to be less susceptible to such illusions.

Method

Participants

Twenty two individuals with a diagnosis of ASD (18 male, 4 female) and 22 typically developed individuals (17 male, 5 female) participated in the current experiment. Individuals with ASD were diagnosed by experienced clinicians and a review of available records and/or assessment with the Autism Diagnostic Observation Schedule (ADOS; Lord, et al., 1989) confirmed that all met DSM-IV (American Psychiatric Association, 2000) criteria for Autism Spectrum Disorder. ADOS scores were only used as an exclusion criteria when participants provided a statement of their diagnosis that did not include information about their developmental history. The 10 individuals included in this study who were unable to provide such details all met relevant cut-offs for an ASD on the ADOS assessment. Two individuals whose ADOS scores fell below the cut-off for an ASD were included in the present study because their medical records clearly

suggested that such a diagnosis was appropriate (exclusion of these participants did not alter the results presented below significantly). Typical participants were recruited from the local community through newspaper advertisements, and brief interviews ensured that none of the participants in either group suffered any psychiatric or neurological disorder (other than ASD) or were taking any psychotropic medication. Typical and ASD participants were individually matched to within 7 points of verbal IQ (WAIS-III^{UK}; The Psychological Corporation, 2000) and, as Table 1 indicates, groups did not differ significantly in terms of performance IQ ($t = 1.41$, $df = 42$, ns) full-scale IQ ($t = 1.29$, $df = 42$, ns) or age ($t = 0.53$, $df = 42$, ns). The experimental procedures outlined below adhere to the ethical guidelines set out by the British Psychological Society and were approved by the University's Senate Ethical Committee.

[INSERT TABLE 1]

Materials & Design

The experimental materials used in the current study were taken directly from Pesta et al's. (2001) second experiment and included 12 groups of 10 orthographically related words, 12 Target Lures, and 3 so-called 'distinctiveness attenuators'. Of the 12 orthographic word groups, six were designated as Set A and six as Set B. Within each of these sets, three groups of words included the orthographic neighbours of three neutral Target Lures (*Hook*, *Shave* and *Peach*

for Set A and *Rink*, *Park* and *Digit* for Set B), whilst the other three groups included the orthographic neighbours of three emotionally charged Target Lures (*Rape*, *Bitch* and *Whore* for Set A and *Slut*, *Hell* and *Penis* for Set B). As outlined by Pesta et al. (2001), the emotional and neutral Target Lures were matched on word frequency (Kučera & Francis, 1967) and letter length, whilst the lists comprising the orthographic neighbours of each type of Target Lure were matched as closely as possible in terms of the number of strict orthographic neighbours of their respective Target Lure. The three ‘distinctiveness attenuators’ (*Fuck*, *Piss* & *Asshole*) were presented during the study phase of the experiment and served to satisfy the participants’ expectations of seeing emotionally charged words during the experiment (for ethical reasons participants were fully informed about the nature of the experimental materials).

During the study phase of the experiment, participants were presented with a sequence of 67 words, including the sixty words from the orthographic word groups of either Set A or Set B, the three ‘distinctiveness attenuators’, and four buffer words (2 at the beginning and 2 at the end of the list). The buffer words were included to counter primacy and recency effects. Words were presented visually on a lap-top monitor at a rate of one word every 3 seconds. Each word appeared in bold, Times New Roman font (size 60) in the centre of the screen, remained there for 2 seconds and was followed by a 1 second blank screen before the onset of the next word. Following Pesta and colleagues, the order of presentation followed a pseudorandom blocked design, whereby sets of 5 words

from a given orthographic word group were presented in sequence, whilst the order of these blocks was counterbalanced across participants. The order of words within each block was randomised. The three 'distinctiveness attenuators' were inserted in serial positions 13, 34 and 50. During the recognition test participants were presented with a random selection of 18 words that they had studied (3 from each orthographic word group), 18 words from the set that they had not studied (3 from each orthographic word group) and all 12 Target Lures. The order of presentation was random and the format of presentation was similar to that during the study phase with the exception that the words remained on the screen until the participants had made their response.

Procedure

Participants were tested individually in a sound attenuated laboratory. Prior to the experiment, participants were briefed about the nature of the experiment. They were told that they would be required to try to remember a list of words for a subsequent memory test and that some of the words in the experiment would be 'sexually charged, vulgar or offensive'. The illusory memory phenomenon was not mentioned at this stage. Once participants had given their consent to take part in the experiment, they were presented with the to-be-remembered list of words. Immediately after the last word, participants were given instructions about the impending recognition memory test. The instructions specified that participants would again see a list of words and that this list would include some

of the words that they had just seen and some new words. Participants were instructed to indicate whether or not they had seen a particular word before and the experimenter noted these responses on an answer sheet. After the end of the recognition test procedure, participants were fully debriefed about the nature of the experiment and paid according to standard University fees.

Results

Prior to analysing the illusory recognition rates of Target Lures, we assessed participants' true and false recognition rates of the orthographic word group items. Following Pesta and colleagues (2001), we computed participants' 'Yes' responses to these items as a function of whether these were part of the studied or unstudied set and according to whether they comprised the orthographic neighbours of the emotional or neutral Target Lures. A 2 (Group) x 2 (Studied vs. Unstudied) x 2 (Orthographic neighbour of emotional vs. neutral Target Lure) mixed ANOVA of these data, which are set out in Table 2, revealed a main effect of Studied/Unstudied ($F(1,42) = 328.84, p < .001$; effect size $r = 0.94$) but no other main effects or interactions ($F < 2.20$; effect size $r < 0.22$). The main effect of Studied/Unstudied simply confirms that true recognition rates exceeded false recognition rates. The important result, however, is that both groups performed similarly well in terms of their overall recognition rates and across words comprising the orthographic neighbours of the emotional and neutral Target Lures. Thus, any differences in illusory Target Lure recognition between groups

or across emotional and neutral Target Lures are unlikely to be due to differences in terms of how well participants remembered the orthographic neighbours of these Target Lures.

[INSERT TABLE 2]

Table 2 also presents the illusory Target Lure recognition rates. A 2 (Group) x 2 (Orthographic neighbour of Studied vs. Unstudied list items) by 2 (Emotional vs. Neutral) mixed ANOVA of these data revealed main effects for the Studied/Unstudied ($F(1,42) = 50.75, p < .001$; effect size $r = 0.74$) and Emotional/Neutral ($F(1,42) = 4.78, p < .05$; effect size $r = 0.32$) factors, confirming that Target Lures are more likely to be misremembered when they are orthographically similar rather than dissimilar to the studied words, and that emotionally charged Target Lures are less likely to be misremembered than neutral Target Lures. A closer inspection of Table 2, also indicates the expected lack of an emotional modulation of illusory memories in the ASD group and planned within-group comparisons confirmed this impression. For the typical group, main effects were observed for both, the Studied/Unstudied ($F(1,21) = 23.08; p < .001$; effect size $r = 0.72$) and Emotional/Neutral ($F(1,21) = 9.27; p < .01$; effect size $r = 0.55$) factors, whilst for the ASD group only the main effect of Studied/Unstudied was significant ($F(1,21) = 27.97; p < .001$; effect size $r = 0.75$) whilst the Emotional/Neutral factor had virtually no effect in this group ($F(1,21) = 0.49; ns$; effect size $r = 0.15$).

Discussion

The principal motivation for the current experiment was the observation that ASD individuals seem to retain emotionally significant information in a qualitatively rather indistinct fashion over time (Gaigg & Bowler, 2008). On the basis of this observation, we suggested that individuals with ASD would be unlikely to have accumulated distinct representations of emotionally salient information throughout their lives, leading us to predict that they should not exhibit an emotional modulation of the illusory memory phenomenon. Before we discuss our results in relation to this hypothesis, we will briefly address the more general question of whether individuals with ASD are as susceptible to orthographically induced memory illusions as typically developed individuals.

As outlined in the introduction, previous studies of memory illusions in ASD seem to suggest that such individuals may be less susceptible than typical individuals to illusory memories that are induced through perceptually anchored associations between to-be-remembered words whilst their susceptibility to conceptually induced memory illusions is more in line with that of typical individuals (Beverdors et al., 2000; Bowler et al., 2000; Hillier et al., 2007). On the basis of the EPF model (Mottron & Burack, 2001; Mottron et al., 2006) this pattern may be explained in terms of the superior perceptual processing abilities of individuals with ASD, which may enhance their ability to discriminate amongst very similar

patterns of perceptual information. In a way, one might consider the present findings to pose a challenge to such an interpretation because we observed no differences between ASD and typical participants in terms of their susceptibility to orthographically induced memory illusions. We hasten to add, however, that orthographic associations between words are not perceptually anchored in the same way as the similarities between the abstract visual patterns used in the Hillier et al. (2007) study. In this context, it would be of interest to devise an experiment in which memory illusions of verbal stimuli are induced through similarities amongst words in terms of font style or font colour, which would more closely resemble the associations of the abstract visual patterns used by Hillier et al. (2007). It is clear that further studies will be needed in order to clarify what kinds of associations amongst stimuli determine the degree to which individuals with ASD are susceptible to illusory memories. All we can conclude for the moment is that studies of this phenomenon may be fruitful in informing theoretical frameworks such as the 'Weak Central Coherence' (e.g., Shah & Frith, 1993) and 'Enhanced Perceptual Functioning' accounts (Mottron & Burack, 2001; Mottron, et al., 2006), which attempt to specify the perceptual and conceptual processing abilities of individuals with ASD.

In relation to our principal hypothesis, our findings support our prediction that individuals with ASD would be as likely to experience illusory memories of emotionally charged as neutral words. More specifically, whilst our findings from typical participants replicated the observations of Pesta et al. (2001), that the

experience of illusory memories is attenuated for emotionally charged as compared to neutral words, we observed no such attenuation for participants with ASD¹. In the context of our recent observation that individuals with ASD do not retain emotionally significant words in a qualitatively distinct fashion over time (Gaigg & Bowler, 2008), we interpret the current findings as follows. Throughout development, individuals with ASD accumulate representations of emotionally significant information that are rather indistinct from their representations of neutral information. More specifically, we argue that autonomic responses during emotionally charged situations in ASD are atypically integrated with the subjectively experienced perception of the situation, resulting in an alteration in how relevant information is consolidated into long-term memory. In support of this view, the atypical pattern of memory for emotional material in ASD tends to be associated with abnormalities in how stimulus induced arousal influences the subjective perception of stimuli. In our previous memory study (Gaigg & Bowler, 2008), for instance, we found that the subjective ratings of emotionality of words in ASD did not correlate with participant's autonomic responses to the words, whereas for typical participants this correlation was significant. Several other studies have reported similar findings in relation to picture stimuli rather than words (Ben Shalom, Mostofsky, Hazlett, Goldberg, McLeod & Hoehn-Saric, 2003; Hillier, Carpenter, Smith, Berntson, & Beversdorf, 2006) and as the recent

¹ One may criticise our conclusions in this respect on the basis that we observed no Group x Emotion interaction in our analyses. It is important to note, however, that even if this interaction were significant, it would be irrelevant in relation to our predictions, since the main effect of Emotion may nevertheless be significant within each group (i.e. the effect could simply be larger in the Typical group), which would suggest that both groups represented emotional words to some extent as qualitatively distinct. Our planned within-group analyses, therefore, are the most appropriate statistical analyses in relation to our predictions.

study by Deruelle et al. (2008) suggests, individuals with ASD remember emotionally significant pictures no better than emotionally neutral ones (unlike typical participants).

Of course, there are other ways to interpret our observations. On the basis of the EPF framework (e.g., Mottron et al., 2006) for instance, one could argue that the enhanced perceptual abilities of individuals with ASD interfered with the processing of the emotional quality of words, thus rendering them relatively indistinct and equally susceptible to the illusory memory phenomenon as neutral words. Such an explanation, however, would have to presume that the emotional quality of a stimulus is processed at a higher-order conceptual level than whatever perceptual process interfered with it. We do not think that such an assumption is tenable since the emotional quality of a stimulus tends to be processed relatively rapidly and automatically at a pre-conceptual level (LeDoux, 1996). Even if it were the case, however, that an atypically well functioning perceptual system interfered with the processing of the emotional quality of information, it would not contradict our interpretation of the current findings. On the contrary, such interference effects might explain why autonomic emotional responses are abnormally integrated with the perceptual and cognitive processes in ASD that mediate the accumulation of truly *emotional* representations of environmental stimuli.

Another way of interpreting the current observations would be to suggest that individuals with ASD did not exhibit an emotional modulation of illusory memories because of more general abnormalities in language development. In fact, since language is acquired in the broader context of social cognition, one might argue that the current findings are the result of atypical reciprocal social development, an argument that could lead back to the theoretical debate that motivated the present experiment in the first place. In this context, however, it is important to consider the present findings not in isolation but in relation to other findings in the field. First, invoking atypical language development as an explanation for the present findings would not specify why individuals with ASD should remember emotionally significant words better than neutral ones over short periods of time (Gaigg & Bowler, 2008; South et al., 2008) whilst at the same time not retaining such words in a qualitatively distinct manner over time (Gaigg & Bowler, 2008). Second, it is unclear how language development could compromise memory for emotional pictures (Deurelle et al., 2008) and how it could alter the extent to which subjective ratings of such pictures are related to arousal responses elicited by them (e.g. Ben Shalom, et al., 2003; Hillier et al., 2006). Third, a language account would be stretched to explain the finding that individuals with ASD acquire classically conditioned fear responses atypically when stimulus contingencies are unpredictable (Gaigg & Bowler, 2007) but not when they are predictable (Bernier, Dawson, Panagiotides & Webb, 2005) and such an account would also not clarify why decision making behaviours in ASD should be atypically related to the level of arousal participants exhibit in response to their

decision making choices (Johnson, Yechiam, Murphy, Queller, & Stout, 2006). Because of this line of evidence, we feel that an explanation of the emotional processing difficulties in ASD in terms of a purely social phenomenon seems no longer tenable. In our opinion this facet of the ASD phenotype is more appropriately explained with reference to emotional processes that operate outside as well as within the social domain and in this respect we argue that a core atypicality in ASD lies in how physiological aspects of emotional experiences influence perception and cognition.

Regardless of whether one accepts or rejects our current interpretation, the observation itself remains the same and suggests that individuals with ASD do not only process socially relevant emotional signals atypically but that they are also relatively insensitive to the emotional significance stimuli that are not directly social in nature. As such, our findings contribute to a growing literature, which favours the view that emotional disturbances constitute a relatively central feature of the ASD phenotype (e.g., Hobson, 2002).

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Table 1

Summary of Age and IQ characteristics of the ASD and Typical Group

Measure	ASD (<i>N</i> = 22)		Typical (<i>N</i> = 22)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age				
(years)	33.5	12.3	35.2	9.6
VIQ ^a	101.1	12.6	103.1	11.5
PIQ ^b	96.7	13.3	102.5	14.1
FIQ ^c	98.7	12.6	103.7	13.1

^a Verbal IQ (WAIS-R^{UK} or WAIS-III^{UK})

^b Performance IQ (WAIS-R^{UK} or WAIS-III^{UK})

^c Full-Scale IQ (WAIS-R^{UK} or WAIS-III^{UK})

Table 2

Proportion of 'Yes' responses to Studied and Unstudied words and the Target Lures related to them as a function of emotionality and group (values in parenthesis reflect the SD).

Word Type	ASD (N = 22)		Typical (N = 22)	
	Studied	Unstudied	Studied	Unstudied
Orthographic word group				
Related to neutral Target Lure	.63 (.27)	.09 (.14)	.66 (.19)	.06 (.08)
Related to emotional Target Lure	.59 (.28)	.04 (.08)	.69 (.26)	.03 (.05)
Target Lures				
Neutral	.39 (.32)	.11 (.19)	.30 (.31)	.12 (.19)
Emotional	.32 (.36)	.09 (.18)	.18 (.20)	.00 (.00)

Note: In relation to the Target Lures, the column labels 'Studied' and 'Unstudied' refer to the distinction between Target Lures that were either orthographically related to the Studied or Unstudied word groups.