Self-referential memory in autism spectrum disorder and typical development: Exploring the ownership effect

Emma Grisdale[a] , Sophie E. Lind[a,b], Madeline J. Eacott[a,e], and David M. Williams[a,c,d]

[a]Department of Psychology, Science Site, Durham University, South Road, Durham, DH1 3LE, United Kingdom. Tel. +44 (0) 191 334 3240 3251. Email emma.grisdale@durham.ac.uk

[b]Present address: Department of Psychology, City University London, Social Sciences Building, Whiskin Street, London, EC1R 0JD, United Kingdom. Tel. +44 (0)20 7040 3372. Email sophie.lind.2@city.ac.uk

[c]Present address: University of Kent, School of Psychology, Keynes College, Canterbury, Kent, CT2 7NP, United Kingdom.

[d]Corresponding author. Tel. +44 (0)1227 827652. Email d.m.williams@kent.ac.uk

[e]Tel: +44 (0) 191 334 3240 43252. Email m.j.eacott@durham.ac.uk

Abstract

Owned objects occupy a privileged cognitive processing status and are viewed almost as extensions of the self. It has been demonstrated that items over which a sense of ownership is felt will be better recalled than other items. As autism spectrum disorder (ASD) is characterised by an impaired self-concept, people with ASD may not demonstrate this ownership effect. Two experiments were conducted which replicate Cunningham, Turk, Macdonald, & Macrae (2008). In Experiment 1, neurotypical adults completed a card sorting task and cards belonging to the 'self' were better remembered than cards belonging to the 'other'. In the second experiment, adults with ASD recalled self- and other-referent items equally well. These results shed light both on the nature of the self-concept in ASD and the relationship between sense of self and the ownership effect.

Keywords: *Autism spectrum disorder, recognition memory, ownership, self-reference effect, self-awareness*

1.1 The Relation between Memory and the Self

Memory and the self appear to be intimately related. For example, Howe and Courage (1997) suggest that the presence of a self-concept is a pre-requisite for the emergence of autobiographical memory. Others (Conway & Pleydell-Pearce, 2000; Wang 2001) have suggested the relationship between memory and the self is cyclical, whereby a fully-functional, dynamic self-concept depends upon the organisation and retrieval of personally meaningful events generated by autobiographical memory, yet in order for a person to encode and make sense of these autobiographical memories, a concept of self must be present to analyse and evaluate their content.

Our understanding of the nature of the self has therefore been informed by investigating the effects of self-related processing on memory and cognition. A prime example of this is the self-reference effect. The self-reference effect refers to the finding that stimuli relating to the self, either implicitly or explicitly, are processed preferentially to stimuli that do not relate to the self (Tversky & Kahneman, 1974). This effect is most clearly evident within the domain of memory and numerous studies have demonstrated that memory for personality trait adjectives which have been processed in relation to the self (for example by answering the question "Are you *clever*?") are recalled or recognised with greater accuracy than trait adjectives processed in relation to another person (for example "Is Meryl Streep *clever*?") (Rogers, Kuiper & Kirker, 1977). Recent studies have suggested that this effect extends to physical objects, as well as linguistic descriptors, with which an agent feels a sense of identification or over which an agent feels a sense of ownership (Cunningham, Turk, MacDonald & MacRae, 2008). This form of the self-reference effect has been termed the "ownership effect" (Beggan, 1992).

1.2 The Ownership Effect

It has been suggested that owned objects (i.e. objects that a person feels a personal investment with and which are deemed to be relevant to the self in some way) occupy a privileged cognitive processing status, being treated almost as extensions of the self (Beggan, 1991). For example, the perceived value of owned objects is higher than that of non-owned objects (the "endowment effect": Kahneman, Knetsch & Thaler, 1991), and owned objects are considered to have more positive characteristics than non-owned objects (the "mere ownership effect": Belk, 1991). Moreover, recent research has shown that the sense of ownership also has pronounced effects on memory. For example, adult participants who were told that they owned certain items were significantly more likely to later recognise these items than those they had been told were owned by a confederate (Cunningham, Turk, MacDonald & MacRae, 2008). This ownership effect is apparent in memory among young children as well as adults. For example, children aged between 4 and 6 years who had sorted pictures of everyday objects between "their" basket and a confederate's basket were more likely to recognise self-owned than other-owned items (Cunningham, Vergunst, Macrae & Turk, 2012). This implies that sense of ownership is a relatively early developing *psychological* aspect of self that clearly affects memory and cognition.

1.3 The Self and Autism Spectrum Disorder

Autistic spectrum disorder (ASD) is a developmental disorder characterised by impairments in social-communication, and by restricted and repetitive behaviour and interests (American Psychiatric Association, 2013). It has been suggested that an

impaired sense of self or self-concept may contribute to these core impairments (see Frith, 2003; Hobson, 1990).

Historically, autism has been linked to the self, with clinicians variously viewing the disorder both as an extreme form of egocentrism (Bleuler, 1905), and more recently a complete absence of the sense of self (Frith, 2003). Yet, in ASD, some aspects of self-awareness appear to be relatively intact. Williams (2010) has suggested that, whereas physical aspects of self may be intact in ASD, psychological aspects may be specifically impaired. Indeed, existing sources of evidence are largely consistent with this position. For example, children with ASD typically display mirror self-recognition (relying on awareness of physical appearance) once they have reached the mental age of 18 months (Ferrari & Matthews, 1983), in line with their typically developing peers. Equally, children with ASD are able to recognise delayed video images of themselves (Lind & Bowler, 2009) and discriminate between self and other caused changes in their environment (Grainger, Williams, & Lind, 2014a), which relies on awareness of physical agency.

In contrast, psychological aspects of self appear to be impaired in people with ASD. The high levels of alexithymia (an inability to describe one's own emotions) (e.g., Hill, Berthoz, & Frith, 2004) and the unusual patterns of pronoun use (e.g., confusing "I" or "me" with "you"; Lee, Hobson & Chiat, 1994) seen in those with ASD are consistent with this proposal. Indeed, sometimes impairments in psychological aspects in self can sometimes be revealed by mirror image enhancements in awareness of physical aspects of self (Spengler, Bird, & Brass, 2010). Similarly, children with ASD show a greater degree of impairment on "self-versions" of classic theory of mind tasks, in which they are required to recognise mental states, such as beliefs and intentions, in themselves (e.g. Williams & Happé, 2009, 2010; see also

Grainger, Williams, & Lind, 2014b). Arguably, this all suggests that awareness of more psychological aspects of self may be diminished in ASD (Williams, 2010; Uddin, 2011).

Evidence concerning the self-reference effect (discussed above in section 1.1) in ASD is particularly relevant to understanding psychological aspects of self in this disorder (see Lind, 2010, for a review). In the first study of this effect in ASD, it was found that participants with ASD failed to show the expected memory advantage for self-referent words (during the study phase, they had been presented with the words in the context of the following question: "Is the meaning of the word similar to - ?"), as compared to words which had been processed at the semantic level (at study they had been presented with the words in the context of the following question: "Does the word describe you?") (Toichi et al., 2002). However, this study included no other-person reference condition and so did not directly compare self-referent and other-referent processing. As such, this study did not directly test the self-reference effect and the results could potentially have been explained in terms of a more general "person reference effect". On the one hand, this study demonstrates that people with autism may make no cognitive distinction between information relating to the self and to semantic information, but it does not necessarily indicate that people with autism make no cognitive distinction between the self and the other. Therefore, the self-reference effect may still be present, if reduced.

On the other hand, Lombardo, Barnes, Wheelright and Baron-Cohen (2007) directly compared self-referent and other-referent processing, asking participants whether a number of trait adjectives could be used to describe either themselves, their best friend, or a fictional character (e.g. Harry Potter). In a standard recognition task, both participants with ASD and neurotypical comparison participants recognised a greater

number of words from the self-referential condition than from the best friend and Harry Potter conditions. However, the differences in the numbers of words recognised in each of the three conditions were reduced in ASD, and, in particular, the difference between the self and the Harry Potter conditions was very small, implying that the self-reference effect is reduced in ASD. In a subsequent study, using children rather than adults, Henderson et al. (2009) partially replicated this finding, demonstrating that children with ASD displayed an almost complete absence of the self-reference effect. However, while the Harry Potter condition was present, this study did not include the best friend condition. This is important because Harry Potter, a fictional character, may not occupy the same cognitive processing status as a real person, particularly one to whom the participant is close.

Thus, although there appears to be some inconsistency in the findings regarding self-referential memory in ASD, on balance, the self-reference effect appears to be reduced in people with the disorder. This is consistent with the notion of impaired psychological self-awareness. What is not yet known is whether individuals with ASD show a reduction in the *ownership* effect. As argued above in section 1.2, the sense of ownership is early to emerge in development and is likely to be a key psychological aspect of self, meaning that exploring the ownership effect in ASD has the potential to shed further light on psychological aspects of the self in ASD. Thus the currently reported findings examine the nature of the ownership effect in ASD.

1.4 The Current Experiments

The current pair of experiments builds on the work of Cunningham, Turk, MacDonald and MacRae (2008) and seeks to ascertain whether the ownership effect is reliably

present in typically developing adults (Experiment 1) and adults with a diagnosis of high-functioning ASD (Experiment 2).

Participants in each study completed (a) a recognition memory test (based on Cunningham et al.'s, 2008, study), that allowed the ownership effect to be quantified, (b) a questionnaire measure (the Private Self-Consciousness Scale; Fenigstein, Scheier, & Buss, 1975) to assess psychological self-awareness, and (c) a quantitative measure of ASD traits (the Autism-spectrum Quotient, Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001).

The main aim of Experiment 1 was to replicate the ownership effect previously observed in typically developing adults (Cunningham, Turk, MacDonald & MacRae, 2008). A secondary aim was to establish whether the ownership effect was related to degree of psychological self-awareness or sub-clinical levels of ASD traits. In Experiment 1, it was predicted (a) that the ownership effect, as measured using a recognition memory task, would be present and (b) that the strength of the effect would be positively correlated with degree of psychological self-awareness as measured by performance on the two questionnaires, and negatively correlated with ASD traits.

Experiment 2 aimed to establish whether individuals with a clinical diagnosis of ASD show a typical ownership effect in memory and whether they show diminished psychological self-awareness as measured using the questionnaire. This is the first time ownership effects have been explored or the private self-consciousness scale (PSC) used in the study of ASD. Here, it was predicted that (a) the strength of the ownership effect would be reduced or absent (due to impoverished psychological self-awareness) among participants with ASD, resulting in a significant group (ASD/comparison) × referent (self/other) interaction with respect to recognition

memory. We did not predict between-group differences in overall recognition memory ability, because recognition memory is widely considered to be undiminished among intellectually high-functioning individuals with ASD (e.g., Boucher, Mayes, & Bigham, 2012). Rather, we predicted different patterns of performance within-participants, reflecting a significant ownership effect among neurotypical comparison participants, but a reduced or absent ownership effect among participants with ASD; (b) the strength of the ownership effect would be positively correlated with degree of psychological self-awareness as measured by performance on the PSC, and negatively correlated with ASD traits, among both groups of participants.

2. General Method

2.1 Stimuli and Materials The stimuli comprised a set of 222 pictures of items commonly available to buy in a supermarket. These items were divided into three shorter lists of 74 items each. The lists were closely matched for mean word length and number of syllables. A MANOVA revealed that there was no significant difference in the number of syllables or the length of words across the three word lists $F(4,428) = .28$, $p = .89$, $\eta_p^2 = 0.89$. Each list rotated through three counterbalanced versions of the task, such that each list appeared as 'self-owned' target items in one version, 'other-owned' target items in one version, and lure items in one version. Participants were randomly assigned to one of the three versions of the task. Stimuli took the form of colour photographs of the items printed onto 885mm x 685mm laminated cards with white backgrounds. During the study phase, self-owned and other-owned items were presented on cards with red and blue borders, respectively.

During the recognition test phase, self- and other-owned target pictures (as well as lure pictures) were presented on cards without coloured borders, ensuring that participants could not simply use border colour to determine whether items belonged to self or other.

Participants were given a red shopping basket into which their cards would be placed. The experimenter had an identical blue shopping basket.

2.2 Procedure

2.2.1 Study Phase.

In the study phase, participants were presented with 148 picture cards (from two of the three lists) stacked in a random order. Half of the pictures (i.e., pictures from one list) had a red border and half (i.e., pictures from the other list) had a blue border. Participants were also presented with a blue shopping basket and a red shopping basket. Participants were instructed to place cards with a red border into the red basket and cards with a blue border into the blue basket. Crucially, participants were told that they 'owned' the red basket and its (eventual) contents while the experimenter 'owned' the blue basket and its (eventual) contents (although it was made clear to participants that they would not get to keep any of the items on completion of the task). It was stressed to participants that, when sorting the cards, they should pay attention both to the colour of the border and to the item shown on the card. Cards were presented in a random order subject to the constraint that no more than four red-bordered or blue-bordered cards appeared in a row.

2.2.2 Test Phase.

A standard unexpected (yes/no) recognition test was used in which the 148 items seen previously in the study phase were presented (but *without* coloured borders), along with 74 previously unseen lure items from the remaining list of items that had not been presented in the study phase. Participants were presented with each item individually and asked whether or not it had appeared in the study phase.

2.3 Questionnaire Measures

Self-awareness was measured using the Private Self-consciousness Scale (PSC - Fenigstein, Scheier, & Buss, 1975). The PSC assesses individual differences in levels of private self-awareness with a focus on a person's awareness of their own internal thoughts and feelings. This scale has been used extensively to assess internal thoughts, feelings and attitudes (Anderson, Bohon, & Berrigan, 1996) (Mittal & Balasubramanian, 1987) and has a high test-retest validity (Fenigsteing, Scheier & Buss, 1975). On this scale, participants can score between zero and 27, with a higher score indicating greater reported self-awareness of the private self.

Participants also completed the Autism-spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). This reliable and valid questionnaire provides a quantitative measure of ASD traits and is sensitive to ASD traits in both clinical and subclinical populations. The AQ is scored out of 50 and scores of 26 or more are considered to indicate a (potentially) clinically significant level of ASD traits (Woodbury-Smith, Robinson, Wheelright, & Baron-Cohen, 2005).

3. Experiment 1

3.1 Participants

Participants were university students, aged between 18 and 24. Forty participants (38 female) took part. None of the participants had any current or past diagnosis of psychiatric disorders, according to self-report. All participants gave their informed consent and received course credit in partial fulfilment of their undergraduate psychology degrees for taking part in the study. This study received ethical approval from Durham University Psychology Research Ethics Committee.

3.2 Results

3.2.1 Experimental task

With respect to recognition performance on the experimental task, we calculated hit rate (proportion of items seen at test that were correctly recognised as target items from the study phase), false alarm rate (proportion of lure items that were incorrectly identified as target items from the study phase), and corrected hit rate (hit rate minus false alarm rate; this provides an overall picture of recognition memory performance)[1]. These measures were calculated separately for self- and other-owned items. Table 1 shows the hit rate, false alarm rate, and corrected hit rate for self-owned and other-owned items.

[Table 1 here]

A repeated-measures ANOVA was conducted using corrected hit rate as the dependent variable and Referent (self-owned/other-owned) as the within-subjects variable. This revealed a significant main effect of Condition, $F(1,39) = 99.88$, $p <$ 001, $\eta_p^{2=}$ 0.72. This reflected the fact that the mean corrected hit rate for self-owned

items was higher than the mean corrected hit rate for other-owned items. Thus, a clear effect of ownership was present, as predicted.

3.2.2 Categorical analysis of experimental task.

In addition to analysing the ownership effect as a continuous variable in each participant group, we also analysed the data categorically. A general concern about only analysing the mean level of experimental task performance in each participant group is that it is unclear whether group differences are driven merely by a relatively small subset of participants. For example, in relation to the current study, it may be that only a small minority of participants showed the ownership effect.

Thus, for the purposes of categorical analyses, participants were deemed to have shown an ownership effect if their corrected hit rate for self-owned items was greater than their corrected hit rate for other-owned items. Using this definition of the ownership effect, 38/40 participants or 95% displayed the ownership effect[2]. The two participants who did not demonstrate the ownership effect recalled equal numbers of self and other owned items.

3.2.3 Questionnaire data and relation to experimental task

Participants scored a mean of 24.05 (*SD* = 5.87; range: 15-37) on the PSC and a mean of 12.52 (*SD* = 5.94; range: 2-23). For the purpose of the correlation analyses, a difference score (corrected hit rates for self-referent items minus corrected hit rates for other referent items) was calculated and used as a measure of the size of the ownership effect.

There were also no significant correlations between ownership (difference) score and PSC score, $r = -.12$, $p = .45$. However, in line with predictions, a significant negative

correlation was found between size of the ownership effect and scores on the AQ, r = -.33, p = .04.

3.3. Discussion

The purpose of Experiment 1 was threefold; firstly to provide a replication of the effect observed by Cunningham, Turk, MacDonald and MacRae (2008) and to extend the effect into an adult population, secondly to examine the associations between the ownership effect and specific aspects of psychological self-awareness as measured by the questionnaires and, thirdly, to act as a baseline for Experiment 2. The larger sample size employed here allows us to establish the reliability of this task at demonstrating the presence of the self-reference effect in a typical population before using it to draw conclusions about the presence or absence of a self-reference effect in a population with ASD.

As expected, the ownership effect was clearly present in this typically developed sample, with self-owned items being recognised significantly more reliably than other-owned items. This is in line with the results obtained by Cunningham, Turk, MacDonald and MacRae (2008). This could be seen as providing evidence supporting hypotheses such as that of Beggan (1991) who suggested that owned objects become a psychological extension of the self. It may even be that the ownership effect is stronger than other self-reference biases within the physical domain since a sense of ownership appears to emerge at an earlier point in developmental time than other aspects of the self-concept and, therefore, may be more deeply ingrained within an individual's psyche (Fasig, 2000).

Data from the PSC was included here to ascertain whether the strength of the self-reference effect displayed was related to difficulties expressing inner thoughts and

feelings. Results revealed that scores on the PSC did not correlate with difference scores and this therefore suggests that the PSC is not measuring an aspect of the self which is relevant for the ownership effect. In contrast, there was a significant negative correlation between scores on the AQ and ownership difference scores, supporting our earlier prediction that the ownership effect may be affected by the presence of ASD-like traits. This potential link was investigated more fully in Experiment 2, where the same task was used with a population of adults with a current diagnosis of ASD.

4. Experiment 2

4.1 Participants

Sixteen adults with ASD (3 female) and 16 typically developing comparison adults (4 female) took part in this experiment, after giving written, informed consent. Participants were recruited from an existing database of people who had previously taken part in studies conducted by the Autism Research Team at Durham University, and who had agreed to be contacted about future research projects. All participants received financial compensation for their participation. Participants in the ASD group had all received formal diagnoses of autistic disorder (n = 12) or Asperger's disorder (n = 4), according to conventional criteria (American Psychiatric Association, 2000; World Health Organization, 1992). Diagnostic information was checked thoroughly to ensure diagnoses were rigorous and current. In addition to these diagnoses, severity of current ASD features was assessed with the Autism Diagnostic Observation Schedule – Generic (ADOS-G; Lord et al., 2000) (in addition to the AQ, which was also used as an experimental measure, as explained in section 2.3).

The AQ was administered to both participants in the ASD group and comparison participants in order to ensure that comparison participants did not display significant ASD-like symptoms and traits. As expected, all comparison participants scored below the ASD cut-off on the AQ (< 26 points).

The ADOS-G is a semi-structured interview and is used as a standardized assessment of social interaction, communication, play and imaginative use of materials. It is widely used in the diagnostic assessment of ASD. This measure was used with participants in the ASD group only. Two participants declined to complete this assessment for personal reasons. Consistent with their formal diagnoses, all participants with ASD who consented to taking part in the ADOS-G scored above the ASD cut-off (≥ 7 points) on this measure. The two participants who declined to complete the ADOS-G scored above the ASD cut-offs on the AQ. Additionally a small minority of participants with a formal diagnosis of ASD scored below the cut-offs for ASD on the AQ. However, this is likely to have been due to the problems of validity which are inherent in using self-report measures. These participants scored above the ASD cut-offs on the ADOS and are therefore retained in the ASD group.

Verbal and non-verbal ability of both groups was assessed using the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999). This allowed the two groups to be matched as closely as possible for both verbal and non-verbal IQ. The groups were also matched closely for chronological age. Importantly, all effect sizes associated with group differences in baseline characteristics of age and IQ were negligible. Participant characteristics are presented in Table 2.

[Table 2 here]

This study received ethical approval from Durham University Psychology Research Ethics Committee.

4.2 Results

4.2.1 Experimental task.

As in Experiment 1, hit rate, false alarm rate, and corrected hit rate were calculated for both self-owned and other-owned items. Table 3 shows these rates among ASD and comparison participants.

[Table 3 here.]

A mixed-design ANOVA was conducted using corrected hit rate as the dependent variable, Referent (self-owned/other-owned) as the within-subjects variable, and Group (ASD/comparison) as the between-subjects variable. This ANOVA revealed a significant main effect of Referent, $F(1,30) = 14.99$, $p = .001$ η_p^2, $= 0.33$, reflecting superior recognition of self-owned items than other-owned items overall. The main effect of Group was not significant, $F(1,30) = 0.34$, $p = .86$, $\eta_p^2 = .001$. However, the interaction between Referent and Group was significant $F(1,30) = 18.80$, $p < .001$, $\eta_p^2 = 0.39$.

A series of paired-samples and independent-samples *t*-tests was conducted to break down this interaction. Among comparison participants, self-owned items were recognised significantly more reliably than were other-owned items, $t(15) = 8.68$, $p < .001$, Cohen's $d = 0.78$. Thus, comparison participants showed the expected ownership effect. However, among ASD participants, the difference between corrected hit rates for self-owned and other-owned items was non-significant, $t(15) = 0.26$, $p = .80$, Cohen's $d = 0.06$, reflecting the absence of an ownership effect in this group. Independent-samples *t*-tests revealed no significant differences between the

ASD and TD groups in recognition of self-owned items, recognition of other-owned items, or in false alarm rates, all ts $\leq$ -1.04, all ps $\geq$.30, all ds $\leq$ 0.42.

4.2.2 Categorical analysis of experimental task.

As in Experiment 1, a categorical analysis was carried out on the data and, as before, participants were deemed to have shown the ownership effect if their corrected hit rate for self-owned objects was greater than their corrected hit rate for other-owned objects. All comparison participants (16/16, 100%), but only 7/16 (44%) of ASD participants, showed an ownership effect. This difference between the groups was statistically significant and associated with a large effect size, $X^2 = 12.52$, $p <$ .001, $\Phi = .63$.

4.2.3 Questionnaire data: Group differences and relation to experimental task

Participants' scores on the AQ are shown in Table 2. On the PSC, participants with ASD scored a mean of 22.18 (SD = 4.23; range: 15-30), whereas comparison participants scored a mean of 19.25 (SD = 5.59; range: 10-28). Although there was no significant difference between ASD and comparison participants in PSC score, the difference was associated with a moderate effect size and approached significance if reported one-tailed, $t(30) = 1.77$, $p = .10$ (two-tailed), Cohen's $d = 0.59$. It is important to note that participants with ASD reported somewhat *greater* levels of self-awareness than did comparison participants.

As in Experiment 1, a series of correlation analyses was conducted to explore the association between the size of the ownership effect (i.e., recognition of self-owned items minus recognition of other-owned items), and (a) the severity of ASD/ASD-like traits (as measured using the AQ) and (b) the degree of self-awareness reported by participants (using the PSC)

In the ASD group, the association between the size of the ownership effect and score on the PSC was moderate-to-large in size and only marginally non-significant and, r = -.47, p = .06. Importantly the direction of the association suggests that as reported self-awareness *increases*, the size of the ownership effect *decreases* among participants with ASD. Among these participants, the correlation between scores on the AQ and the size of the ownership effect was small and non-significant, r = -.11, p = .69.

In the comparison group, the association between the size of the ownership effect and score on the PSC was moderate-to-large in size and only marginally non-significant and, r =.48, p = .06. Importantly, unlike among ASD participants, the direction of the association suggests that as reported self-awareness increases, so too does the size of the ownership effect among comparison participants. A Fisher's Z test indicated that the association between the size of the ownership effect and PSC score was significantly more positive among comparison participants than among participants with ASD, Z = 2.56, p = .005. . Finally, the correlation between scores on the AQ and the size of the ownership effect was small and non-significant among comparison participants, r = -.10, p = .72.

4.3 Discussion

Experiment 2 examined whether the ownership effect seen in Experiment 1 was also present in a group of adults with high-functioning autism. As a sense of ownership over objects is a key component of the psychological self-concept (Beggan, 1991) which is claimed to be impaired in ASD (e.g., Williams, 2010), it was hypothesised that this aspect of the self-reference effect would be absent or diminished in the group with ASD.

Our results were in line with this hypothesis. The comparison group displayed a strong self-reference effect, with self-referent items being consistently more accurately recalled than other-referent items. This effect was not present in the ASD group. This provides further evidence that people with ASD have an impaired or unusual psychological self-concept, because psychological ownership over items did not influence cognition/memory among participants with this disorder in the same way as it did among neurotypical participants..

The questionnaire measures were again included to ascertain whether performance on the PSC and/or AQ was related to the strength of the self-reference effect. Among both participant groups, the association between PSC score and the size of the ownership effect was borderline statistically significant. However, the direction of the association between these variables differed between the diagnostic groups. Among ASD participants, the association was negative, whereas among comparison participants, the association was positive. In other words, whereas self-reported awareness of the private self predicted performance on an objective measure of the effect of the self-ownership on memory among neurotypical adults, it was quite the opposite in participants with ASD. This finding among ASD participants may

seem striking. However, it is not the first time that individuals with ASD have been shown to *report* high levels of self-awareness despite showing diminished performance on an experimental measure of such self-awareness (e.g. Grainger, Williams, & Lind, 2014b). This may imply that diminished self-awareness in this disorder is manifested in inaccurate self-report on questionnaire measures, or it may imply that experimental measures of self-awareness do not tap the same forms of awareness that individuals with this disorder report having.

7. 5. General Discussion

Experiment 1 explored the relationship between the psychological self-concept and the ownership effect in a population of typically developing adults while Experiment 2 extended this to examine the nature of the self-reference bias in the domain of ownership in a population of adults with ASD.

In both Experiments 1 and 2 the participants in the comparison group showed a robust ownership effect. The effect found was large and consistent, implying that the self-reference effect is reliable and resilient in this area. One potential limitation of Experiment 1 is the gender imbalance (the sample comprised 95% females). The percentage of females in our study was very similar to the percentage in the sample employed by Cunningham et al. (2008) (90% females in their study). In this respect, therefore, our replication of Cunningham et al.'s findings is particularly striking. However, this gender imbalance may mean that the results reported in the current study, as well as the results reported by Cunningham et al., may not be representative of neurotypical males/the general population. However, mitigating against this somewhat is the fact that in Experiment 2 we observed a large ownership effect

among a sample of neurotypical adults that comprised predominantly males (75% males in Experiment 2). Nonetheless, future replications of this effect in a larger sample of male participants would be welcome.

The robustness of the ownership effect seen in the current study supports the view that a sense of ownership influences memory to a significant extent. The pattern of self-reference seen here is typical of the self-reference pattern seen in studies that directly test other aspects of the self-concept, for example, by using visually or verbally presented linguistic descriptors (Engelkamp, 1982; Rogers, Kuiper & Kirker, 1977). Our findings are also relevant to the on-going debate about whether ownership can be considered to be a process dependent upon physical contact with the object in question or whether it is entirely psychological in nature. It has been suggested by Cunningham et al. (2007), that physical contact has no influence on the strength of the ownership effect observed and the current findings support this view. While our participants did handle the self-owned objects, importantly, they also handled the other owned objects, and yet, the ownership effect persisted.

In contrast to the robust ownership effect found in the comparison group, the ownership effect was absent in the ASD group, with items from both the self-referent and other-referent conditions being recalled equally well. However, overall numbers of items correctly recognised did not differ between groups; the ASD group simply recognised near equal numbers of self and other referent words, rather than showing a preference for self-referent words. This implies that the pattern of performance seen in the group with ASD was not due to a general impairment in memory, nor general inattention to the task or objects. This is in line with the results of studies of other aspects of the self-reference effect in ASD – for example, Lombardo, Barnes, Wheelright and Baron-Cohen (2007) found a similar pattern of results when memory

for self and other referent trait adjectives was considered. The results support our initial predictions that aspects of the psychological self-concept are impaired in ASD while the physical self-concept remains relatively unimpaired (Williams 2010; Lind, 2010).

Having established that the ownership effect is robust in comparison participants in both studies and absent in the ASD group, we can consider the nature of the relationship between the ownership effect and the self. It had been hypothesised that the ownership effect depended on a sense of the psychological self that is diminished in ASD. The logic behind this hypothesis is that, in order for information to be processed in relation to the self (and hence encoded deeply, relative to other information), one's sense of self/self-concept needs to be intact. We hypothesised that this sense of self/self-concept is diminished in ASD and, thus, that information would not be processed in the self-relevant manner that it can be among neurotypical individuals. Our results are in keeping with this hypothesis. However, one alternative explanation for the current set of results is that awareness/sense of the psychological self is undiminished in ASD, but somehow "blocked" from influencing memory[3]. Although this alternative explanation of the current results is conceptually possible, we believe that our initial explanation is more likely to be true. If it were the case that psychological self-awareness was undiminished in ASD, but prevented from influencing cognition (presumably because of atypical connectivity between neuro-cognitive mechanisms/brain regions), then we would not expect to see significant impairments among people with ASD on more direct tests of psychological self-awareness (i.e., tests that do not measure self-awareness indirectly via its influence on cognition). Arguably, therefore, the fact that many studies have shown ASD-specific impairments on such direct tests of psychological self-awareness (see Williams, 2010)

makes it plausible to suggest that diminished self-awareness in ASD was a direct cause of the reduced ownership effect among participants with ASD in the current study.

However, while our results support this view, they also raise further issues. In Experiment 1, the strength of the ownership effect did not correlate with any aspect performance on the PSC, a questionnaire conventionally used to measure aspects of the self-concept. This suggests that if the ownership effect is reliant on an aspect of self, it is not measured by this instrument (although there was a near-significant correlation between the size of the ownership effect and PSC scores among the smaller sample of neurotypical adults in Experiment 2). However, in Experiment 1, the strength of the ownership effect did correlate with scores on the AQ, a measure of ASD traits used in both clinical and subclinical populations, and again based on self-report. This suggests that whatever the underlying basis of the ownership effect is, it is related to ASD traits in the general population.

In conclusion, the current study demonstrates a robust self-reference effect using the ownership task in neurotypical adults that is significantly impaired in participants diagnosed with ASD. This sheds light both on the nature of the self-concept in ASD, and the relation between sense of self and the self-reference effect manifested by the ownership effect.

Acknowledgements

This research was completed in partial fulfilment of Emma Grisdale's doctoral degree, which was funded by a Durham University PhD studentship. The authors wish to thank sincerely Sheila Cunningham for the use of her testing materials and her help with task development. We are extremely grateful to all the participants in this research.

Footnotes

1. We employed corrected hit rate as our primary measure of memory task performance, rather than another commonly used measure – d'– in order to facilitate comparison with previous studies of the ownership effect, each of which employed corrected hit rate. However, it is important to note that when data from the current study were calculated using d', the results were substantively the same as when using corrected hit rate.

2. It is important to note that, during the *study* phase of the experiment, the border colour of stimuli was not counterbalanced across conditions (self-owned stimuli always had a red border and other-owned stimuli always had a blue border). To ensure that the ownership effect that we found was not merely a product of the different border colour of stimuli in each condition, we conducted a pilot study in which we reversed the border colour of the stimuli across conditions (self-owned stimuli always had a *blue* border and other-owned stimuli always had a *red* border). Out of the 10 participants who completed this alternative version of the task, *all* 10 showed an ownership effect and a mixed ANOVA revealed a significant main effect of condition on mean corrected hit rate, reflecting superior recognition of self-owned items than other-owned items, $F(1,9) = 30.68$, $p < .001$, $\eta_p^{2=}$ 0.77. Thus, it is highly unlikely that the ownership effect we observed in the main study was merely an artefact of the red border colour of self-owned stimuli.

3. We would like to thank an anonymous reviewer for highlighting this alternative explanation.

References

Anderson, E. M., Bohon, L. M., & Berrigan, L. P. (1996). Factor Structure of the Private Self-Consciousness Scale. *Journal of Personality Assessment, 66*(1), 144.

American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders: DSM-IV-TR.* American Psychiatirc Publishing Inc.

Amsterdam, B. (1972). Mirror self-image reactions before age two. *Developmental psychobiology, 5*(4), 297-305.

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The autism-spectrum quotient (AQ): Evidence from asperger syndrome/high-functioning autism, malesand females, scientists and mathematicians. *Journal of autism and developmental disorders, 31*(1), 5-17.

Beggan, K On the social nature of nonsocial perception: The mere ownership effect *Journal of Personality and Social Psychology, 62* (1992), pp. 229–237

Belk, R.W (1991) The ineluctable mysteries of possessions *Journal of Social Behavior and Personality, 6,* 17–55

Bleuler, E. (1905). *Dementia Praecox or The Group of Schizophrenias*. New York: International Universities Press.

Boucher, J., Mayes, A., Bigham, S. (2012). Memory in autistic spectrum disorder. *Psychological Bulletin, 138(3),* 458-496.

Conway, M. A., & Pleydell-Pearce, C. W. (2000). The construction of autobiographical memories in the self-memory system. *Psychological Review, 107*(2), 261.

Cunningham, S. J., Turk, D. J., Macdonald, L. M., & Macrae, C. N. (2008). Yours or mine? Ownership and memory. *Consciousness and Cognition,*

17, 312–318.

Cunningham, S. J., Vergunst, F., Macrae, C. N., & Turk, D. J. (2012). Exploring early self-referential memory effects through ownership. *British Journal of Developmental Psychology*.

Cunningham, S.J., Turk, D.J., MacDonald, L.M., & MacRae, C.N. (2008). Yours or mine? Ownership and memory. *Consciousness and Cognition, 17*, 312-318.

Engelkamp, J. (1991). *Memory of action events: Some implications for memory theory and for imagery:* Springer

Fasig, J. (2000). Toddlers' understanding of ownership: Implications for self-concept development. *Social Development, 9*, 370–382.

Fenigstein, A., Scheier, M. E, & Buss, A. H. (1975). Public and private self-consciousness: Assessment and theory. *Journal of Consulting and Clinical Psychology, 43*, 522-527.

Ferrari, M., & Matthews, W. S. (1983). Self-recognition deficits in autism: Syndrome-specific or general developmental delay? *Journal of Autism and Developmental Disorders, 13*, 317–324.

Frith, U. (2003). *Autism: Explaining the Enigma*. Malden: Blackwell Publishing.

Grainger, C., Williams, D.M., & Lind, S.E. (2014a). Online action monitoring and memory for self-performed actions in autism spectrum disorder. *Journal of Autism and Developmental Disorders, 44,* 1193-206.

Grainger, C., Williams, D.M., & Lind, S.E. (2014b). Metacognition, metamemory, and mindreading in high-functioning adults with autism spectrum disorder. *Journal of Abnormal Psychology, 123*, 650-659.

Henderson, H. A., Zahka, N. E., Kojkowski, N. M., Inge, A. P., Schwartz, C. B., Hobson, J. & Bowler, D.M. (Eds.) (2010). The self in autism [Special issue]. Autism, *14(5).*

Hill, E., Berthoz, S., &Frith U.(2004). Brief report: cognitive processing of own emotions in individuals with autistic spectrum disorder and in their relatives. *Journal of Autism and Developmental Disorders, 34*, 229-235.

Hobson, R. P. (1990). On the origins of self and the case of autism. *Development and Psychopathology*, *2*, 163-181.

Howe, M. L., & Courage, M. L. (1997). The Emergence and Early Development of Autobiographical Memory. *Psychological Review*, *104*(3), 499-523.

Hurlburt R, Happe´ F, Frith U. Sampling the form of inner experience in three adults with asperger syndrome. *Psychol Med 1994;* 24: 385–395.

Kahneman,D., Knetsch,J.L.,Thaler, R. The endowment effect, loss aversion and status quo bias *Journal of Economic Perspectives, 5* (1991), pp. 193–206

Lee, A., Hobson, R. P., & Chiat, S. (1994). I, you, me, and autism: An experimental study. *Journal of Autism and Developmental Disorders, 24*, 155–176.

Lee, A., & Hobson, R. P. (1998). On Developing Self-concepts: A Controlled Study of Children and Adolescents with Autism. *Journal of Child Psychology and Psychiatry*, *39*(8), 1131-1144.

Lind, S. E. (2010). Memory and the self in autism: A review and theoretical framework. *Autism, 14*(5), 430-456.

Lind, S., & Bowler, D. (2009). Recognition Memory, Self-Other Source Memory, and Theory-of-Mind in Children with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders, 39*(9), 1231-1239.

Lombardo, M. V., Barnes, J. L., Wheelwright, S. J., & Baron-Cohen, S. (2007). Self-Referential Cognition and Empathy in Autism. *PLoS ONE, 2*(9), e883.

Lord, C., Risi, S., Lambrecht, L., Cook Jr, E. H., Leventhal, B. L., DiLavore, P. C., ... & Rutter, M. (2000). The Autism Diagnostic Observation Schedule—Generic: A

standard measure of social and communication deficits associated with the spectrum of autism. *Journal of autism and developmental disorders*, *30*(3), 205-223.

Mittal, B., & Balasubramanian, S. K. (1987). Testing the Dimensionality of the Self-Consciousness Scales. *Journal of Personality Assessment, 51*(1), 53.

Rogers, T. B., Kuiper, N. A., & Kirker, W. S. (1977). Self-reference and the encoding of personal information. *Journal of personality and social psychology*, *35*(9), 677.

Toichi, M., Kamio, Y., Okada, T., Sakihama, M., Youngstrom, E. A., Findling, R. L., et al. (2002). A lack of self-consciousness in autism. *The American journal of psychiatry*, *159*(8), 1422-1424.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *science*, *185*(4157), 1124-1131.

Uddin, L. Q. (2011). The self in autism: An emerging view from neuroimaging. *Neurocase*, *17*(3), 201-208.

Wang, Q. (2001). Culture effects on adults' earliest childhood recollection and self-description: Implications for the relation between memory and the self. *Journal of Personality and Social Psychology*, *81*(2), 220-233.

Wechsler, D. (1999). *Wechsler abbreviated scale of intelligence*. New York, NY: The Psychological Corporation: Harcourt Brace & Company.

Williams, D. (2010). Theory of own mind in autism Evidence of a specific deficit in self-awareness? *Autism*, *14*(5), 474-494.

Williams, D., & Happé, F. (2010). Representing intentions in self and other: Studies of autism and typical development. *Developmental Science*, *13*, 307-319.

Williams, D., & Happe, F. (2009). What Did I Say? Versus What Did I Think? Attributing False Beliefs to Self Amongst Children With and Without Autism. *Journal of Autism and Developmental Disorders*, *39*(6), 865-873.

Woodbury-Smith, M. R., Robinson, J., Wheelwright, S., & Baron-Cohen, S. (2005). Screening adults for Asperger syndrome using the AQ: A preliminary study of its diagnostic validity in clinical practice. *Journal of autism and developmental disorders*, *35*(3), 331-335.

World Health Organization (1992). *The ICD-10 classification of mental and behavioural disorders: Clinical descriptions and diagnostic guidelines.* Geneva: Author

Tables

Table 1: *Means and Standard Deviations For Hit Rates, False Alarm Rates and Corrected Hit Rates in Each Condition (Experiment 1)*

Measure	Condition	*M*	*SD*
Hit rate	Self-owned	.65	.15
	Other-owned	.45	.14
False alarm rate	N/A	.18	.11
Corrected hit rate	Self-owned	.46	.18
	Other-owned	.26	.13

Table 2

Participant Characteristics for Experiment 2 (Means, Standard Deviations and Inferential Statistics)

	Group				
	ASD (n = 16; 13 male)	Neurotypical (n = 16; 12 male)	*t*	*p*	Cohen's *d*
Age (years)	31.33 (9.91)	35.31 (14.70)	-0.90	.38	0.32
VIQ	110.19 (13.99)	113.07 (13.78)	-0.59	.56	0.21
PIQ	112.53 (14.21)	116.69 (10.86)	-0.92	.37	0.30
FSIQ	112.31 (14.49)	116.63 (12.44)	-0.90	.37	0.32
AQ Total Score	34.63 (9.90)	14.56 (5.59)	7.06	<.001	2.50
ADOS Social + Communication Score	12.54 (2.06)	-			

Table 3

Means and Standard Deviations for Hit Rates, False Alarm Rates and Corrected Hit Rates for Each Group in Each Condition (Experiment 2)

	Condition	ASD		Comparison	
		M	*SD*	*M*	*SD*
Hit rate	Self-owned	.66	.16	.73	.12
	Other-owned	.67	.14	.65	.12
False alarm rate	N/A	.11	.07	.13	.05
Corrected hit rate	Self-owned	.55	.18	.61	.12
	Other-owned	.56	.16	.52	.11