The Self in Autism and Its Relation to Memory

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The Multifacted Nature of Memory and the Self

Among psychologists and philosophers alike, it is widely assumed that memory, particularly autobiographical memory, and the self are inextricably linked (e.g., Conway, 2005; Hume, 1739/2003; James, 1890; Locke, 1690/1995; Prebble et al., 2013; Wilson & Ross, 2003). Indeed, the relation between the two constructs is generally thought to be bidirectional in nature. Without memory for one's past personal experiences, one's sense of self – one's personal identity – would be impoverished. In Wilson and Ross's (2003) words, "we are what we remember" (p.137). But equally, without a sense of self one would be unable to appreciate the personal significance of the events that one experiences. That there is a link between the two is undeniable. However, the precise nature of the relation requires careful consideration, and is likely to be far more complex and subtle than one might imagine at first glance. This is, in no small part, because memory and the self are not unitary entities, but multifaceted in nature (despite what introspection tells us). Hence, the relation between memory and the self requires careful unpacking.

In this chapter, we start by considering some definitions of memory and the self. We then consider in some detail how memory and the self might be related on the psychological level. We then consider the relevance of these theories to autism spectrum disorder, providing a critical review of relevant research on the self in autism, followed by some hypotheses concerning how diminished sense of self might predict and explain the unique memory profile we see in the ASD population.

Facets of Memory

The idea that memory consists of multiple systems is now widely accepted (e.g. Schacter & Tulving, 1994). For the current purposes, one of the most important distinctions to have been drawn is between episodic and semantic memory (e.g., Tulving, 2001). Broadly, these hypothetical, functionally distinct, but interactive neuro-cognitive systems are thought to underpin long-term memory for

personally experienced events and objective, factual knowledge, respectively. By definition, episodic memories are associated with a unique spatial temporal context – they are memories of experiences that occurred in a particular *place* at a particular *time* (e.g., remembering celebrating your last birthday with friends at your favourite restaurant). Episodic retrieval is also uniquely associated with autonoetic awareness, a type of self-conscious awareness that gives rise to a sense of "mental time travel" – mentally re-experiencing a past event from a subjective perspective or mentally re-inhabiting a past state of self (e.g., feeling embarrassed at recalling everyone in the restaurant singing "Happy Birthday" to you). In contrast, semantic memories are not associated with any spatio-temporal context – they do not contain any information about when or where the memory was encoded (e.g., you may know precisely when and where you were born, without recalling anything about the context in which you learnt that information). Semantic memories are characterised by noetic (knowing) rather than autonoetic (self-knowing) awareness, and do not involve any sense of mental time travel (Wheeler, Stuss, & Tulving, 1997).

Autobiographical memory – the focus of the current volume – has been defined in a variety of ways by different authors, but is frequently (and, in our view, confusingly) considered to be synonymous with episodic memory (e.g., Gilboa, 2004). Here, we use the term "episodic" to refer specifically to the memory *system*, and the term "autobiographical" to refer specifically to a particular type of memory *content* (i.e., information pertaining to the self) (Lind, 2010). Thus, to ensure clarity, we distinguish (a) autobiographical episodic memory (e.g., remembering what happened on one's last birthday); (b) *non*-autobiographical episodic memory (e.g., remembering an article from the newspaper this morning); (c) autobiographical semantic knowledge (e.g., knowledge of one's place of birth); and (d) *non*-autobiographical semantic knowledge (e.g., knowledge of the alphabet). As we will attempt to argue in

this chapter, (a), (b), and (c) are likely to be related to sense of self, though the nature of the relation is likely to differ in each case.

Facets of the Self

Several theories have proposed different aspects of the self (e.g., Lewis, 1995; Neisser, 1988; Rochat, 2003). The most well known and widely accepted of these theories was originally proposed by William James (1890), who distinguished between the "I" (henceforth "I-self") – the self as the *subject* of experience – and the "me" (henceforth "me-self") – the self as the *object* of experience. Others have adopted the terms "self-experience" and "self-knowledge" to refer to these aspects, respectively. The I-self is arguably involved in all forms of conscious, mental activity. However, the me-self is involved only in certain contexts. The terms "self-awareness" and "self-concept" are frequently used in the literature and are generally thought to relate specifically to the me-self (e.g., Prebble et al., 2013). Here we use the term "self-awareness" to refer to the *process* by which some aspect of the self becomes the object of consciousness, and the term "self-concept" to refer to the enduring, but continuously updated, mental *representation* of the self (i.e., a set of beliefs about the self). Through self-awareness, it is possible to focus one's attention on various aspects of the self, including physical sensations, emotions, thoughts, memories, and one's self-concept. It is through self-awareness that we gain self-knowledge or self-understanding, and this information may potentially become part of one's self-concept. Thus, a rich and accurate self-concept most likely relies on having a sufficient level of self-awareness.

In addition to considering the I-self and me-self as different aspects of the self, a further pertinent distinction, between "present" and "temporally extended" aspects of self, has been drawn by some theorists (e.g., Lemmon & Moore, 2001; Prebble et al., 2013). The present self refers to the self as it is experienced or known about in the present moment, whereas the temporally extended self refers to the self as it is experienced or known about across the present, past and future, including a sense of personal

continuity through time. Although it is undoubtedly an oversimplification to consider the self purely in terms of the I/me and present/temporally extended dimensions, this type of framework has clear utility for considering the relation between memory and the self (see Prebble et al., 2013). Hence we have chosen to use this model to frame the following section, which attempts to broadly sketch out the putative relation between memory and the self.

The Relation Between Memory and the Self

So how do these hypothetical aspects of self relate to the different types of memory discussed above? If we start from the assumption that the I-self must, by definition, be involved in all forms of conscious memory, that leaves us to consider if and how the me-self relates to these forms of memory. Tulving (e.g., 2001) considers episodic memory (for both autobiographical and non-autobiographical content) to be closely tied to the self insomuch as episodic *retrieval* entails autonoetic – or "self-knowing" – consciousness. Thus, it requires one to focus attention on one's mental representation (a memory) of a past state of self in order to mentally re-experience it. This clearly implies the involvement of the me-self (i.e., the self as the object of experience), given that one is consciously focusing attention on one's self.

Indeed, self-awareness is also likely to be crucial to the *encoding* of episodic memories. For a memory to be encoded from a subjective, first-person ("field") perspective, the original event must presumably be *experienced* from this perspective. Hence, self-awareness is thought to enable experiences to be encoded episodically. At the same time, episodic memory is said to underpin the *temporally extended* self. On some level, when we remember a past event, we recognize it as a *past* experience – we do not believe that we are currently experiencing it. Hence episodic memory (and indeed episodic foresight) may be necessary for the phenomenal experience of temporal continuity – the

feeling that we are essentially the same person across time. Here the bidirectional nature of the relation between memory and the self becomes apparent.

Furthermore, while semantic memory is likely to underpin the self-concept (another manifestation of the me-self – the self as the object of consciousness), episodic memories with autobiographical content may also be considered integral to the self-concept, providing "the detail needed for a rich and nuanced self-understanding" (Prebble et al., 2013, p. 827). Given that the temporally extended self-concept incorporates multiple, alternative representations of self that must be understood *as* alternative representations of the same enduring self, metarepresentation (Perner, 1991) may also be a prerequisite (Povinelli & Simon, 1998).

From a developmental perspective, Howe and Courage (1993) proposed that the development of a self-concept is the cornerstone of the emergence of autobiographical episodic memory in early childhood. They argued that it acts as an organizational structure, which interprets and integrates events with respect to the self. Without a self-concept, it should not be possible to encode memories as personally relevant. The self-concept is said to reach a "critical mass" at around 2 years of age, coinciding with the onset of rudimentary autobiographical episodic memory, and indeed there is some evidence to support this claim (Harley & Reese, 1999). This developmental approach complements the approach outlined thus far in this chapter: semantic autobiographical memory may be integral to the development of the self-concept; this enables episodic autobiographical memory to emerge; this then feeds back to further elaborate on the self-concept. Once again, the bidirectional nature of the relation between memory and the self is highlighted.

Some evidence for the organizational properties of the self-concept on memory comes from studies that manipulated the extent to which the to-be-remembered material was self-relevant in some way. Within the neurotypical literature, it is well established that individuals show superior memory for

information that is considered self-relevant, or that has been encoded in relation to the self (Symons & Johnson, 1997). This "self-reference effect" can be thought of as a type of depth-of-processing effect (Craik & Tulving, 1975), and is thought to occur because processing information in relation to the self-concept, which acts as an organizing structure, should facilitate deeper, more elaborate encoding of this information within memory. This deeper encoding, in turn, makes this information more likely to be retrieved, relative to information that has not been processed in relation to the self-concept.

Finally, in addition to the involvement of self in retrospective aspects of memory, "future-oriented" aspects of memory are also thought to require a me-self. For example, prospective memory is the ability to carry out intended, planned actions at the appropriate moment in the future (McDaniel & Einstein, 2007). Commonly, researchers distinguish between event-based, which involves carrying out a planned action upon the occurrence of a pre-specified event (e.g., taking food out of the oven *when the timer goes off*), and time-based prospective memory, which involves carrying out a planned action at a specific future point in time (e.g., taking food out of the oven *at 3pm*). On the one hand, a robust temporally-extended me-self allows one, at the stage of *encoding* one's plan to act in the future, to imagine oneself in the future actually carrying out the plan (e.g., when deciding to get milk on the way home from work, imagining approaching and entering the supermarket, and then buying the milk) (Atance & O'Neill, 2001). By utilizing autonoetic awareness to imagine oneself carrying out one's plan in the future, one's plan gets encoded deeply and is thus more likely to be retrieved at the moment it should be carried out (Brewer, Knight, Meeks, & Marsh, 2011; Brewer, Knight, Marsh, & Unsworth, 2010). On the other hand, at the stage of *retrieving* one's intention, one arguably needs to represent one's intention as such. That is, at the moment when one's planned action should be carried out, one needs to activate *and represent* one's previously formed intention to act (Ford, Driscoll, Shum, & Macaulay, 2012; Williams, Boucher, Lind, & Jarrold, 2013). In this way, one's me-self is also thought

to contribute to prospective memory ability via the metacognitive ability to become aware of one's own mental states.

Having outlined a theoretical model for the relation between memory and the self, we will now consider how this may apply to individuals with autism spectrum disorder (ASD), a disorder that a number of researchers have suggested is characterized by diminished self-awareness and self-knowledge (e.g., Frith, 2003; Hobson, 1990; Russell, 1997) and that is also characterized by a particular profile of strengths and weaknesses in memory (Boucher et al., 2012). Below we first review the relevant literature on self in ASD, before considering the profile of memory strengths and difficulties in this disorder and how limitations of self-awareness/self-concept may explain this profile.

The Self in Autism

A number of researchers have suggested that individuals with ASD have a diminished sense of self (e.g., Hobson, 1990; Lind, 2010; Lombardo & Baron-Cohen, 2010; Williams, 2010) or even an "absent self" (Frith, 2003). Our view is that although it is implausible to suggest that individuals with ASD have diminished I-selves (i.e., have attenuated subjective experiences of the world), they may have diminished me-selves. For example, they may have reduced or atypical self-awareness (i.e., attention to the self) and consequently under-elaborated or inaccurate self-concepts (e.g., they may have overly positive or negative beliefs about themselves). In the following sections, we review evidence that is relevant to this proposal. Something important to flag up at this stage is the fact that if an individual performs poorly on a "self" task of some kind, it can be difficult to determine whether this is due to problems with the *process* of self-awareness (attention to self) or problems with their *mental representation* of self – it is very difficult to tease these apart experimentally (moreover, in some cases, people can perform atypically for reasons that have nothing to do with the self). However, in most cases, one can at least draw the broader conclusion that there is/is not a problem with the me-self.

Although there are a considerable number of studies showing typical performance on some types of "self" task among people with ASD – notably visual self-recognition tests – on balance, existing evidence suggests that individuals with ASD have atypical me-selves.

Mirror Self-Recognition in Autism

The mark test of mirror self-recognition (Amsterdam, 1972; Gallup, 1970) is widely considered to be the definitive test of self-awareness. The task involves surreptitiously marking a child's face with a spot of rouge (or placing a sticker on their hair) and assessing their behavioural response when they subsequently see themselves in a mirror. Touching the rouge or sticker is taken as evidence of self-recognition, and typically developing children generally show this reaction at around 18 months of age (e.g., Anderson, 1983). The developmental significance of such mark-directed behavior has been hotly debated and there have been disagreements over the cognitive requirements of the task (e.g., Hobson, 1990; Mitchell, 1997). Nevertheless, the broad consensus is that mirror self-recognition implies that a child has a mental representation of what they typically look like and that this self-representation has become the object of their conscious awareness (Amsterdam, 1972; Neisser, 1995; Nielsen, Suddendorf, & Slaughter, 2006). Hence successful mirror self-recognition implies both a sufficient *self-concept* (knowledge of one's own appearance) and the capacity for self-awareness (i.e., the me-self). Studies of mirror-self-recognition in autism (Dawson & McKissick, 1984; Ferrari & Matthews, 1983; Neuman & Hill, 1978) have tended to suffer from methodological weaknesses, making it difficult to draw absolute conclusions (see Lind, 2010). Notably, given that autism is rarely diagnosed or even suspected in children under 18-months (the mean age of passing the task in typical development), it is very difficult to establish whether there is any degree of developmental delay in this cognitive milestone. Nevertheless, older children with ASD (even those with significant intellectual difficulties) appear to be able to recognize themselves in mirrors (but see Carmody & Lewis, 2012). However, mirror self-

recognition may only require very rudimentary self-awareness and self-knowledge. Note that even pigeons have been found to show mark-directed behavior in tests of mirror self-recognition (Epstein et al., 1981). Hence, it would be very surprising if children with ASD were *not* capable of mirror self-recognition. If we are to understand the me-self in ASD in more depth, it is necessary to look at tasks and situations that require a more sophisticated level of self-awareness.

Delayed Video Self-Recognition in Autism

Based on the assumption that mirror self-recognition measures the present self, Povinelli and colleagues (1996) adapted the paradigm to incorporate a temporal element in an attempt to chart the development of the temporally extended self. In this novel adaptation, which is known as the delayed video self-recognition paradigm, children were videotaped while they played a game with an experimenter. During the game, the experimenter surreptitiously placed a large sticker on the front of their hair. After the game was complete, the child was shown the recording, allowing them to see the sticker placement. As in the mirror self-recognition task, mark directed behavior was the key variable of interest, but in this case, it was taken to imply that children had a *temporally extended* self-concept/self-awareness. The researchers argued that children need to reason that they are the same person as the person they see in the video and understand the temporal causal relation between their present self watching the video, and their past self being videoed, in order to realize that the sticker will still be on their head here and now, not just there and then. Povinelli et al. found that whereas 3-year-olds tended not to show mark-directed behavior in response to delayed video images of themselves, 4-year-olds did so reliably, and this was taken as evidence for the emergence of the temporally extended self at around age 4 years. To our knowledge, only two published studies have explored delayed video self-recognition in ASD (Lind & Bowler, 2009; Dissanayake et al., 2010). Each of these studies found intact performance, relative to matched typically developing comparison children (average $\phi = .25$, average *p*

= .35). However, on the basis of existing data, we cannot be sure that delayed video self-recognition is not delayed relative to chronological age – neither of these studies tested young enough children to establish this (Lind et al.'s sample included only a handful of children aged under 4 years, and the youngest child in Dissanayake et al.'s study was aged 4). Nevertheless these findings echo those obtained in studies of mirror self-recognition, implying that both the present and temporally extended me-self are sufficient to enable visual self-recognition among young people with ASD.

Response to Own Name and First-Person Pronoun Use in Autism

The two lines of evidence discussed thus far have suggested that the me-self is intact in ASD – insofar as tasks requiring a fairly low level of self-awareness are unproblematic for people with the disorder. However, there are other sources of evidence that may be considered to the contrary. One striking example is reduced responsiveness to name. It is frequently noted that many children with ASD fail to orient to their name (e.g., Nadig et al., 2007). For neurotypical individuals, hearing one's own name – whether someone is trying to get our attention or whether we overhear someone talking about us with other people – has a powerful and immediate effect, causing us to "prick up our ears." In ASD, although there are probably several factors that contribute to an attenuated response to one's name (e.g., social-cognitive and social-motivation factors), it seems likely that it is also a reflection of a diminished me-self – a failure to appreciate that this word you are hearing is *your* name and refers to *your* self (Lombardo & Baron-Cohen, 2010).

Other potential indicators of diminished self-awareness include difficulty using first person pronouns such as "I", "me", and "my" (including substituting third person pronouns for first person pronouns) among children with ASD (Jordan, 1996; Lee, Hobson, & Chiat, 1994; Lind & Bowler, 2009a). For example, a child may say, "You want a drink" to request a drink for themselves. There may even be some subtle differences in first person pronoun use among intellectually high-functioning

adults with ASD. For example, Lombardo et al. (2007) found that such individuals used the terms moderately less frequently ($d = 0.56$, $p = .04$) than sex, age, and IQ matched neurotypical individuals in a self-focus sentence completion task. This finding implies that participants with ASD were focusing attention on themselves (i.e., becoming self-aware – part of the me-self) less frequently than their neurotypical counterparts.

Self-Conscious Emotion, Awareness of Own Emotions, Alexithymia and Interoception in Autism

Several studies have suggested that people with ASD are less likely than their neurotypical counterparts to experience so-called "self-conscious" emotions (i.e., emotions that arise through self-evaluation, such as embarrassment, shame, pride, and guilt). For example, although children with ASD clearly experience pleasure, they are less likely to experience pride in response to a personal achievement (Kasari, Sigman, Baumgartner, & Stipek, 1993). In the context of mirror-self-recognition tasks, behaviour such as blushing, shy smiling, gaze aversion, and preening are taken to indicate embarrassment and pride, and they are frequently noted among young typically developing children (Amsterdam, 1972). However, studies of mirror self-recognition in ASD have generally noted the absence of these behavioural indicators of self-conscious emotion. Diminished expression of self-conscious emotion may *potentially* be attributable to a diminished me-self – the experience of these emotions involves self-evaluation; these emotions are *about* the self and therefore involve self-awareness and, necessarily, some form of self-representation. However, diminished self-conscious emotion may also be explained by difficulties with social cognition (notably, they are often referred to as "social" rather than "self-conscious" emotions). Thus, it is a possibility that children with ASD have the capacity for self-evaluation but lack awareness of (or are unconcerned by) socially accepted standards and behaviours. Hence they may have no clear benchmark for how one is "supposed to be or behave" to compare to their own self-representation. It is also interesting to note that despite showing

fewer outward expressions of self-conscious emotion, at least some studies have shown that children with ASD are perfectly able to describe past instances in which they have experienced such emotions (Hobson et al. 2006; Williams & Happe, 2010; but see Losh & Capps, 2006; Capps, Yirmiya, & Sigman, 1992).

In addition to evidence regarding expression of self-conscious emotion in ASD, research on emotional self-awareness in people with this disorder is highly relevant in the current context. Individuals with autism tend to self-report elevated levels of alexithymia, that is, they consider themselves to have difficulty identifying and describing their own emotions (e.g., Berthoz & Hill, 2005; Lombardo et al., 2007). However, there is something a little paradoxical about asking someone – whether they have ASD or not – to rate how self-aware they are using a self-report method that surely relies on a certain level of self-awareness (Williams, 2010; but see Gaigg et al. 2016). Nevertheless, there is some limited empirical support for the idea that people with ASD have diminished emotional self-awareness.

Using a more objective approach, Ben Shalom et al. (2006) found that compared to approximately age- (but not IQ-) matched typically developing children, intellectually high-functioning children with ASD showed normal physiological responses to pleasant, unpleasant, and neutral pictures (taken from the International Affective Picture System [IAPS]), as indicated by changes in skin conductance (unfortunately the precise descriptive and inferential statistics were not reported), but their self-reported ratings of the pleasantness of the pictures were significantly or marginally significantly different (higher for pleasant pictures, $p = .04$; lower for unpleasant, $p = .03$, and neutral, $p = .05$, pictures) from those given by comparison children (unfortunately no descriptive statistics or effect sizes were reported) . In an extension of this method, Bölte et al. (2008) presented images from the IAPS designed specifically to elicit fear, anger, disgust, happiness, and sadness to intellectually high-

functioning adults with ASD and neurotypical comparison adults (only roughly matched for age and IQ). They obtained objective, physiological measures (heart rate and blood pressure), as well as subjective, self-report measures of valence and arousal. Replicating Ben-Shalom et al.'s findings, only small (and non-significant) effect sizes were observed between the groups for the physiological measures (*d*s = 0.03 to 0.66, *p*s = .06 to .99). However, several medium to large between-group effects were observed on the self-report measures (these were not always statistically significant but this was most likely due to the small sample size of $N = 20$). Specifically, participants with ASD gave more positive valence scores for fear ($d = .67$, $p = .13$), anger ($d = .51$, $p = .49$) and sadness ($d = .63$, $p = .08$) pictures (with only small differences for neutral, disgust, and happiness pictures; *d*s = .20 to .40, *p*s = .13 to .48) than comparison participants, and reported a higher level of arousal for neutral pictures ($d = 0.70$, $p = .04$) and a lower level of arousal for sadness pictures ($d = 1.18$; $p = .02$) (with only small differences on other picture types; *d*s = 0.10 to 0.40, *p*s = .12 to .33). Although Ben-Shalom et al.'s and Bolte et al.'s studies suffer from some weakness, particularly with regard to loose matching procedures and small sample sizes, they nevertheless provide suggestive evidence that although people with ASD have typical physiological emotional reactions to "emotional" stimuli, they may have diminished awareness of these reactions (a function of the me-self). These findings complement research documenting self-reported alexithymia, which in isolation may not be considered particularly compelling. Intriguingly, research exploring "interoception" (awareness of internal bodily sensations) has shown that children and adolescents with ASD are able to judge their own heart rate as accurately as neurotypical individuals (unfortunately precise inferential statistics were not reported) (Schauder et al., 2015). Although further research is needed, this study fits the emerging picture that self-awareness in ASD may involve several peaks and troughs.

Metacognitive Skills and Attribution of Mental States to Self in Autism

There is extensive evidence that individuals with ASD have diminished awareness of others' mental states, including their beliefs and intentions (so-called "mindreading" or "mentalizing"). For example, children with ASD tend to have difficulty with so-called "false belief tasks", such as the "Sally-Anne" task (Baron-Cohen et al., 1989). Here, the child watches a scenario in which one doll, Sally, places her marble in a basket and then leaves the scene. While she is gone, another doll, Anne, transfers the marble to a box. The key test question for the participant is, when Sally returns, where will she look for her marble? To correctly predict that Sally will look in the (now empty) basket, the child must attribute a mistaken belief (that the marble is still in the basket) to Sally. The difficulty that children with ASD have in generating correct predictions in such tasks is widely thought to reflect their diminished awareness of *others'* mental states in general.

Despite the enormous body of literature exploring awareness of other people's mental states in ASD, there exists comparatively little research regarding awareness of one's *own* mental states (so-called "metacognition"; e.g., taking a large gulp of liquid from a glass only to discover that it is wine, and becoming aware of your previous mistaken belief that the glass contained water) in this disorder. What research into metacognition in ASD does exist, however, points to an equivalent difficulty with this ability and with mindreading (e.g., Grainger et al., 2014a, 2016). Children with ASD are as likely to fail self-versions of classic mindreading tasks in which participants are required to explain their *own* behavior in terms of mental states (e.g., beliefs and intentions), as they are likely to fail mindreading tasks in which participants are required to explain others' behavior in terms of mental states (e.g., Phillips et al., 2001; Williams & Happé, 2008). For instance, in the classic "Smarties" false belief task, a child is shown a tube of Smarties (a popular type of children's candy in the UK) and asked what is inside. The vast majority of children (with or without ASD) appropriately respond "Smarties". The experimenter then reveals that the tube contains something unexpected, such as a pencil and then asks

the child the key test question, "What did you think was in the tube before you saw inside?" Children with ASD tend to incorrectly answer, "A pencil", thereby showing a lack of awareness of their previous false belief about the tube's contents (i.e., that it contained Smarties). Such a difficulty in forming a meta-representation of one's own mental states (an aspect of the me-self) should have consequences for many aspects of memory, as we discuss later in the chapter.

Awareness of Own Social Skills, ASD Traits, and Personality Traits in Autism

Studies that compare self-ratings to informant ratings of social skills (e.g., a person's ability to engage in chit-chat or make friends), ASD traits (e.g., a person's ability to notice small details or their difficulties with changes in routine), and personality traits (e.g., whether a person is curious, lazy, or reliable) are another potentially illuminating source of evidence with respect to self-awareness. Several such studies have found that children with ASD give themselves significantly higher ratings than do their parents on equivalent self/informant versions of social skills questionnaires, but not all of these studies have included a comparison group (e.g., Knott et al., 2006; Lerner et al., 2012). Without a comparison group, one cannot conclude that this represents a diminution of self-awareness – perhaps all individuals, neurotypical and autistic alike, show this type of positive bias. However, on balance, those studies that *have* included comparison participants suggest this is probably not the case.

Koning and MacGill-Evans (2001) found that adolescent boys with ASD rated their social skills significantly higher than parents (d = 1.26) or teachers (d = 0.83) rated them. In contrast, the self-ratings of an age- and vocabulary-matched neurotypical comparison group did not significantly differ from parent (d = 0.49) or teacher (d = 0.14) ratings. More recently, Johnson et al. (2010) found, on the one hand, that children and adolescents with ASD gave themselves significantly *lower* scores (d = 1.76, p < .001) on the Autism-spectrum Quotient (Baron-Cohen et al., 2001) and significantly *higher* scores (d = 1.79, p < .001) on the Empathizing Quotient (Baron-Cohen & Wheelwright, 2004) than their parents

did, although there were no significant self-parent differences in scores (d = 0.27, p > .05) on the Systemizing Quotient (Baron-Cohen et al., 2003). On the other hand, sex, age, and IQ matched typically developing children did not score themselves significantly differently from their parents on these three measures (all ds ≤ 0.37, all ps > .05). More recently, Kalyva (2010) found a more mixed pattern of results. Children and adolescents with ASD rated their own social skills significantly higher than their teachers rated them (d = 0.99, p > .001) but significantly lower than their fathers rated them (d = 0.95, p > .001). Within this group, the discrepancy between self and mother ratings was small and non-significant (d = 0.31, p = .25). Among a typically developing comparison group (who were matched closely on age, but had somewhat higher verbal IQs, d = 0.60, p = .06), it was found that self-ratings of social skills corresponded closely with mother ratings, (d = 0.07, p = .25), were somewhat lower than father ratings (d = 0.52, p = .08), and were considerably higher than teacher ratings (d = 0.69, p = .01),

In a recent study, Schriber et al. obtained self and parent reports of personality using the Big Five Inventory. Children and adolescents with ASD were compared to typically developing children matched on age but who had significantly higher full scale IQs (d = 0.88, p < .01). An interesting pattern of results emerged. In the ASD group, participants gave themselves more favourable ("self-enhancing") ratings than did their parents, associated with effect sizes raging from small to large in magnitude, across all five of the Big Five dimensions; extraversion (d = 0.27, p > .05); agreeableness (d = 0.15, p > .05), conscientiousness (d = 0.83, p < .01), neuroticism (d = 0.89, p < .01), and openness (d = 0.44, p < .05), with differences reaching statistical significance on three out of the five dimensions. However, the opposite pattern was observed in the comparison group: typically developing participants tended to give themselves less favorable ("self-diminishing") ratings than their parents did, associated with effect sizes raging from small to medium in magnitude, across all five dimensions (extraversion: d = 0.23, p > .05; agreeableness: d = 0.70, p < .01; conscientiousness: d = 0.27, p > .05; neuroticism: d = 0.43, p < .01;

openness: $d = 0.44$, $p < .05$), with differences reaching statistical significance on two out of the five dimensions. Thus, although the evidence is not totally clear-cut and further research is warranted, it does seem to suggest that young people with ASD are less aware of their social skills and ASD traits than typical individuals are.

Self-Concept in Autism

Developing a self-concept is thought to rely on a sufficient degree of self-awareness: If one cannot become aware of a feature of oneself then, that feature simply cannot become part of one's concept of self. The fact that children with ASD are able to pass tests of visual self-recognition suggests that they have representations of what they look like. However, this is a very basic level of self-knowledge and it cannot be assumed on the basis of this evidence alone that the quantity or accuracy of self-knowledge is typical in ASD.

Self-concept in ASD has been explored in several studies that have employed Damon and Hart's (1988) self-understanding interview. This interview assesses various domains of self-knowledge, which are separated into the categories of self-as-subject/I-self (including continuity, distinctiveness and agency domains) and self-as-object/me-self (including physical, active, psychological, and social domains). It is worth highlighting that the "self-as-subject/I-self" category is a misnomer in this context. This component of the interview cannot be regarded as a measure of pre-reflective self-*experience*. Rather, it measures self-*knowledge* of one's temporal continuity through time ("continuity"), one's distinctiveness from other people ("distinctiveness"), and formation, existence, and control of self ("agency"). Thus, data obtained from both strands of the interview shed light purely on the me-self.

Lee and Hobson (1998) were the first to adopt this method among people with ASD. They employed a sample of adolescents with ASD who had low verbal ability, and age- and verbal ability-matched "mentally retarded" comparison adolescents. With respect to the self-as-subject category,

participants from both groups produced very few self-descriptive statements relating to continuity, distinctiveness, or agency (possibly because of verbal limitations). However, the researchers noted that the majority of references to continuity among the ASD group referred to "recollections" of early infancy whereas none of those referred to by comparison participants concerned early infancy. With respect to the self-as-object category, the researchers found that relative to comparison adolescents, adolescents with ASD reported significantly more self-descriptive statements about physical and active characteristics, equal numbers of psychological characteristics (though qualitative differences were noted), and fewer social characteristics (again, qualitative differences were noted).

Farley et al. (2010) administered the self-as-subject portion of the self-understanding interview only,6 to a verbally able group of adolescents with ASD, and age- and verbal mental age-matched typically developing adolescents. They found significant differences in numbers of self-descriptive statements, favouring the typically developing group, in the agency domain, but not the distinctiveness or continuity domains. Intriguingly, Jackson et al. (2012) found the reverse pattern of results in the self-as-subject portion of the interview among a sample of intellectually high-functioning *adults* with ASD and age (but not IQ) matched neurotypical adults: They found significant differences in the continuity and distinctiveness domains but not the agency domain. Jackson et al. also explored the self-as-object component of the interview and found that adults with ASD produced significantly fewer self-descriptions than neurotypical adults in the social and psychological domains, but not the physical or active domains. Overall then, across studies, there does not appear to be a clear pattern of between-group differences in the self-as-subject domain of the self-understanding interview. However, participants with ASD appear to have typical (or even enhanced) self-concepts in the physical and active domains, but diminished self-concepts in the psychological and social domains.

Conclusions About the Self in Autism

It is clear that people with ASD are not completely self-unaware. The existing evidence suggests they are capable of visual self-recognition using mirror images and delayed videos of themselves. They also appear to have typical, or even enriched, self-concepts with respect to physical traits and abilities. However, there is accumulating evidence to indicate that the me-self is atypical in ASD. Research suggests that people with ASD show reduced response to their own names; have difficulties using first-person pronouns; express fewer self-conscious emotions; show diminished awareness of their own emotions and mental states; have reduced awareness of their own social skills and ASD traits; and have atypical self-concepts.

How Might a Diminished Me-Self Explain the Memory Profile in Autism?

If we refer back to the framework set out earlier in the chapter, we can apply this, taking into account the evidence considered above, to predict and explain patterns of memory strengths and difficulties that we see/might see in ASD. If the me-self is diminished in ASD, we should expect it to have several consequences for memory functioning. Specifically, if people with ASD have diminished self-awareness, it should negatively influence episodic memory (including episodic autobiographical memory), episodic future thinking, and prospective memory. Moreover, if individuals with ASD lack self-*knowledge* and have under-elaborated/inaccurate self-concepts because they have diminished self-*awareness,* one should predict atypical patterns of performance on self-referential memory tasks. That is, people with ASD should not, on average, show the kind of memory advantage for self-related information that neurotypical individuals show. On the other hand, we would not expect to see any deficits in semantic memory *per se* – since this should not require the me-self. However, one might expect to see specific deficits in *autobiographical* semantic memory. Thus, although problems with self-awareness should not affect the *process* of semantic memory, they may affect the *content* that gets

encoded within it. In the following sections, we explain these predictions in full and provide a review of existing evidence from each of these areas.

Episodic Memory and Episodic Foresight in Autism

There is now a considerable amount of evidence to suggest that individuals with ASD have impaired episodic memory (Bowler et al., 2011). Retrieval from episodic and semantic memory are said to be associated with autonoetic (self-knowing) and noetic (knowing) awareness, respectively. Autonoetic and noetic awareness are associated with their own distinct experiential qualities, and it is possible to distinguish them through introspection. Episodic (autonoetic) retrieval, or *remembering,* is associated with a rich recollective experience in which one mentally re-lives the previously experienced event and has a quality of "warmth and intimacy" (James, 1890). Semantic (noetic) retrieval, or *knowing,* is associated with a feeling of familiarity but no sense of re-living a past episode. Researchers have capitalized on this ability to introspectively distinguish between these different states of awareness during memory retrieval in order to gauge the relative contributions of episodic and semantic memory, respectively, to performance on laboratory memory tasks. The widely used "remember-know" task (Tulving, 1985) is the classic example of this.

In a typical remember-know task, participants are asked to complete a recognition memory test and, for each test item they identify as previously seen during the study phase of the experiment, they are asked to judge whether they actually *remember* the item being presented at study or just *know* that it was presented at study. Neurotypical adults generally provide a mixture of *remember* and *know* responses in such tests, reflecting the contribution of both episodic and semantic memory to task performance. Thus, if individuals with ASD have impaired self-awareness and, consequently, impaired autonoetic consciousness, they should show less *remembering* and more *knowing* in such tests.

Indeed this is what Bowler and colleagues showed across two studies (Bowler, Gardiner, and Grice, 2000; Bowler et al., 2007). Compared to age and IQ matched neurotypical adults, adults with ASD showed diminished rates of remembering, despite undiminished levels of item recognition. The findings imply that adults with ASD experience autonoetic awareness less frequently than people without ASD. Thus, individuals with ASD appear to have marked difficulties with non-autobiographical episodic memory, and as one might expect, these extend to autobiographical episodic memory. Several studies have shown reduced to autobiographical episodic memory specificity in adults with ASD (e.g., Crane et al., 2013; Goddard et al., 2007; Lind & Bowler, 2010; Tanweer et al., 2010) and reduced accuracy in children with ASD (Lind, Bowler, & Raber, 2014), relative to age and IQ matched neurotypical comparison participants.

There is now widespread agreement and considerable empirical support for the idea that the episodic memory system is involved not only in recalling past experiences but also in imagining possible future experiences (e.g., Atance & Martin-Ordas, 2014; Schacter & Addis, 2007; Suddendorf & Redshaw, 2013; Wheeler et al., 1997). This latter ability has been referred to as episodic future thinking, episodic simulation, prospection, and episodic foresight by various authors. Episodic foresight is said to involve future-oriented mental time travel and, like episodic remembering, involves autonoetic awareness. Hence, if people with ASD have problems with self-awareness generally and autonoetic awareness specifically, we should expect to see difficulties with episodic foresight as well as episodic memory. Indeed, recent research shows that both children (Terrett et al. 2013; Lind, Bowler, & Raber, 2014) and adults (Lind & Bowler, 2010; Lind, Williams, Bowler & Peel, 2014; but see Crane et al., 2012, for counter evidence) with ASD have difficulty with episodic foresight. The verbal reports of possible future personal experiences produced by people with ASD have been found to be less specific (Lind & Bowler, 2010), less elaborate (Lind, Williams, Bowler, & Peel, 2014; Terrett et al., 2013), and

less plausible (Lind, Bowler, & Raber, 2014) than those produced by neurotypical individuals. These findings overall are consistent with the notion that autonoetic awareness is diminished in ASD.

Semantic Autobiographical Memory in Autism

The vast majority of studies of autobiographical memory in ASD have explored *episodic* autobiographical memory, but a limited number have investigated semantic autobiographical memory – or factual knowledge about the self. This research was sparked by a case study by Klein et al. (1999) who documented that a young, intellectually able man with ASD had detailed semantic knowledge of his personality traits but had great difficulty in generating episodic memories of occasions when he had demonstrated those traits. Crane and Goddard (2008) systematically investigated both episodic and semantic autobiographical memory in a series of tasks among a sample of intellectually high-functioning *adults* with ASD and neurotypical comparison adults. Whereas adults with ASD evinced impairments in episodic autobiographical memory (e.g., recounting what they did on their last birthday), there was no evidence of difficulties with semantic autobiographical memory (e.g., recalling the name and address of their secondary school). This otherwise methodologically rigorous study did, however, suffer from one limitation – accuracy of responses was not independently verified. Participants in this study – both with and without ASD – may potentially have reported entirely spurious information. This approach is not uncommon in studies of autobiographical memory, but it does make it difficult for us to draw clear conclusions about whether these results imply a diminished or undiminished me-self in ASD.

In contrast, Bruck, London, Landa, and Goodman (2007) found that intellectually high-functioning *children* with ASD showed significantly less accurate semantic autobiographical knowledge (responses were verified by parents), as assessed with questions about personal facts such as "What's your mother's name?" However, this finding should be interpreted with a degree of caution because the typically developing comparison group from the study had a significantly higher mean IQ than the ASD

group. This IQ decrement could potentially account for significant group differences in semantic autobiographical knowledge. Thus, although there is some suggestive evidence that autobiographical semantic memory is impaired in ASD, any conclusions at this stage would be quite tentative without further research.

Prospective Memory in Autism

Strikingly, the study of prospective memory in ASD is an emergent research field with only a handful of studies published to date. However, given the theoretical relation between the me-self and prospective memory, there are good reasons to suspect that (at least certain aspects of) this ability will be diminished in ASD. Two forms of prospective memory are commonly distinguished. Event-based prospective memory involves remembering to carry out an intended action (e.g., take the food out of the oven) upon the occurrence of a specific event (e.g., when the timer goes off). Time-based prospective memory involves remembering to carry out an intended action (e.g., take the food out of the oven) at a specific point in the future (e.g., in 10 minutes).

A typical time-based prospective memory paradigm requires participants to perform a specific action (e.g., press a pre-specified keyboard key) at specific time intervals (e.g. every two minutes) while being engaged in an on-going task such as categorising images. Throughout, participants can monitor the elapsed time by pressing a specific key. A typical event-based PM task requires participants to perform a specific action (e.g., press a pre-specified keyboard key) when a specific event occurs (e.g. an image of an animal appears as part of the ongoing task). The crucial difference between the two is that event-based prospective memory is thought to rely less than time-based prospective memory on *self-initiated* retrieval of one's intention (McDaniel & Einstein, 2007). This is because retrieval of one's intended action is cued in an event-based task by the event itself (e.g., hearing a timer go off cues retrieval of one's intention to take the food out of the oven). In contrast, in time-based prospective

memory tasks, retrieval of one's intended action must be self-initiated, because there is no cue (i.e., event) to remind one of it. This is important because self-initiated retrieval may depend (in part, at least) on the me-self (and/or temporally-extended self-awareness). It has been argued that retrieving one's intentions relies on the ability to recognise one's own intentions in the first place (Williams et al., 2013); thus a difficulty with metacognition in ASD could lead to a time-based prospective memory deficit in ASD. In fact, this is exactly what we see with regard to prospective memory in ASD.

Evidence from research under both naturalistic and laboratory conditions has revealed a clear impairment of time-based prospective memory in both children and adults with ASD in comparison to typically developing peers (Altgassen, Koban, & Kliegel, 2012; Altgassen, Williams, Bölte, & Kliegel, 2009; Henry et al., 2014; Kretschmer, Altgassen, Rendell, Bolte, & Bölte, 2014; Williams et al., 2013; Williams, Jarrold, Grainger, & Lind, 2014). This unambiguous result is remarkable, given that the studies differed considerably in their methodological approach and that most of the studies showed that participants with ASD *were* able to monitor time appropriately (thus, time-based prospective memory deficits cannot be merely the result of limitations in time-processing). In contrast,

Event-based prospective memory paradigms also require participants to perform an ongoing task (e.g., press a pre-specified keyboard key). However, the prospective memory action needs to be executed on the appearance of a pre-specified prospective memory cue/event that is embedded into the ongoing task (e.g., press the key *when the screen colour changes from white to yellow*). Although some studies have found that event-based prospective memory is diminished in ASD (Altgassen et al., 2012; Brandimonte, Filippello, Coluccia, Altgassen, & Kliegel, 2011; Kretschmer et al., 2014; Yi et al., 2014), most of these studies suffer from methodological issues that may have confounded results (e.g., failure to match groups for age and IQ, failure to match groups for ongoing task performance, failure to check that the prospective memory instruction was even encoded appropriately; see Landseidel et al,, under

review). When more controlled studies have been conducted, they have always found event-based prospective memory to be unimpaired in ASD (even in samples that show a clear time-based prospective memory deficit) (Altgassen & Koch, 2014; Altgassen, Schmitz-Hubsch, & Kliegel, 2010; Henry et al., 2014; Williams et al., 2013; Williams et al., 2014).

This pattern of impaired time-based, but unimpaired event-based, prospective memory in ASD is important in relation to the topic of the current chapter, because event-based prospective memory is thought to rely less than time-based prospective memory on *self*-initiated retrieval of one's intention (McDaniel & Einstein, 2007). This is because retrieval of one's intended action is *cued* in an event-based task by the event itself (e.g., hearing a timer go off cues retrieval of one's intention to take the food out of the oven). In contrast, in time-based prospective memory tasks, retrieval of one's intended action must be *self-initiated*, because there is no cue (i.e., event) to remind one of it. Therefore, self-awareness/temporally extended self may be less crucial for event-based prospective memory than for time-based prospective memory (see Altgassen et al., 2015; Neroni, Gamboz, & Brandimonte, 2014). Thus, even if it turns out that event-based prospective memory is unimpaired in ASD, this does not show that a limitation of the me-self does not contribute to diminished time-based prospective memory in ASD.

The Self-reference and Ownership Effects in Autism

Studies of self-referential memory provide a direct test of the capacity of individuals with ASD to encode material in relation to their self-concept, and may provide further evidence regarding whether or not individuals with ASD have intact or impaired me-selves. As such, if self-concept is diminished among individuals with ASD, they should show diminished self-reference effects, relative to neurotypical individuals.

Several studies have examined the "self-reference effect" in ASD, each showing a diminished (Lombardo et al., 2007) or absent (Henderson et al., 2009; Toichi et al., 2002) effect in this population. For example, in one study, Lombardo and colleagues employed a typical self-referential memory paradigm with adults with ASD, as well as age- and IQ-matched neurotypical adults. In this study, individuals were presented with psychological trait adjectives and asked to rate the extent to which each word described themselves, a close friend, or Harry Potter. After a delay, participants were given a surprise recognition test, in which they were presented with the adjectives from the previous study phase of the task alongside new lure adjectives. Both groups showed self-reference effects (Harry Potter < Close Friend < Self) but the effect was stronger in the neurotypical group than the ASD group.

Additional evidence of difficulties with self-referential processing in ASD comes from a recent study exploring "ownership" in this population (Grisdale et al., 2014). Previous research with neurotypical individuals indicates that objects people feel they own hold a privileged status in memory and people are more likely to remember objects they "own" compared to objects they do not own (see Cunningham et al., 2008). One explanation for this "ownership effect" is that owned objects are treated almost as an extension of one's self within memory (see Beggan, 1992). If so, individuals with ASD might be expected to demonstrate a reduced ownership effect. To test this prediction, Grisdale et al. employed a task where participants were required to sort pictures of objects that people commonly buy in supermarkets into two shopping baskets. It was explained that they "owned" the objects in one of the baskets, whilst the objects in the other basket belonged to the experimenter. It was found that neurotypical adults recalled cards belonging to the self significantly better than cards belonging to the experimenter. However, in keeping with studies of self-reference effect in ASD, adults with ASD recalled self- and other-owned cards equally well. Thus, while neurotypical adults showed a clear ownership effect, this effect was absent in the ASD group.

Summary and Conclusions

In our view, it is uncontroversial to conclude that aspects of self-awareness and self-concept are diminished in ASD. Also, it is relatively clear that people with ASD have a particular memory profile of memory strengths (e.g., in semantic memory) and limitations (e.g., in episodic memory, prospective memory). How and to what extent difficulties with self and memory limitations are causally related is somewhat less clear. Certainly, we are not claiming that limitations of the me-self are the only possible causes of memory difficulties; memory (like the self) is multi-faceted and has multiple underlying bases. Thus, a number of difficulties (other than with self-awareness/self-concept) among people with ASD probably contribute to impairments of memory. However, there is a relatively large body of evidence that a diminution of the me-self contributes to memory difficulties in this disorder. The findings of reduced self-reference and ownership effects in ASD suggest strongly that the self-concept does not have the same organizational properties/effects in memory.

If our conclusions are correct and people with ASD do have attenuated me-selves, this may have practical implications, particularly for eyewitness testimony and forensic interviewing. The quality of eyewitness memory depends both on the quantity and quality of the information provided by the witness – in court, one is asked to tell the "whole truth" (quantity) and "nothing but the truth" (quality) (Koriat et al., 2001; Maras & Bowler, 2014). In fact, a diminished me-self could potentially result in less complete *and* less accurate testimony. In this chapter, we have argued that an attenuated me-self at least contributes to episodic memory difficulties in ASD. Difficulty with episodic memory should, in turn, lead to less complete eyewitness testimony, which by its very nature relies on recollection of a specific event, including details such as what happened, who was there, and where and when it occurred. As well as being less complete, the testimony of people with ASD may potentially also be less accurate than that of neurotypical people. Several studies have shown that even intellectually able individuals with

ASD have difficulty judging the accuracy of their own memories – a clear example of diminished self-awareness. This may mean they have difficulties "screening out" potentially inaccurate event details when they are providing eyewitness accounts. Clearly then, an attenuated me-self has potentially far-reaching consequences for individuals. Having said all this, we are reluctant to draw *firm* conclusions – particularly with respect to the eyewitness testimony of people with ASD – without further, more direct research on the topic.

Summary/conclusion points

- Several theories propose that the self and memory are multifaceted and have a complex and bidirectional relation with one another
- Such theories have clear applications to the case of autism – a large body of research suggests impairments in aspects of self and aspects of memory in this disorder
- We conclude that impairments in self-awareness and self-representation are likely to contribute to the memory difficulties that many individuals with autism experience

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