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A Relational Processing Framework of Memory in Autism Spectrum Disorder
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Ever since the seminal studies of Beate Hermelin and Neil O'Connor during the 1960s and 1970s, it has been known that individuals with autism spectrum disorder (ASD), compared to typically developing individuals, learn and remember things differently. They tend not to benefit from meaningful relations among stimuli to facilitate memory (e.g., Tager-Flusberg, 1991), their memory is often void of contextual details that situates past events in a particular place and time in personal history (e.g., Lind & Bowler, 2010a), and they often find it difficult to spontaneously recall information without aids for retrieval (Bowler, Gardiner, & Berthollier, 2004). At the same time, many individuals with ASD can also demonstrate exceptional memory skills. Autistic savants such as Stephen Wiltshire, for example, draw cityscapes in intricate detail following just a few minutes of exposure (Treffert, 1988, 2009) and although such eidetic memory is rare, it is not uncommon for individuals with ASD to demonstrate superior rote memory skills (Hermelin & O’Connor, 1970) or to remember details of events that would escape almost everyone else (e.g., Grandin, 2006). This pattern of strengths and difficulties is neither a unique nor a necessary feature of ASD, but interest in this topic is growing because of the functional consequences that memory difficulties can have for an individual. This is, perhaps, nowhere as evident as in the context of the criminal justice system.

Whether it is as a victim, witness, or even a suspected perpetrator of crime, individuals who come into contact with the criminal justice system will often be required to provide accurate accounts of past events that should be rich in relevant detail and provide a coherent narrative of the unfolding of events over time (i.e., who did what

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1 See also http://www.stephenwiltshire.co.uk/
2 Rote memory describes memory for material that is relatively meaningless, either by virtue of the material per se (e.g., abstract shapes; arbitrary sequences of letters, numbers, or words), or by virtue of the relations between the material and its context (e.g., remembering train time-tables without a need to travel on relevant routes).
to whom, where, and when). Recent evidence is beginning to shed light on how indi-
viduals with ASD cope with such demands and how their particular profile of memory
strengths and weaknesses impacts their ability to give evidence. To provide a broader
context for this emerging literature, the present chapter provides an overview of the
memory profile in ASD from the perspective of the distinctions between relational
and item-specific memory processes on the one hand, and between recollection and
familiarity on the other. After a brief introduction to these distinctions, three lines of
evidence are summarized, which suggest that relational memory and recollection are
compromised in ASD whereas item-specific memory and familiarity are relatively pre-
served. A final section then considers what the implications of this pattern are for how
individuals with ASD should be supported in the context of the criminal justice sys-
tem. It is important to note, however, that the evidence summarized in this chapter
primarily concerns individuals with ASD who do not have significant intellectual and/
or language impairments.

Distinctions in memory

It is now well established that our ability to remember the past is the result of a
number of interacting processes that govern how memories are initially formed,
how securely they are retained, and how likely it is that they can be retrieved at a
later stage. A detailed overview of the various distinctions that have been drawn in
this context is beyond the scope of this chapter (see Neath & Suprenant, 2003, for
comprehensive overviews). Instead, we focus on two related distinctions that have
proven useful for understanding the memory profile associated with ASD: between
relational and item-specific processing on the one hand, and recollection versus
familiarity on the other.

The distinction between relational and item-specific processing was first formalized in
a pair of publications by Einstein and Hunt (1980) and Hunt and Einstein (1981) to
integrate two influential perspectives of the time about which information people
needed to process effectively in order to ensure successful memory. One view held that
memory crucially depended on the processing of commonalities between to-be-remem-
bered elements or events, which could serve to organize material around a common
theme that would subsequently aid retrieval (Tulving, 1966; Tulving & Patkau, 1962).
Evidence for the operation of such organizational processes stemmed from the observa-
tion that participants generally remembered sets of interrelated items better than unre-
related items (Cofer, 1965; Hyde & Jenkins, 1969) and that this memory advantage was
predicted by the extent to which participants spontaneously organize to-be-remem-
bered stimuli into clusters of categorically (e.g., fruit) or associatively (e.g., table-chair)
related items during retrieval (Tulving, 1962, 1966). There was also evidence for a
rather different view, however, which emphasized the processing of the unique details
of to-be-remembered stimuli as important for successful memory. Specifically, it was
well established that memory is better when stimuli are processed for their meaning
instead of their perceptual properties (e.g., Tresselt & Mayzner, 1960). According to
the Levels of Processing (LoP; Craik & Lockhart, 1972) account, this is because meaning
is represented at a deeper level of an information processing hierarchy than more super-
ficial perceptual information, and deeper levels of processing render memory traces
more elaborate and distinct, and thus, more readily accessible for retrieval.
Organizational and LoP accounts of memory seemed antithetical because they each emphasized the processing of *relational* versus *item-specific* information as important for successful memory. However, Einstein and Hunt (1980) argued that both processes could be operating in parallel and contribute independently to successful memory. They argued that the extent to which people spontaneously process either type of information depends on the nature of the to-be-remembered material. Highly interrelated stimuli, such as categorically related words or objects that are commonly found together in a particular room, would naturally encourage relational processing, whereas stimuli that are more distinctive (e.g., a knife in a bathroom rather than a kitchen) would encourage item-specific processing. Einstein and Hunt (1980) reasoned that if both types of information contribute independently to successful memory, encouraging relational processing should be most effective for material that would spontaneously give rise to item-specific processing. Conversely, encouraging item-specific processing should be most effective for material that would otherwise stimulate relational processing. These predictions were confirmed in a series of experiments in which participants were asked to study lists of related and/or unrelated words under conditions that either drew attention to relational (e.g., sorting words into categories) or item-specific (e.g., rating words on pleasantness) information (Einstein & Hunt, 1980; Hunt & Einstein, 1981; Hunt & Seta, 1984). In all experiments, words that were obviously related were better remembered following item-specific processing, whereas less obviously related words were better remembered following relational processing. It is interesting to note that memory was best overall when participants engaged both processes together, confirming that relational and item-specific information contribute *additively* to memory success. Another important observation was that study instructions that directed participants’ attention to relational information were most beneficial for facilitating their ability to freely recall material, whereas instructions that directed attention to item-specific information were most beneficial for their ability to discriminate studied from non-studied items in tests of recognition (Einstein & Hunt, 1980) or to retrieve items in response to cues such as category labels (Hunt & McDaniel, 1993; Hunt & Smith, 1996). This finding was important because it established a functional independence between relational and item-specific processing with the former serving an organizational function that can guide unaided retrieval (e.g., Tulving, 1962, 1966), while the latter serves a discriminative function that renders items more distinct, and thus, more easily identifiable on tests of recognition or accessible in response to relevant cues. To put this into context, relational processing would be expected to enhance an eye-witnesses ability to freely describe the appearance of a perpetrator of a crime or any weapons or objects that may have been involved. By contrast, item-specific processing would be expected to benefit the identification of a perpetrator among similar individuals in a line-up, or to identify a specific knife among many as the weapon involved in a crime.

Since the early studies of Hunt and colleagues, a wealth of behavioral and neuropsychological evidence has accumulated to support the distinction between relational and item-specific processing (Davachi, 2006), which has proved useful not only for explaining typical memory functions, but also the memory difficulties that are associated with older age (Old & Naveh-Benjamin, 2008) and disorders such as schizophrenia (Ranganath, Minzenberg, & Ragland, 2008) and ASD (e.g., Bowler, Gaigg, & Lind, 2011). A complementary distinction that has proven equally useful in these contexts is that between *recollection* and *familiarity*, which differentiates
between distinct ways of retrieving memories rather than the processes involved during memory formation. Recollection describes the retrieval of contextually rich memories that involve details about where, when, and how a particular experience occurred and how different elements of that experience relate to one another. A prototypical example of recollection is brought to life in Marcel Proust’s *In Search of Lost Time* (1946), where the protagonist, upon tasting a Madeleine, re-lives the following experience from his childhood (see also Hobson & Hermelin, 2008):

> And suddenly the memory revealed itself. The taste was that of the little piece of Madeleine which on Sunday mornings at Combray (because on those mornings I did not go out before mass), when I went to say good morning to her in her bedroom, my aunt Léonie used to give me, dipping it first in her own cup of tea or tisane (p.68).

In contrast to such vivid recollections, familiarity describes the process of retrieving knowledge that is not bound to a particular place or time in our past such as knowing the boiling point water, or recognizing our butcher on the bus without realizing where we know him from. As these descriptions suggest, the distinction between recollection and familiarity is closely related to that between relational and item-specific processing in so far as that recollection involves the retrieval of relational information whereas familiarity is primarily based on the retrieval of item-specific information. Although there are nuances to this parallel that are beyond the scope of this chapter (see Mayes, Montaldi, & Migo, 2007), considerable evidence corroborates a close link between these processes. First, neural evidence indicates that the brain areas that support relational processing during memory formation are also involved in retrieval in the form of recollection while the areas that support item-specific processing are involved in retrieval in the form of familiarity (Davachi, 2006; Mayes et al., 2007). In other words, the brain mechanism recruited by both relational processing and by recollection is different from the one broadly shared by item-specific processing and familiarity. This particular pattern of functional separation and overlap is further supported by evidence from several patient populations who demonstrate parallel impairments in relational processing and recollection while item-specific processing and familiarity are spared (Ragland et al., 2012). Perhaps more relevant for the present purposes, evidence also shows that recollection critically underpins free recall, whereas recognition memory can be mediated by recollection or by familiarity (see Yonelinas, 2002). Returning to the earlier example above, witnesses might be able to pick out a perpetrator from a line-up because one of the individuals feels distinctly more familiar or because they can recollect seeing that individual in the specific context of the witnessed crime (e.g., where they stood, what they wore, who they were arguing with, etc.). By contrast, a sense of familiarity would not suffice for witnesses to freely describe the appearance of a perpetrator because such a description would critically depend on the ability to recollect the combination of details (skin tone, height, eye color, etc.) that identify a specific individual.

To sum up these somewhat tedious technicalities, the processing of relations among the elements of unfolding events serves to organize material in memory, which is particularly important when we subsequently try to freely recall the events or bring back to mind rich contextual detail (i.e., recollection). The processing of individual elements of events, by contrast, serves to aid the discrimination of previously encountered versus new material on tests of recognition through a sense of familiarity. In most
situations, people process both relational and item-specific information in parallel, and thus, retrieve memories through a combination of recollection and familiarity. However, as the following sections illustrate, several lines of evidence suggest that individuals with ASD may find it relatively more difficult to process relational than item-specific information, and therefore, rely more heavily on familiarity rather than recollection when retrieving past events.

Familiarity, recollection, and remembering
the personal past

A general observation in memory studies of individuals with ASD is that they tend to experience greater difficulties on tests of free recall than tests of recognition or cued recall (Boucher, Mayes, & Bigham, 2012). In its own right, this pattern suggests greater difficulties with retrieval through recollection than through familiarity, but there is also more direct evidence for this dissociation. Specifically, several studies have taken advantage of the fact that the distinction between recollection and familiarity is respected in natural language where we differentiate between events that we remember and facts that we know. In a typical experiment that draws on this distinction, participants would be asked to study a set of stimuli, and subsequently, indicate whether they remember or know the items they recognize. Participants are told that remembering must entail recognition of the item along with additional contextual information, such as remembering where, when, or how it was presented, or remembering any thoughts that might have come to mind at the time of studying it. Knowing, by contrast, must entail recognition of the item without any additional contextual information.

The “Remember/Know” paradigm has been used extensively in the study of typical memory function (Gardiner, 2001; Gardiner, Ramponi, & Richardson-Klavehn, 2002; Yonelinas, 2002), and several studies of ASD have revealed relatively specific difficulties with remembering but not knowing (Bowler, Gardiner, & Gaigg, 2007; Bowler, Gardiner, & Grice, 2000; Cooper et al., 2015; Souchay, Wojcik, Williams, Crathern, & Clarke, 2013). For example, Bowler, Gardiner, and Grice (2000) asked participants with and without ASD to study a list of high- and low-frequency words, and found that the ASD group reported fewer remember but more know experiences than comparison participants. Both groups demonstrated a well-established word-frequency effect, whereby low-frequency words were better remembered than high-frequency words, and only recognition in the form of remembering but not knowing was affected by word frequency in both groups. This observation was important because it confirmed that experiences of remembering were quantitatively reduced but not qualitatively different in ASD compared to non-ASD participants, which was further corroborated by Bowler, Gaigg, and Gardiner (2008) across three experiments (but see Massand & Bowler, 2015; Massand, Bowler, Mottron, Hosein, & Jemel, 2013, for relevant neurophysiological data). In other words, when individuals with ASD say that they “remember” or “know” something, they tend to describe qualitatively similar experiences to individuals without ASD. Souchay et al. (2013) further extended this finding to recognition memory for pictures, where individuals with ASD again reported fewer remembering experiences in the context of overall preserved levels of recognition. Finally, Tanweer, Rathbone, and Souchay (2010)
showed that even when individuals with ASD retrieve experiences about their personal pasts, they are less likely to remember these experiences in vivid contextual detail while they have no difficulties knowing which events occurred. This last finding has been replicated across a number of studies investigating autobiographical memory retrieval (Crane & Goddard, 2008; Crane, Goddard, & Pring, 2009; Crane, Lind, & Bowler, 2013; Lind & Bowler, 2010b; Lind, Williams, Bowler, & Peel, 2014). Such findings carry the important implication that witnesses with ASD can be expected to “know” what they have witnessed even if they would have difficulties furnishing this knowledge with concrete contextual detail. Converging evidence from so-called source memory studies lend further support to this conclusion.

In a typical source memory experiment, participants are asked to study items that are presented in different formats or contexts. For instance, stimuli might be presented in different fonts, in different locations on a screen, in different lists or by different people. Alternatively, participants might be asked to do different things with the stimuli such as simply reading them, thinking about actions related to them or generating rhymes. The former constitute examples of external source information in that the participant plays no active role in influencing the contextual details that define the presentation of the item. The latter constitute internal source information because the participants’ thoughts or behavior define the context under which the items are studied. In line with the observation of attenuated recollection in other paradigms, a number of studies have shown that individuals with ASD often have difficulties remembering such contextual details (Bigham, Boucher, Mayes, & Anns, 2010; Lind & Bowler, 2009; Ring, Gaigg, & Bowler, 2015; Russell & Jarrold, 1999), particularly when these details need to be freely recalled. For instance, Bowler et al. (2004) asked participants to study lists of words either by actively performing one of four encoding tasks (e.g., think about a rhyme) or by passively studying words that were presented on the top or bottom of the screen or in a male or female voice. On a subsequent recognition test, participants first needed to indicate whether or not they recognized words from the previous study lists. If they did, they were then either asked to recall how the word was presented or what encoding task they had performed, or to choose the relevant contextual detail from a list. The findings showed that individuals with ASD were worse than comparison participants at recalling contextual details, but they were as good as comparison participants in recognizing them. Bowler, Gaigg, and Gardiner (2015) extended this observation to show that ASD participants benefit significantly more than a comparison group from retrieval support to remember in which of three screen locations words had been studied earlier. Similarly, difficulties in recalling the sequential order in which dots are presented on a screen are also ameliorated in ASD when relevant screen locations are highlighted for the participant to choose from (Bowler, Poirier, Martin, & Gaigg, 2016). In other words, whereas the free recall of contextual source information often proves difficult for individuals with ASD, source recognition often does not, which is generally in line with difficulties in recollection rather than familiarity processes during retrieval.

Although the evidence outlined thus far suggests that ASD is characterized by difficulties with recollection but not familiarity during memory retrieval, none of the studies outlined above provide evidence that this difference is linked to abnormalities with the processing of relational versus item-specific information during memory formation. The next sections set out evidence that addresses this issue directly, but first
it is useful to note another aspect of the source memory literature that lends indirect support. As previously noted, overall levels of recognition memory are generally preserved in ASD. This is true for studies that have employed the Remember/Know recognition procedure (e.g., Bowler et al., 2007; Gaigg, Bowler, Ecker, Calvo-Merino, & Murphy, 2015), and the majority of studies that have tested recognition for single items (see Boucher et al., 2012, for a comprehensive review). It may seem surprising therefore that in the context of source memory studies, individuals with ASD often demonstrate recognition memory difficulties for the to-be-remembered items. For instance, in the study by Bowler et al. (2004) outlined earlier, the authors observed a small but nevertheless significant recognition memory decrement in the ASD relative to the comparison group. In a source memory experiment by Massand and Bowler (2015) that required participants to study line drawings presented in one of two different colors, results also revealed marginally attenuated recognition memory in ASD alongside difficulties in remembering the color of the pictures that were recognized. Substantially attenuated item recognition was also observed by Ring, Gaigg, and Bowler (2016) when participants were asked to study various sets of abstract images that were presented in different locations on a screen. These observations may seem at odds with the finding of generally preserved recognition memory in ASD, but as the Remember/Know procedure illustrates, recognition performance can be mediated by recollection or by familiarity. Unlike other recognition memory paradigms, source memory paradigms may direct participants’ attention to the relations between items because of the source properties they share (e.g., the screen locations). This relational information could augment item recognition through recollection, thus disadvantaging individuals with ASD vis-à-vis comparison groups. Admittedly, this is a rather speculative interpretation, but it serves to highlight that individuals with ASD must not be assumed to have preserved memory for item information in all circumstances.

The encoding of item-specific and relational meaning

When Hermelin and O’Connor first investigated memory functions in ASD, one of their earliest observations was that autistic children did not seem to demonstrate a memory advantage for meaningful over nonmeaningful material. For instance, whereas children without autism could recall sequences of words that formed grammatically intact sentences far better than randomly ordered word sequences, children with autism recalled both types of sequence equally well (Hermelin & O’Connor, 1967). Similarly, children without autism could recall sequences of conceptually related words or pictures better than unrelated sequences while children with autism could not (Hermelin & O’Connor, 1967). Many subsequent studies have corroborated these initial observations (e.g., Maister, Simons, & Plaisted-Grant, 2013; Tager-Flusberg, 1991), but a number of studies have also demonstrated similar memory benefits for meaningful over non-meaningful material in ASD (Ameli, Courchesne, Lincoln, Kaufman, & Grillon, 1988). The distinction between item-specific and relational memory processes has helped to resolve this apparent inconsistency by suggesting that individuals with ASD have relatively few difficulties drawing on the meaning of individual items to facilitate memory, whereas difficulties arise when meaning can be derived from relations among the items.
One of the first studies to suggest that item-specific meaning facilitates memory relatively typically in ASD was a study by Ameli et al. (1988), who asked children with and without ASD to study sets of either meaningful pictures or abstract line drawings. During subsequent test trials, children needed to identify new images that had been inserted in the original study sets, and both groups of children found this substantially easier for the meaningful pictures rather than the abstract shapes. Further evidence for preserved processing of item-specific meaning in ASD has come from studies employing levels of processing manipulations. As noted earlier, memory is generally superior following the processing of stimuli for their meaning instead of more superficial perceptual properties. Mottron, Morasse, and Belleville (2001) examined this in ASD by drawing participants’ attention either to semantic (e.g., “show me the name of a vegetable”) or perceptual (e.g., “Show me the word starting with NA”) properties of different words. On a subsequent free-recall test, individuals with and without ASD demonstrated a similar memory advantage for the words encoded for their meaning. However, while comparison participants benefited more from semantic than perceptual cues to retrieve additional items they had not spontaneously recalled, ASD participants benefitted equally from both types of cues. Instead of suggesting an impairment in processing items for their meaning, this indicates an enhanced ability to process perceptual properties of stimuli in ASD, which was further corroborated by Toichi and Kamio (2002). These authors also asked participants to study words by drawing attention to their meaning (e.g., “Is it a drink?”) or their perceptual features (e.g., “Does it sound like table?”). On a subsequent recognition memory test, comparison participants again demonstrated a clear memory advantage for the words encoded for their meaning. Although individuals with ASD did not demonstrate this advantage, this was not because of poorer memory for words encoded for their meaning, but because of superior memory for words processed for their perceptual properties. Thus, LoP studies suggest not only that the encoding of item-specific meaning is preserved in ASD, but also that the encoding of item-specific perceptual properties may be enhanced, which could make witnesses with ASD a particularly useful source of information about perceptual details of witnessed events that might escape a typical observer. For instance, witnesses with ASD may be better able to identify the specific colors of clothing, objects, or vehicles involved in a crime and they may be able to report details of the environment that might not necessarily be relevant to the crime per se (i.e., the central meaning of the event), but that could serve other witnesses as retrieval cues for further relevant details.

Studies examining associatively generated memory illusions further support the idea that the processing of item-specific meaning and perceptual details are preserved in ASD, while the processing of relational meaning is compromised. Specifically, when asked to study lists of words comprising items that are highly associated with a target word that is not on the list (e.g., bed, pillow, night, dream, and tired for the target word sleep), adults with ASD are as likely as comparison participants to falsely recall this target word (Bowler, Gardiner, Grice, & Saavalainen, 2000; Hillier, Campbell, Keillor, Phillips, & Beversdorf, 2007; but see Beversdorf et al., 2000, for subtle differences). At the same time, however, they tend to recall fewer of the actual items that are on the to-be-remembered list (Bowler et al., 2000). This apparent paradox is resolved when considering the fact that memory illusions are predicted primarily by the associative strength between each to-be-remembered list item and the critical target word, whereas veridical recall of the list items is predicted by the associative
strength between the list items themselves\(^3\) (Roediger, Watson, McDermott, & Gallo, 2001). In other words, memory illusions are elicited by virtue of the fact that all list items share an item-specific meaning, whereas free recall of list items is dependent on the utilization of this meaning to relate the items to one another. The pattern of preserved memory illusions alongside reduced recall of list items in ASD therefore suggests sufficient processing of item-specific meaning to elicit memory illusions, but difficulties utilizing this meaning to relate the to-be-remembered items to one another to facilitate veridical recall. It is interesting to note that in one of the experiments by Hillier et al. (2007), memory illusions were elicited for abstract shapes rather than meaningful words, and in that study, individuals with ASD were less likely to demonstrate illusory memories. Similar to the LoP studies, therefore studies of memory illusions suggest that the encoding of perceptual information may be enhanced in ASD.

A final line of evidence, which links difficulties in the processing of relational meaning to the difficulties individuals with ASD experience in recollection rather than familiarity during retrieval, stems from comparisons of tests of free recall, cued recall, and recognition. As noted earlier, relational processing serves an organizational function that is particularly important for free recall, whereas item-specific processing serves a discriminative function that aids performance on tests of recognition and cued recall (Hunt & Smith, 1996). The majority of studies that have demonstrated reduced memory benefits from meaningful relations between stimuli in ASD have employed tests of free recall (Bowler, Matthews, & Gardiner, 1997; Gaigg, Gardiner, & Bowler, 2008; Loth, Gómez, & Happé, 2011; Maister et al., 2013; Tager-Flusberg, 1991). On such tests, individuals with ASD also demonstrate reduced category clustering (Bowler, Gaigg, & Gardiner, 2009; Gaigg et al., 2008; Minshew & Goldstein, 1993), which indexes the type of organizational function that relational memory processes serve. By contrast, studies employing cued-recall (Bowler, Gaigg, & Gardiner, 2010; Mottron et al., 2001) or recognition procedures (Bowler et al., 2008) tend to find no ASD related impairment in using meaning to aid memory. For example, Tager-Flusberg (1991) found that children with autism benefited less than comparison children from categorical relations among words to facilitate free recall, but when memory was cued with appropriate category labels, no group differences were found. Similarly, Bowler and colleagues (2008) asked participants to study words that were presented either alongside related or unrelated context words (e.g., Crop-Grain vs. Crop-Screen). When memory was subsequently tested through free recall, only comparison participants demonstrated a memory advantage for words presented alongside related words, but when recognition memory was tested, both groups demonstrated a similar memory advantage for the words encoded in a meaningful context. Finally, a number of studies using the California Verbal Learning Test (CVLT) also show that individuals with ASD have difficulties drawing on meaningful relations among stimuli to facilitate primarily free recall rather than recognition or cued recall. The CVLT asks participants first to learn a list of categorically related words over five successive free-recall trials before cued-recall and recognition memory is assessed. Minshew and Goldstein (1993; also Minshew, Goldstein, Muenz, & Payton, 1992) found that ASD participants experienced difficulties during the free-recall learning trials while their

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\(^3\) Associative strength, in this context, refers to the probability with which the presentation of an item leads participants to respond with another item (i.e., the target word or another list item) during free association where participants are simply asked to say the first words that come to mind.
performance on the recognition test was virtually identical to that of a comparison group. Although findings on the cued-recall part of the CVLT are somewhat mixed (Minshew & Goldstein, 1993 vs. Minshew et al., 1992 and Minshew & Goldstein, 2001), many other studies have reported preserved cued recall for related material in ASD (Boucher & Warrington, 1976; Bowler et al., 1997; Bowler et al., 2010; Gardiner, Bowler, & Grice, 2003; Mottron et al., 2001; Tager-Flusberg, 1991). Overall, therefore, there is considerable evidence to suggest that individuals with ASD only struggle to benefit from meaningful relations among items to facilitate their free recall but not their cued recall or recognition.

Direct evidence for relational memory difficulties in ASD

The evidence outlined thus far is in line with the suggestion that difficulties in relational rather than item-specific processing contribute to the difficulties individuals with ASD experience in contextually rich recollection. The evidence, however, is rather circumstantial. Recently, a number of studies have tested this hypothesis more directly by manipulating encoding conditions to direct participants’ attention either to relational or item-specific information. For example, Gaigg et al. (2008) followed the original paradigms developed by Hunt and Seta (1984) outlined earlier, and asked participants to study two lists of words that were made up of varying instances of different categories (e.g., 2 Sports, 4 Clothing, 8 Weapons, 12 Countries, and 16 Animals). For the first list, participants were simply asked to try to remember the words before recalling as many as they could. Since Hunt and Seta (1984) demonstrated that relational processing primarily benefits the recall of less obviously related items, the prediction for individuals with ASD was that they should have difficulties in recalling items of the smaller categories, which is precisely what was observed. For the second list, participants were instructed to study the list either by rating each item in terms of pleasantness (promoting item-specific processing) or by sorting the items into their respective categories (promoting relational processing). Here, the ASD group performed worse than the comparison group only following the relational orienting task and a number of indices that could be derived from the participants’ recall responses further supported the idea that individuals with ASD rely more heavily on item-specific rather than relational processing during memory formation (see also Bowler et al., 2009). A subsequent study furthermore established a direct link between these relational processing difficulties during study and attenuated recollection during retrieval. Gaigg et al. (2015) asked people with and without ASD to study word triplets while deciding whether none, two, or all three words were categorically related (i.e., a relational orienting task). During a subsequent forced choice recognition test, participants needed to discriminate studied from non-studied triplets and indicate whether their choices were based on remembering, knowing, or guessing. Replicating earlier work, remember responses were reduced in ASD in the context of overall preserved recognition rates. Critically, only the proportion of remember but not know responses increased as a function of the number of categorical links in the word triplets in both groups, implicating difficulties in the processing of such relations as a source of attenuated recollection in ASD.

Although the above experiments link relational processing difficulties in ASD to problems in recollection, the implications for the criminal justice system are not
immediately clear. Studies that have employed associative recognition tests may make these implications more transparent because of the use of more ecologically valid stimulus materials than the somewhat arbitrary word lists in the previously mentioned studies. For instance, Bowler, Gaigg and Gardiner (2014) used an experimental paradigm that emulates the problem eyewitnesses face when they try to re-construct accurate details about an event (e.g., where a blue car was parked) from fragmentary memories. Specifically, they asked participants to study sets of 22 colored line drawings of common objects that were arranged in various positions of a 6x6 grid. During a first experiment, participants were asked simply to remember certain features of this grid, such as the colors that were presented, the locations that were occupied by objects, or the identities of these objects. On subsequent forced choice recognition tests for these features, ASD and comparison participants performed equally well. In other words, both groups retained specific details of the to-be-remembered grid of objects equally well. In a second experiment, however, participants were required to remember the precise object-color and object-location combinations because a subsequent recognition test would require them to identify objects that were presented in their original colors or locations from those that had their features recombined (e.g., a yellow ball and green shoe might turn at test into a green ball and yellow shoe). In this experiment, participants with ASD performed substantially worse. Thus, while their memory for item-specific features of stimuli was preserved, their memory for the relations between these features was compromised. Ring et al. (2015) extended these observations to more naturalistic scenes by requiring participants to remember in which of three plausible room locations, certain objects were presented. For example, participants needed to remember that, in a picture of a bathroom, a hairbrush was presented on a sink, rather than a shelf, and that a sponge was on the corner of a bath rather than the sink. During subsequent item recognition tests, ASD and comparison participants performed equally well at recognizing the objects and the locations that had been studied earlier. However, when participants were asked to put the objects either back into their original locations or into different locations, the ASD participants performed worse. Note that the recognition of the items and locations could be achieved through a combination of recollection and familiarity, whereas the requirement to put objects back into their original or new locations relies on the ability to accurately recollect exactly where the specific objects were originally presented. Thus, the observations confirm that at least the explicit recollection of object-location relations is a source of difficulty for individuals with ASD. Cooper et al. (2015) further corroborated this finding by showing that ASD participants also experience difficulties detecting whether objects have either been substituted or moved in pictures of rooms they were asked to remember. Interesting to note in the Cooper et al. study is that participants were asked to specify whether they remembered or knew that objects had been substituted or relocated and group differences were driven primarily by reduced remembering in ASD. Thus, a number of recent studies now confirm a close link between relational processing difficulties during memory formation in ASD and the recollection of contextually rich information at retrieval.

4 Aspects of the data suggested that individuals with ASD retain similar implicit knowledge of object-location relations in memory as comparison participants.
Conclusions and Implications

There is now a considerable body of evidence that supports the idea that memory in ASD is characterized by a relative bias to process item-specific rather than relational information during memory formation, with the consequence that retrieval in the form of contextually rich recollection is compromised whilst the process of familiarity is relatively preserved. As noted at the outset of this chapter, this pattern is neither a necessary nor a unique feature of ASD, but it has important implications for how individuals with this disorder should be supported in the criminal justice system. The memory profile in ASD suggests that witnesses on the autism spectrum should ideally not be required to freely recall events from the past, but be supported in their retrieval through the provision of relevant cues or tests of recognition that would allow them to draw on item-specific memory to retrieve information. Even with such support, however, individuals with ASD would be expected to find it difficult to retrieve relational information that could be vital to criminal investigations. Remembering the spatial or temporal relations among elements of a prior event inevitably relies heavily on the ability to encode and recollect relevant relations, and therefore, individuals on the autism spectrum would often find it difficult to retrieve exactly where things were in relation to one another, and exactly how events unfolded over time when trying to recount a previous event. At the same time, individuals with ASD may find it easier to remember some important details about events that might escape others. As we have shown, the processing of item-specific information may be enhanced in ASD in so far as that certain perceptual features of stimuli are retained very well. If interviewed about a crime they witnessed, therefore individuals with ASD should have no more difficulties than other people in identifying the objects that were involved or in remembering how many individuals were involved—in fact, they may report details about the event that would escape most others (e.g., colors of clothing, particular furniture in the room, etc.).

Take-Home Points

- Individuals with ASD tend to have more fragmented memories of complex events because of a bias to process details specific to individual elements of those events (item-specific processing) rather than how those elements relate to one another and to the wider context in which they are situated (relational processing).
- As a result of their bias for item-specific rather than relational processing, individuals with ASD tend to find it more difficult to freely recall information than to identify previously seen information among new information on tests of recognition. This is because relational information serves an organizing function in memory that is particularly important for free recall, whereas item-specific information serves a discriminating function that can aid recognition.
- It is important to appreciate, however, that individuals with ASD may also experience difficulties on tests of recognition memory, particularly when such tests require the identification of particular relational details or when recognition of single items might benefit from relational information pertaining to that item.
References


