Autism spectrum conditions affect preferences in valued personal possessions

Penny Spikins, Barry Wright and Callum Scott

University of York

Author Note

Penny Spikins, Department of Archaeology, University of York, UK,

Barry Wright, Department of Health Sciences, University of York, UK

Callum Scott, Department of Archaeology, University of York, UK

This research was supported in part by grants from the Creativity Priming Fund, University of York and the Sir John Templeton Foundation, and the survey was carried out with assistance from the National Autistic Society, UK.

Correspondence concerning this article should be addressed to Penny Spikins, Department of Archaeology, University of York, YORK YO1 7EP, UK

Contact: penny.spikins@york.ac.uk

Abstract

Although autism has been characterised as a *disorder* certain selective advantages of autism have been identified which may represent a selective trade-off for reduced 'folk psychology' and provide a potential explanation for the incorporation of autism genes in the human evolutionary past. Such potential trade-off skills remain to be explored in terms of selectively advantageous or disadvantageous behaviours in the distant past however. Here we present the results of an analysis of the relationship between AQ (autism quotient) and attitudes to valued personal possessions on the basis of a study of 550 participants. We find that individuals with autism have a reduced tendency to value and preserve objects as reminders of relationships/attachment figures and place a greater value on the direct practical function of their personal possessions. The latter strategy may have been more selectively advantageous in certain contexts whilst less advantageous in others in the distant evolutionary past.

Keywords: Autism, autism spectrum condition, selective trade-offs, personal possessions, material culture

Introduction

Autism, typically seen as a disorder, is nonetheless associated with a range of potential 'trade-off' skills which may have been selectively advantageous in certain contexts in the evolutionary past. Though the condition has been described in terms of a balance towards abilities in *'folk physics'* at the expense of *'folk psychology'* (Baron-Cohen, Wheelwright, Spong, et al. 2001), enhanced abilities in autism are known to extend beyond technical skills (Shah and Frith 1993) or realms such as engineering and mathematics (Baron-Cohen et al. 1998; Iuculano et al. 2014) and to include heightened sensory skills, such as olfactory (Lane et al. 2010), vision (H. Smith and Milne 2009), and musical pitch (Heaton 2009) sensitivities. Moreover as well as such enhanced skills over 60% of individuals with autism possess special isolated talents, sometimes called 'savant skills' (Meilleur, Jelenic, and Mottron 2015) such as exceptional calendrical or memory abilities.

Estimates suggest that of the order of 2% of the modern UK and US population have an autism spectrum condition, based on diagnosis of school age children (Baron-Cohen, Scott, et al. 2009; Kim et al. 2011) or adult Autism Quotient (AQ) scores (Ruzich et al. 2015) with similar rates in traits seen cross-culturally (Wakabayashi et al. 2007). Autism without intellectual impairment is not necessarily a disability (Baron-Cohen 2000), with many individuals with autism without intellectual disability occupying positions of esteem and having families and children (Baron-Cohen et al. 1998; Lau and Peterson 2011). Indeed in studies of students at Cambridge for example those within the range suggestive of autism tended to see their autistic traits as valuable and did not complain of any unhappiness (Baron-Cohen, Wheelwright, Skinner, et al. 2001a, 12).

The status of individuals with autism spectrum conditions in the evolutionary past remains unclear however. Arguments for how autism spectrum conditions become part of human diversity tend to be based on generalisations about the condition, such as that individuals with autism will prefer to be alone and thrive as solitary foragers (Reser 2011), or will be particularly focused on tool-making activities (Lomelin 2011). There is no clear consensus on the selection pressures or timing of

inclusion. Thus whilst both Charlton and Rosenkarnz (2016) and Del Giudice et al (2010) argue that autism became more prevalent with the origins of agriculture, Masataka (2016) argues that autism will have become less prevalent in this period as group size and interactions increase. Moreover few studies relate theories to analysis of relevant patterns of behaviour.

A key component of the issue is that autism is more complex than any simple generalisation of being 'less social'. Most individuals with autism are fully socially integrated in society. Moreover whilst complex social understanding is impaired, most adults with autism have sufficient theory of mind abilities to get along socially (Baron-Cohen 1989; Baron-Cohen 2006). Moreover though individuals with autism find complex emotions difficult to identify autism is not simply associated with reduced empathy, as some aspects of empathy (e.g. related to pain) can be intact (Rogers et al. 2007; Bird et al. 2010; Hadjikhani et al. 2014). Likewise there is no necessary reduction in abilities at cheat detection (Rutherford and Ray 2009). Furthermore individuals with autism show a heightened understanding of other people with autism (Komeda et al. 2015) and of animals (Prothmann, Ettrich, and Prothmann 2009).

A limited number of studies of specific behaviours argued to represent evolutionary trade-offs between individuals who have autism compared to those with neurotypical development have been carried out. Research for example shows that individuals with autism are less able to identify angry faces (Wright et al. 2008) Masataka draws on evidence that may be more likely to focus on dangerous animals (2016), and Del Guidice draws on evidence that individuals with autism have higher commitments to partners and less interest in short term mating (2010). Both contrasting patterns of behaviour are seen as trade-off tendencies in the evolutionary past with balanced selection pressures. However the observed behavioural differences are difficult to assess in the evolutionary past.

The question of selective trade-offs has come under greater scrutiny as the genetic record illustrates that individuals with autism *were present* in the human evolutionary past. Certain genes for autism

have been shown to be part of the shared ape genome (Marques-Bonet and Eichler 2009; Dumas et al. 2012; Gualtieri 2014). Nonetheless some key genes, notably 16p11.2 CNV (Nuttle et al. 2016), AUTS2 (Oksenberg et al. 2013) and DNA flanking 15q13.3 (Antonacci et al. 2014) are more recent, approximately pre-dating emergence of modern humans as a species ie prior to 150,000 years ago. The phenotypic expression of autism is not simple, with complex genetic and environmental influences (Eapen 2011) and the presence of around 30% of cases arising through spontaneous mutation, typically associated with autism with intellectual impairment (Ronemus et al. 2014). However it is clear that autism is for the most past highly heritable and subject to some elements of positive selection (Gaugler et al. 2014; Polimanti and Gelernter 2017). Moreover selection through cultural influences has shaped the evolution of autistic traits, and autism has in turn affected human culture (Spikins 2009; Spikins, Wright, and Hodgson 2016a). Understanding the integration of individuals with autism thus demands a biocultural approach (Carroll et al. 2017) which moves beyond a neurological and clinical understanding of autism to behaviours in a wider social context.

Autism and behaviours towards valued personal objects

Here we develop an evolutionary behavioural understanding of the incorporation of individuals with autism in the distant past by considering how autism affects engagement with valued possessions.

Valued objects are highly significant in an evolutionary context, especially given that carrying objects would have been particularly costly in past highly mobile hunter-gatherer societies. The use of valued objects in such societies include not only functioning tools affecting practical survival but also objects which would have affected social ties and reputation (Spikins 2012) as well as those which provided a means of comfort in the absence of loved ones (Lucas A. Keefer et al. 2012/7; L. A. Keefer and Landau 2014). Indeed objects with no direct functional use in terms of survival and purely a social significance start to regularly appear in the archaeological record from around 100,000 years ago. Indeed objects with no direct functional use in terms of survival and purely of social significance start

to regularly appear in the archaeological record from around 100,000 years ago. Identical personal objects to those used by today's San peoples (therefore showing remarkable continuity), include both social and functional items such as stone arrowheads, personally identified bone points, bones with notational marks, ostrich eggshell beads, and marine shell beads and can be seen for example dating to 44,000bp at Border Cave in South Africa (d'Errico et al. 2012). The creation and use of valued items with both social and practical functions were clearly an important part of the cultural repertoire of humans in the distant past with any differences in preferences affecting survival in different contexts.

By understanding how autism affects preferences for valued personal objects in modern contexts we can develop an understanding of how differential selection might have influenced the integration of autism in an evolutionary context. Whilst anecdotal evidence suggests that material things, such as familiar possessions, play different roles in the lives of individuals with autism there has however been little research in this area. Certain lines of research have suggested potential mechanisms by which cognitive differences associated with autism may affect how objects are used and valued. Differences in interpersonal interactions (Dawson et al. 2004; Klin et al. 2009; Chevallier et al. 2012) are well known for example and can affect how infants engage with people or their material world. Some infants with autism prefer to relate to objects rather than people (Swettenham et al. 1998), especially if the object is related to a circumscribed interest (Sasson and Touchstone 2014) and their play with objects is less representational and less social than those without autism (Rowland and Schweigert 2009/4). Sensory processing differences (Kern et al. 2006) and a perceptual focus on detail associated with autism may contribute to a different engagement with the material world. Happé and Frith (2006) for example demonstrate a common focus on detail amongst those with autism which may explain why infants with autism are attracted to details which others often fail to notice, for example numbers on lampposts (Wakabayashi et al. 2007; Baron-Cohen, Ashwin, et al. 2009). Equally the art of talented adults with autism, such as that of Peter Myers (Myers, Baron-Cohen, and Wheelwright 2004) or Stephen Wiltshire (Wiltshire 1991; Wiltshire and Casson 1987) shows *a different vision* in a clear preference for recording and representing precise details. Anecdotal

evidence suggests that constant, structured and familiar material environments including collections and data records can provide a sense of comfort and that collections of objects are a frequent preoccupation (D. J. A. Smith 2009).

Understanding the relationship between autism spectrum conditions and material culture presents challenges, particularly as the significance of certain objects is typically built up over long periods and cannot therefore be easily studied in an experimental setting. Moreover relationships with material objects are often complex. In many cases the observed personal environment of many individuals with autism may not show particularly obvious distinctive features for example, with many individuals with high functioning autism motivated to 'pretend to be normal' (Willey 1999). Underneath the surface, objects may nonetheless be fulfilling different functions in different ways.

Methods

Here, by designing scenarios which test the roles played by particular objects we aimed to understand how individuals differ in the significance they attach to personal objects. We carried out an online survey drawing on participants from a local population via on exhibition and local radio appearance discussing the prehistory of autism, via responses from students at York University, and via dissemination through the National Autistic Society (UK) web site. The survey used a well validated autism spectrum questionnaire termed the autism-spectrum quotient (AQ) alongside a questionnaire designed to elicit an individual's beliefs about, and engagement with, material objects and was approved by the relevant Ethics Committee. The AQ is a self-report measure designed to measure traits on the autism spectrum (Baron-Cohen, Wheelwright, Skinner, et al. 2001b; Woodbury-Smith et al. 2005). It is extensively used and shows large separation between individuals who are neurotypical and those with autism spectrum disorders (Ruzich et al, 2015). It reports five subscales namely social interaction, communication, attention switching, imagination and attention to detail, although some authors suggest that there are two main factors with the first four subscales coming together as a social interaction factor with attention to detail as a second main factor (Hoekstra et al, 2008). Baron-

Cohen and colleagues have determined through a large scale study that an AQ of 32 or above is strongly associated with clinical manifestations of a diagnosis of an autism spectrum condition (Baron-Cohen, Wheelwright, Skinner, et al. 2001b) making this measure a useful proxy for autism. The material objects beliefs and engagement (MOBE) questionnaire was developed for this study by putting together an expert panel of senior clinicians with a long expertise of autism spectrum disorders and researchers with expertise in the field of archaeology and material culture. The questionnaire built on knowledge and experience of how the significance of objects is assessed within a typical population as well as research and consultation with those involved with environments affecting adolescents and adults with autism (for example in disability services within the university environment). It was designed to give the broadest possible view about value judgements in relation to objects. The questionnaire consists of 13 straightforward questions about engagement with and beliefs about objects. Questions related to childhood favourite objects, childhood imaginary friends and significant objects chosen to be saved in a disaster/crisis scenario. Where participants gave examples of objects these were placed into subcategories before analysis was completed. For example, a photograph of a loved one would be categorised in the subcategory of sentimental value/reminder of close relationship rather than functional/practical value. Significance was tested using the chi square test, unless otherwise stated.

550 participants completed the survey. Participants were divided into two groups on the basis of their AQ score: those who exceeded the recommended cut off of 32 that would make them high risk for an autism spectrum condition, here termed AU and those who were below 32 and are low risk, here termed NT. 50 individuals (9.1%) exceeded this threshold for inclusion into the AU group (figure 1).

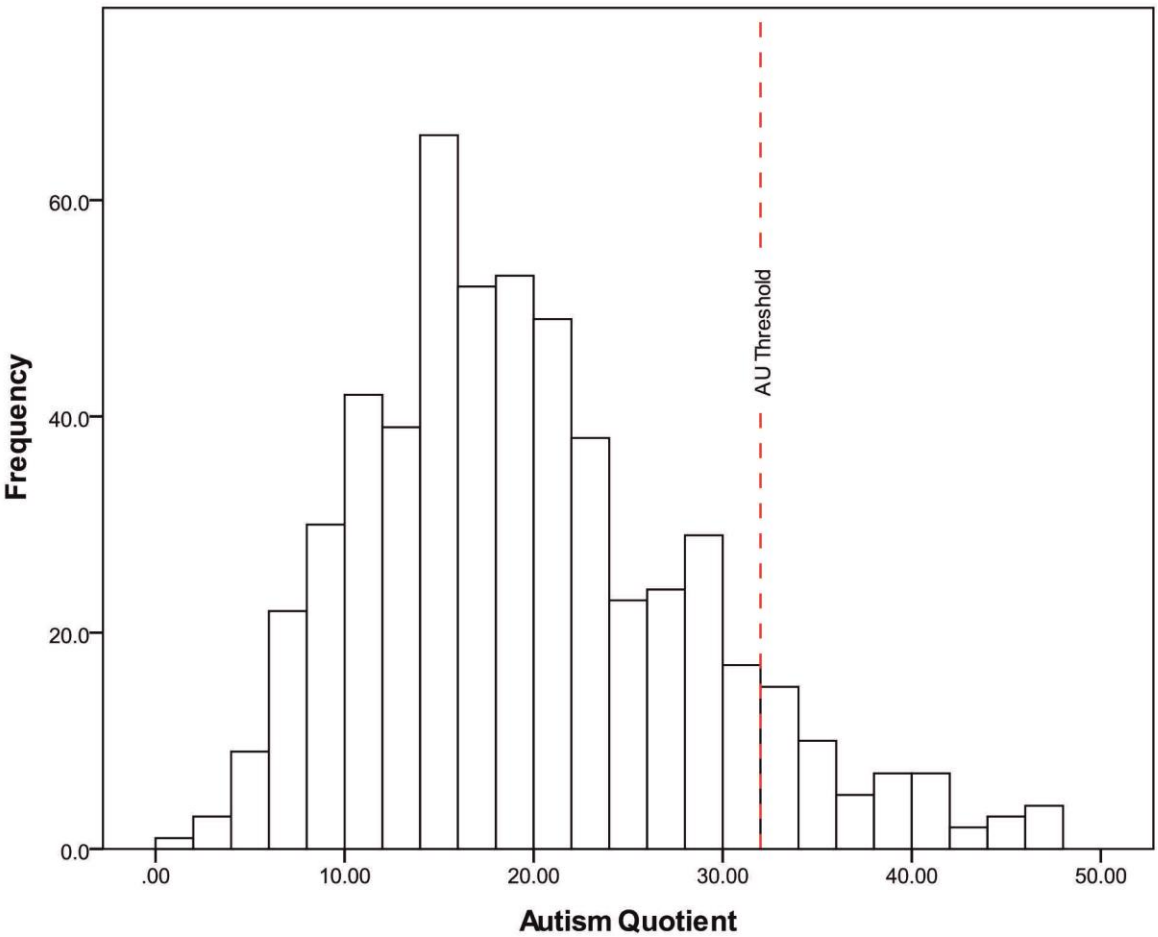

Figure 1. Participants' distribution of scores on the Autism Quotient (AQ) with the threshold for a high risk for autism (AU) participants marked at 32.

Participants were also asked The MOBE questionnaire relating to their engagement with the material world (blind to AQ score).

Results

There was a significant difference is what types of objects participants chose to take with them in a crisis situation involving a fire at home. AU participants selected more *functionally useful objects*, including items such as laptops or objects housing important information. For example an AU participant stated 'I have a personal document file labelled "Take this in case of fire", I would take that' and another AU participant would have taken took their 'Apple Time Capsule [file backup server]' - for computer'. The most popular category of items to take were computer related (41.7%). NT participants on the other hand were more likely to select objects with *purely sentimental value*, including for example photographs of loved ones (17.9%),, treasured teddy bears (7.4%) or other mementoes which were deemed 'irreplaceable' (figure 2) (statistical significance $p = 0.008$). For example one NT participant's single item to rescue from the fire would be their 'family archive of photographs and letters - this includes my Grandad's autobiography and letters he wrote to my Grandma during the war.'

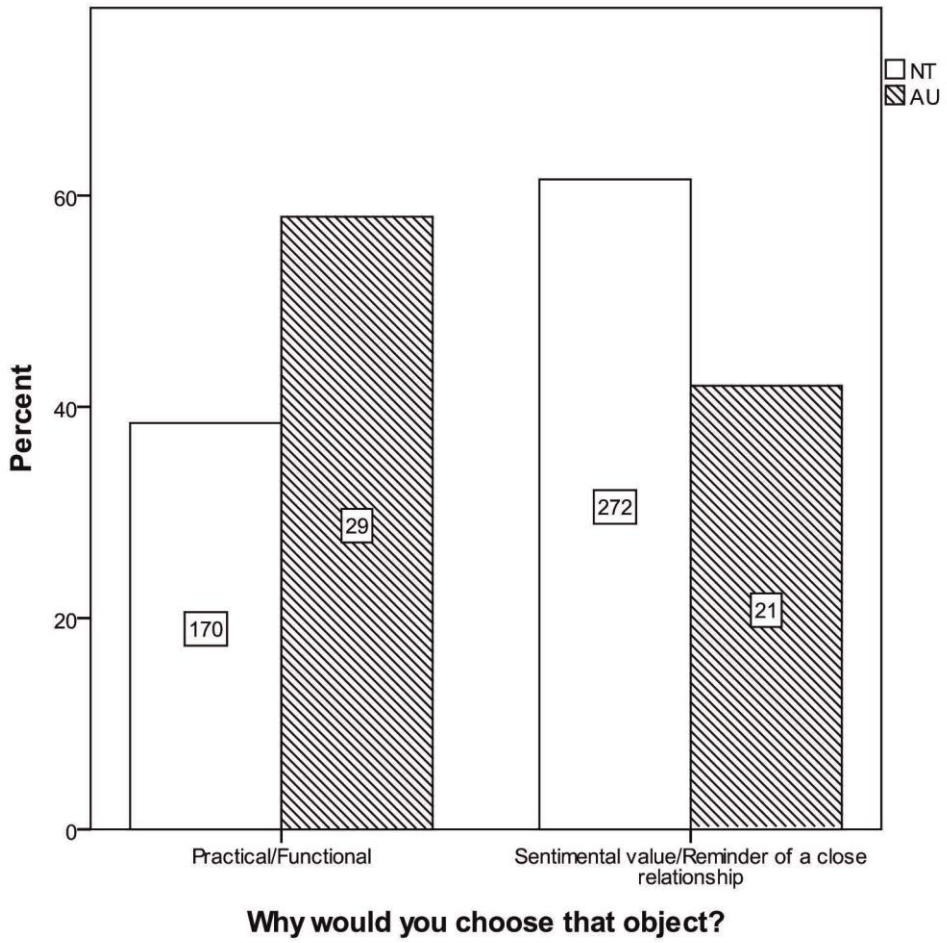

Figure 2. Percentage of participants who chose to take a practical/functional object or an object with purely sentimental value/reminder of a close relationship from a fire at their home.

When asked what objects would be chosen to take with them to a desert island a similar contrast was revealed. AU individuals were again *more likely to select practical/functional objects than objects with sentimental value or reminders of relationships* ($p = 0.041$, figure 3). For example an item commonly selected by AU participants was a computer (14.9%), whilst photos (17.7%) were the most common objects selected by NT participants, followed by companion animals (10.1%). One NT participant chose to take for example 'a locket with photos of my family in it, given to me by my mother'. AU individuals were also more likely to take items that were actively entertaining than items that remind them of people or relationships ($p = 0.022$, figure 9).

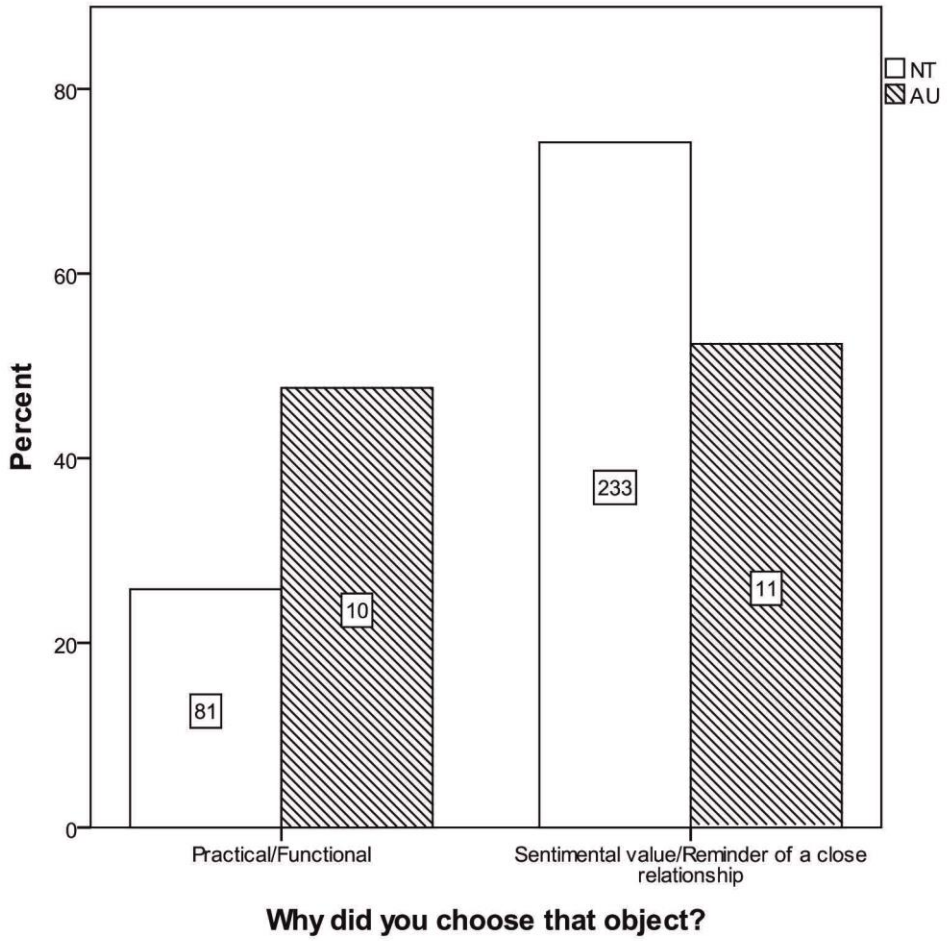

Figure 3. Percentage of participants who would take practical/functional object or an object with purely sentimental value/a reminder of a close relationship with them to the desert island.

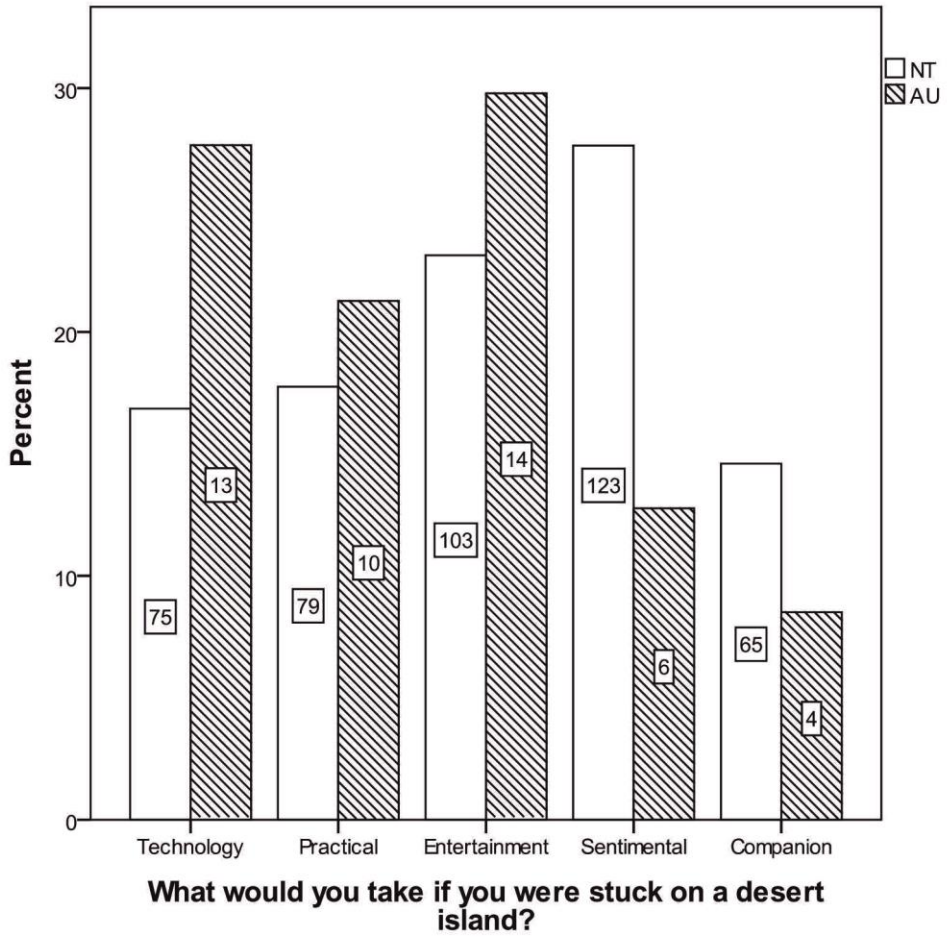

Figure 4. Categories of objects participants would take with them to a desert island.

Those AU participants who still owned their favourite object from their childhood were more likely than NT participants to still use that object, rather than have their object stored away out of use (p = 0.049, figure 5). Specific aesthetic or sensory aspects were often significant for example 'Cuddly Red Panda hand puppet... [like it because] it was unusual and had striking blue eyes' or 'Satin edging from a cot blanket ('Blue Blanket')... [like it because] texture (both on hands and mouthfeel), smell, taste, colour.' or 'My fuzzy (stuffed animal) cat... [liked it because] it was my friend. I could talk to it, even when talking to people was hard.'

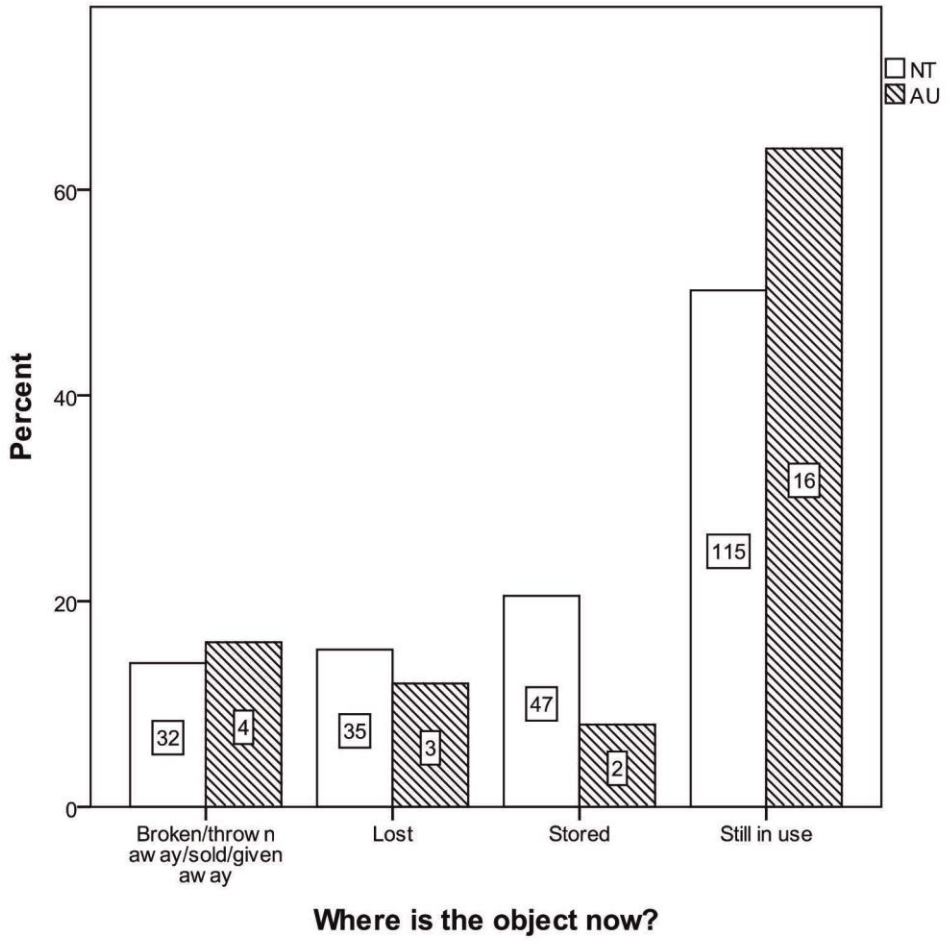

Figure 5. Present location of favourite childhood objects.

Discussion

We found that differences in attachment to functionally useful objects or socially significant reminders of others and the relative values placed on different types of objects reflect a balance in preferences between neurotypical individuals and those with autism. These findings are supported by research on responses to words. Significant differences have been found between individuals with autism and those who are neurotypical in their neurological responses to the words 'hug' and 'adore' for example, with neurotypical individuals responding in terms of a self-referential and emotional response whilst individuals with autism responding neurologically to the physical (impersonal semantic abstract-physical) properties of these words (Just et al. 2014). Similar neurological responses were however recorded between individuals with autism and neurotypical individuals to words related to tools or buildings (Shinkareva et al. 2008). Whilst the cognitive basis of such preferences remains to be fully understood there are clear behavioural implications for how individuals with autism relate to language and to material culture.

Implications in an evolutionary context

In the hunting and gathering societies of the distant past success, survival and reproduction will have depended directly on both the practical economics of existence (finding food, shelter etc) and indirectly on social interactions or one's *social standing*. Survival outside of a social group would have been unlikely, particularly in the context of predation (Camarós et al. 2015). Moreover, food sharing is central to hunter-gatherer adaptations, with even the most able individuals sometimes dependant on others for food or care and so dependant on their accumulated social reputation (Spikins 2012; Spikins, Wright, and Hodgson 2016a). Amongst the Ache for example even the least vulnerable of the population, adult males, are too ill or injured to hunt and dependant on others for support around a third of the time (Gurven et al. 2000). Perhaps unsurprisingly costly signals of positive social reputation appear from at least 1.8 million years ago in both extended direct care of the injured or

vulnerable and in non-functional attention to aesthetics in tool forms (Spikins 2015).

The survival advantages of valuing and choosing to retain or rescue in a crisis those objects which have either an immediate practical or an indirect emotional value in the distant past will have varied depending on context. Personal hunting gear and other essential items are likely to be carried at all times. However choices will have been made about which other objects are transported and which are left behind. If survival is truly at stake then the increased availability of functioning weapons, tools, containers for water etc may be the difference between life and death, and the extra costs of carrying objects with only an emotional significance may be a serious constraint. However valuing objects with an emotional significance acts as a sign of emotional commitment, and objects which act as reminders of loved ones improve security and emotional resilience (L. A. Keefer and Landau 2014). There are likely to have been different contexts in which different tendencies to look after and value different types of objects may be selectively advantageous. Equally it seems likely that a process of group selection whereby groups with diverse approaches better able to cope in crisis than those with single approach (and commonly valued objects). Considering both individual and group level selection it isn't difficult to see how individuals with a functional approach to valued objects would have a role as much as those who had a greater tendency to place the most value in non-functional things. Moreover examples exist within anthropological accounts of distinctive individuals with autistic traits who bring a unique knowledge and understanding to their societies (Spikins, Wright, and Hodgson 2016b).

Examples taken from a specific element of hunter-gatherer material culture in the distant past - European Magdalenian portable art (dating to around 17-12,000 years ago ie during the last ice age) - illustrates this point. Hunter-gatherers in the Magdalenian period were highly mobile, particularly as these groups were typically heavily dependant on migrating reindeer and any objects carried will have incurred a energy costs. Nonetheless portable art thrives in this period. Though much art appears as a pragmatic embellishment of functional objects (such as spear throwers), many portable art items are of no direct functional use but rather are highly symbolic, show exceptional artistic skill and may act

to improve social reputation or as an emotional support, likely to be part of complex myths and narratives. A small percentage of portable objects are in contrast however not aesthetically pleasing but a source of detailed practical information, analogous to modern data storage devices. Small pieces of bone have been used to record the phases of the moon and its position in the sky for example (Hayden and Villeneuve 2011). There are also examples of maps. One particular example comes from Abauntz cave in northern Spain (Utrilla et al. 2009). This pebble is engraved with a clearly defined map of the surroundings, showing the location of specific topographic features, as well as mountain passes, the locations of typical game animals and marshes. Both types of 'art' object have their uses with mobility pressures constraining what could be transported. It isn't difficult to imagine however that at certain times practical information of a detailed nature is of greater survival value than objects apparently linked to real or imagined beings and at other times the converse is true. Moreover groups which include within them a diversity of approaches to personal objects are likely to be able to draw on differing possibilities to react to challenges and solve problems using material things and as a result have been more resilient than those with only very similar approaches and attitudes.

Differential preferences for personal possessions illustrate a significant mechanism through which differing cultural, social and ecological pressures will have interacted with the varying spectrum of traits of autism across hunter-gatherer populations in the distant past to drive a dynamic process of selection.

Implications for policy and practice

There are also implications in terms of policy and practice in relation to individuals with autism. Most particularly a normative model of what types of objects should provide comfort to neurotypical children and adults may not be most appropriate for individuals with autism. Understanding that sensory processing may be different in children with autism (Marco et al. 2011) and that this impacts upon relationships with objects of attachment and security (Kalpidou 2012) is relevant to practice.

In cases of children requiring intensive support, encouraging an understanding of the significance of functional objects in their lives may be more appropriate than attempting to encourage a 'normal' attachment to reminders of loved ones. Functional objects may be 'a point of reliability in a chaotic world' (words of an anonymous adult with autism). The case of Ben Carter, a UK teenager with severe autism who inspired international media attention when he nearly died of dehydration as his usual Tommy Tippee cup was broken, vividly illustrates the importance of understanding how significant the world of functioning objects can be for example.

In the case of adults within society, improved understanding may provide for better sources of support, and more comforting and secure environments. Providing new functional items of the latest style or design may not be as desirable and maintaining old, familiar and functioning items for example. We should not necessarily expect that adults with autism *should* find photographs or mementoes of loved ones reassuring, and understand that functional objects from childhood may carry a far greater significance than might be expected. Similarly children with autism in stressful situations (e.g. requiring hospital treatment) may be calmed by very different objects (e.g. a rubber band or electronic device) than a neurotypical child (e.g. a cuddly toy).

Conclusions

Despite substantial research interest in autism there has been a relative lack of research into behaviours which represent selective trade-offs to autistic traits in the evolutionary past. Such behaviours are key to understanding the evolutionary integration of autism into human societies. One such area of research exploration relates to interactions with objects. Here we present new evidence of differential preferences towards valuing and preserving personal objects which are reminders of loved ones or close relationships or serve clear practical functions between neurotypical and autistic individuals. By considering a novel realm of behaviour, that of relationships to material culture, we also crucially open up the possibility of developing evolutionary hypotheses with the potential to be testable against the preserved material record of hunting and gathering societies in the distant past.

References

Antonacci, Francesca, Megan Y. Dennis, John Huddleston, Peter H. Sudmant, Karyn Meltz Steinberg, Jill A. Rosenfeld, Mattia Miroballo, et al. 2014. "Palindromic GOLGA8 Core Duplicons Promote Chromosome 15q13. 3 Microdeletion and Evolutionary Instability." *Nature Genetics* 46 (12). Nature Publishing Group: 1293–1302.

Baron-Cohen, Simon. 1989. "The Autistic Child's Theory of Mind: A Case of Specific Developmental Delay." *Journal of Child Psychology and Psychiatry, and Allied Disciplines* 30 (2): 285–97.

———. 2000. "Is Asperger Syndrome/high-Functioning Autism Necessarily a Disability?" *Development and Psychopathology* 12 (3): 489–500.

———. 2006. "The Hyper-Systemizing, Assortative Mating Theory of Autism." *Progress in Neuro-Psychopharmacology & Biological Psychiatry* 30 (5): 865–72.

Baron-Cohen, Simon, Emma Ashwin, Chris Ashwin, Teresa Tavassoli, and Bhismadev Chakrabarti. 2009. "Talent in Autism: Hyper-Systemizing, Hyper-Attention to Detail and Sensory Hypersensitivity." *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 364 (1522): 1377–83.

Baron-Cohen, Simon, Patrick Bolton, Sally Wheelwright, Victoria Scahill, Liz Short, Genevieve Mead, and Alex Smith. 1998. "Autism Occurs More Often in Families of Physicists, Engineers, and Mathematicians." *Autism: The International Journal of Research and Practice* 2 (3). Citeseer: 296–301.

Baron-Cohen, Simon, Fiona J. Scott, Carrie Allison, Joanna Williams, Patrick Bolton, Fiona E. Matthews, and Carol Brayne. 2009. "Prevalence of Autism-Spectrum Conditions: UK School-Based Population Study." *The British Journal of Psychiatry: The Journal of Mental Science* 194 (6): 500–509.

Baron-Cohen, Simon, Sally Wheelwright, Richard Skinner, Joanne Martin, and Emma Clubley.

2001a. “The Autism-Spectrum Quotient (AQ): Evidence from Asperger Syndrome/High-Functioning Autism, Males and Females, Scientists and Mathematicians.” *Journal of Autism and Developmental Disorders* 31 (1). Kluwer Academic Publishers-Plenum Publishers: 5–17.

———. 2001b. “The Autism-Spectrum Quotient (AQ): Evidence from Asperger Syndrome/High-Functioning Autism, Malesand Females, Scientists and Mathematicians.” *Journal of Autism and Developmental Disorders* 31 (1). Kluwer Academic Publishers-Plenum Publishers: 5–17.

Baron-Cohen, Simon, Sally Wheelwright, Amanda Spong, Victoria Scahill, John Lawson, and Others. 2001. “Are Intuitive Physics and Intuitive Psychology Independent? A Test with Children with Asperger Syndrome.” *Journal of Developmental and Learning Disorders* 5 (1). academia.edu: 47–78.

Bird, Geoffrey, Giorgia Silani, Rachel Brindley, Sarah White, Uta Frith, and Tania Singer. 2010. “Empathic Brain Responses in Insula Are Modulated by Levels of Alexithymia but Not Autism.” *Brain: A Journal of Neurology* 133 (Pt 5): 1515–25.

Camarós, Edgard, Marián Cueto, Carlos Lorenzo, Valentín Villaverde, and Florent Rivals. 2015. “Large Carnivore Attacks on Hominins during the Pleistocene: A Forensic Approach with a Neanderthal Example.” *Archaeological and Anthropological Sciences*, May. Springer Berlin Heidelberg, 1–12.

Carroll, Joseph, Mathias Clasen, Emelie Jonsson, Alexandra Regina Kratschmer, Luseadra McKerracher, Felix Riede, Jens-Christian Svenning, and Peter C. Kjærgaard. 2017. “Biocultural Theory: The Current State of Knowledge.” *Evolutionary Behavioral Sciences* 11 (1). Educational Publishing Foundation: 1.

Charlton, Bruce, and Patrick Rosenkranz. 2016. “Evolution of Empathizing and Systemizing: Empathizing as an Aspect of Social Intelligence, Systemizing as an Evolutionarily Later Consequence of Economic Specialization.” *The Winnower* April 20th 2016.

Chevallier, Coralie, Gregor Kohls, Vanessa Troiani, Edward S. Brodkin, and Robert T. Schultz. 2012. “The Social Motivation Theory of Autism.” *Trends in Cognitive Sciences* 16 (4): 231–39.

Dawson, Geraldine, Karen Toth, Robert Abbott, Julie Osterling, Jeff Munson, Annette Estes, and Jane Liaw. 2004. “Early Social Attention Impairments in Autism: Social Orienting, Joint Attention,

and Attention to Distress." *Developmental Psychology* 40 (2): 271–83.

Del Giudice, Marco, Romina Angeleri, Adelina Brizio, and Marco R. Elena. 2010. "The Evolution of Autistic-like and Schizotypal Traits: A Sexual Selection Hypothesis." *Frontiers in Psychology* 1 (August): 41.

Dumas, Laura J., Majesta S. O'Bleness, Jonathan M. Davis, C. Michael Dickens, Nathan Anderson, J. G. Keeney, Jay Jackson, et al. 2012. "DUF1220-Domain Copy Number Implicated in Human Brain-Size Pathology and Evolution." *American Journal of Human Genetics* 91 (3): 444–54.

Eapen, Valsamma. 2011. "Genetic Basis of Autism: Is There a Way Forward?" *Current Opinion in Psychiatry* 24 (3): 226–36.

Errico, Francesco d', Lucinda Backwell, Paola Villa, Ilaria Degano, Jeannette J. Lucejko, Marion K. Bamford, Thomas F. G. Higham, Maria Perla Colombini, and Peter B. Beaumont. 2012. "Early Evidence of San Material Culture Represented by Organic Artifacts from Border Cave, South Africa." *Proceedings of the National Academy of Sciences of the United States of America* 109 (33): 13214–19.

Gaugler, Trent, Lambertus Klei, Stephan J. Sanders, Corneliu A. Bodea, Arthur P. Goldberg, Ann B. Lee, Milind Mahajan, et al. 2014. "Most Genetic Risk for Autism Resides with Common Variation." *Nature Genetics* 46 (8): 881–85.

Gualtieri, C. Thomas. 2014. "Autism and Schizophrenia Are Disorders of Evolvability." *Open Journal of Medical Psychology* 2014. Scientific Research Publishing. http://file.scirp.org/Html/7-2250080_42577.htm.

Gurven, M., W. Allen-Arave, K. Hill, and M. Hurtado. 2000. "'It's a Wonderful Life'. Signaling Generosity among the Ache of Paraguay." *Evolution and Human Behavior: Official Journal of the Human Behavior and Evolution Society* 21 (4): 263–82.

Hadjikhani, N., N. R. Zürcher, O. Rogier, L. Hippolyte, E. Lemonnier, T. Ruest, N. Ward, et al. 2014. "Emotional Contagion for Pain Is Intact in Autism Spectrum Disorders." *Translational Psychiatry* 4 (January): e343.

Happé, Francesca, and Uta Frith. 2006. "The Weak Coherence Account: Detail-Focused Cognitive Style in Autism Spectrum Disorders." *Journal of Autism and Developmental Disorders* 36 (1):

5–25.

Hayden, Brian, and Suzanne Villeneuve. 2011. “Astronomy in the Upper Palaeolithic?” *Cambridge Archaeological Journal* 21 (03). Cambridge University Press: 331–55.

Heaton, Pamela. 2009. “Assessing Musical Skills in Autistic Children Who Are Not Savants.” *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* 364 (1522): 1443–47.

Iuculano, Teresa, Miriam Rosenberg-Lee, Kaustubh Supekar, Charles J. Lynch, Amirah Khouzam, Jennifer Phillips, Lucina Q. Uddin, and Vinod Menon. 2014. “Brain Organization Underlying Superior Mathematical Abilities in Children with Autism.” *Biological Psychiatry* 75 (3): 223–30.

Just, Marcel Adam, Vladimir L. Cherkassky, Augusto Buchweitz, Timothy A. Keller, and Tom M. Mitchell. 2014. “Identifying Autism from Neural Representations of Social Interactions: Neurocognitive Markers of Autism.” *PloS One* 9 (12): e113879.

Kalpidou, Maria. 2012. “Sensory Processing Relates to Attachment to Childhood Comfort Objects of College Students.” *Early Child Development and Care* 182 (12): 1563–74.

Keefer, L. A., and M. J. Landau. 2014. “Non- human Support: Broadening the Scope of Attachment Theory.” *Social and Personality Psychology Compass*. Wiley Online Library. http://onlinelibrary.wiley.com/doi/10.1111/spc3.12129/full.

Keefer, Lucas A., Mark J. Landau, Zachary K. Rothschild, and Daniel Sullivan. 2012/7. “Attachment to Objects as Compensation for Close Others’ Perceived Unreliability.” *Journal of Experimental Social Psychology* 48 (4): 912–17.

Kern, Janet K., Madhukar H. Trivedi, Carolyn R. Garver, Bruce D. Grannemann, Alonzo A. Andrews, Jayshree S. Savla, Danny G. Johnson, Jyutika A. Mehta, and Jennifer L. Schroeder. 2006. “The Pattern of Sensory Processing Abnormalities in Autism.” *Autism: The International Journal of Research and Practice* 10 (5): 480–94.

Kim, Young Shin, Bennett L. Leventhal, Yun-Joo Koh, Eric Fombonne, Eugene Laska, Eun-Chung Lim, Keun-Ah Cheon, et al. 2011. “Prevalence of Autism Spectrum Disorders in a Total Population Sample.” *The American Journal of Psychiatry* 168 (9). Am Psychiatric Assoc: 904–12.

Klin, Ami, David J. Lin, Phillip Gorrindo, Gordon Ramsay, and Warren Jones. 2009. “Two-Year-Olds with Autism Orient to Non-Social Contingencies rather than Biological Motion.” *Nature* 459 (7244): 257–61.

Komeda, Hidetsugu, Hirotaka Kosaka, Daisuke N. Saito, Yoko Mano, Minyoung Jung, Takeshi Fujii, Hisakazu T. Yanaka, et al. 2015. “Autistic Empathy toward Autistic Others.” *Social Cognitive and Affective Neuroscience* 10 (2): 145–52.

Lane, Alison E., Robyn L. Young, Amy E. Z. Baker, and Manya T. Angley. 2010. “Sensory Processing Subtypes in Autism: Association with Adaptive Behavior.” *Journal of Autism and Developmental Disorders* 40 (1): 112–22.

Lau, Winnie, and Candida C. Peterson. 2011. “Adults and Children with Asperger Syndrome: Exploring Adult Attachment Style, Marital Satisfaction and Satisfaction with Parenthood.” *Research in Autism Spectrum Disorders* 5 (1): 392–99.

Lomelin, Daniel E. 2011. “An Examination of Autism Spectrum Disorders in Relation to Human Evolution and Life History Theory,” Nebraska Anthropologist, , February. http://digitalcommons.unl.edu/nebanthro/57/.

Marco, Elysa J., Leighton B. N. Hinkley, Susanna S. Hill, and Srikantan S. Nagarajan. 2011. “Sensory Processing in Autism: A Review of Neurophysiologic Findings.” *Pediatric Research* 69 (5 Pt 2): 48R – 54R.

Marques-Bonet, T., and E. E. Eichler. 2009. “The Evolution of Human Segmental Duplications and the Core Duplicon Hypothesis.” *Cold Spring Harbor Symposia on Quantitative Biology* 74 (August): 355–62.

Masataka, Nobuo. 2016. “Implications of the Idea of Neurodiversity for Understanding the Origins of Developmental Disorders.” *Physics of Life Reviews*, November. doi:10.1016/j.plrev.2016.11.002.

Meilleur, Andrée-Anne S., Patricia Jelenic, and Laurent Mottron. 2015. “Prevalence of Clinically and Empirically Defined Talents and Strengths in Autism.” *Journal of Autism and Developmental Disorders* 45 (5): 1354–67.

Myers, P., S. Baron-Cohen, and S. Wheelwright. 2004. *An Exact Mind: An Artist with Asperger Syndrome*. Jessica Kingsley.

Nuttle, Xander, Giuliana Giannuzzi, Michael H. Duyzend, Joshua G. Schraiber, Iñigo Narvaiza, Peter H. Sudmant, Osnat Penn, et al. 2016. “Emergence of a Homo Sapiens-Specific Gene Family and Chromosome 16p11.2 CNV Susceptibility.” *Nature* 536 (7615): 205–9.

Oksenberg, Nir, Laurie Stevison, Jeffrey D. Wall, and Nadav Ahituv. 2013. “Function and Regulation of AUTS2, a Gene Implicated in Autism and Human Evolution.” *PLoS Genetics* 9 (1): e1003221.

Polimanti, Renato, and Joel Gelernter. 2017. “Widespread Signatures of Positive Selection in Common Risk Alleles Associated to Autism Spectrum Disorder.” *PLoS Genetics* 13 (2): e1006618.

Prothmann, Anke, Christine Ettrich, and Sascha Prothmann. 2009. “Preference For, and Responsiveness To, People, Dogs and Objects in Children with Autism.” *Anthrozoös* 22 (2): 161–71.

Reser, Jared Edward. 2011. “Conceptualizing the Autism Spectrum in Terms of Natural Selection and Behavioral Ecology: The Solitary Forager Hypothesis.” *Evolutionary Psychology: An International Journal of Evolutionary Approaches to Psychology and Behavior* 9 (2): 207–38.

Rogers, Kimberley, Isabel Dziobek, Jason Hassenstab, Oliver T. Wolf, and Antonio Convit. 2007. “Who Cares? Revisiting Empathy in Asperger Syndrome.” *Journal of Autism and Developmental Disorders* 37 (4): 709–15.

Ronemus, Michael, Ivan Iossifov, Dan Levy, and Michael Wigler. 2014. “The Role of de Novo Mutations in the Genetics of Autism Spectrum Disorders.” *Nature Reviews. Genetics* 15 (2): 133–41.

Rowland, Charity M., and Philip D. Schweigert. 2009/4. “Object Lessons: How Children with Autism Spectrum Disorders Use Objects to Interact with the Physical and Social Environments.” *Research in Autism Spectrum Disorders* 3 (2): 517–27.

Rutherford, M. D., and Darrien Ray. 2009. “Cheater Detection Is Preserved in Autism Spectrum Disorders.” *Journal of Social, Evolutionary & Cultural Psychology: JSEC* 3 (2). NorthEastern Evolutionary Psychology Society: 105.

Ruzich, Emily, Carrie Allison, Paula Smith, Peter Watson, Bonnie Auyeung, Howard Ring, and

Simon Baron-Cohen. 2015. “Measuring Autistic Traits in the General Population: A Systematic Review of the Autism-Spectrum Quotient (AQ) in a Nonclinical Population Sample of 6,900 Typical Adult Males and Females.” *Molecular Autism* 6 (1). BioMed Central Ltd: 2.

Sasson, Noah J., and Emily W. Touchstone. 2014. “Visual Attention to Competing Social and Object Images by Preschool Children with Autism Spectrum Disorder.” *Journal of Autism and Developmental Disorders* 44 (3): 584–92.

Shah, A., and U. Frith. 1993. “Why Do Autistic Individuals Show Superior Performance on the Block Design Task?” *Journal of Child Psychology and Psychiatry, and Allied Disciplines* 34 (8): 1351–64.

Shinkareva, Svetlana V., Robert A. Mason, Vicente L. Malave, Wei Wang, Tom M. Mitchell, and Marcel Adam Just. 2008. “Using FMRI Brain Activation to Identify Cognitive States Associated with Perception of Tools and Dwellings.” *PloS One* 3 (1): e1394.

Smith, Dr Jacqui Ashton. 2009. “Helping Pupils with Autism.” *SECED Newsletter* 2009 (3): null.

Smith, Hayley, and Elizabeth Milne. 2009. “Reduced Change Blindness Suggests Enhanced Attention to Detail in Individuals with Autism.” *Journal of Child Psychology and Psychiatry, and Allied Disciplines* 50 (3): 300–306.

Spikins, Penny. 2009. “Autism, the Integrations of ‘difference’and the Origins of Modern Human Behaviour.” *Cambridge Archaeological Journal* 19 (02). Cambridge Univ Press: 179–201.

———. 2012. “Goodwill Hunting? Debates over the ‘meaning’of Lower Palaeolithic Handaxe Form Revisited.” *World Archaeology* 44 (3). Taylor & Francis: 378–92.

———. 2015. *How Compassion Made Us Human: The Evolutionary Origins of Tenderness, Trust and Morality*. Pen and Sword.

Spikins, Penny, Barry Wright, and Derek Hodgson. 2016a. “Are There Alternative Adaptive Strategies to Human pro-Sociality? The Role of Collaborative Morality in the Emergence of Personality Variation and Autistic Traits.” *Time and Mind* 9 (4): 289–313.

———. 2016b. “Are There Alternative Adaptive Strategies to Human pro-Sociality? The Role of Collaborative Morality in the Emergence of Personality Variation and Autistic Traits.” *Time and Mind: The Journal of Archaeology, Consciousness and Culture*.

Swettenham, J., S. Baron-Cohen, T. Charman, A. Cox, G. Baird, A. Drew, L. Rees, and S. Wheelwright. 1998. "The Frequency and Distribution of Spontaneous Attention Shifts between Social and Nonsocial Stimuli in Autistic, Typically Developing, and Nonautistic Developmentally Delayed Infants." *Journal of Child Psychology and Psychiatry, and Allied Disciplines* 39 (5): 747–53.

Utrilla, P., C. Mazo, M. C. Sopena, M. Martínez-Bea, and R. Domingo. 2009. "A Palaeolithic Map from 13,660 calBP: Engraved Stone Blocks from the Late Magdalenian in Abauntz Cave (Navarra, Spain)." *Journal of Human Evolution* 57 (2): 99–111.

Wakabayashi, Akio, Simon Baron-Cohen, Tokio Uchiyama, Yuko Yoshida, Miho Kuroda, and Sally Wheelwright. 2007. "Empathizing and Systemizing in Adults with and without Autism Spectrum Conditions: Cross-Cultural Stability." *Journal of Autism and Developmental Disorders* 37 (10): 1823–32.

Willey, Liane Holliday. 1999. *Pretending to Be Normal: Living with Asperger's Syndrome*. Jessica Kingsley Publishers.

Wiltshire, Stephen. 1991. *Floating Cities: Venice, Amsterdam, Leningrad, and Moscow*. Michael Joseph.

Wiltshire, Stephen, and Hugh Maxwell Sir Casson. 1987. *Drawings*. Dent.

Woodbury-Smith, M. R., J. Robinson, S. Wheelwright, and S. Baron-Cohen. 2005. "Screening Adults for Asperger Syndrome Using the AQ: A Preliminary Study of Its Diagnostic Validity in Clinical Practice." *Journal of Autism and Developmental Disorders* 35 (3): 331–35.

Wright, Barry, Natalie Clarke, Jo Jordan, Andrew W. Young, Paula Clarke, Jeremy Miles, Kate Nation, Leesa Clarke, and Christine Williams. 2008. "Emotion Recognition in Faces and the Use of Visual Context in Young People with High-Functioning Autism Spectrum Disorders." *Autism: The International Journal of Research and Practice* 12 (6): 607–26.