



## Systemizing and special interests: Characterizing the continuum from neurotypical to autism spectrum disorder



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### ABSTRACT

Special interests have been studied in children with autism spectrum disorder (ASD) but not in adults. Using an online survey, it was found that individuals with ASD reported more intense interests in systemizable domains, relative to neurotypical adults. Self-reported systemizing preference was correlated with intensity of interest in systemizable domains both for those with ASD and for neurotypical young adults. Few gender differences were found in the neurotypical group in the expected categories of machines, technology and vehicles, where gender differences have been found in children. Gender differences in these categories did appear for the ASD group. We propose a strength-based model of special interests, with the hobbies of neurotypical forming a continuum with the special interests of ASD.

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### 1. Introduction

Among individuals with Asperger syndrome, repetitive behaviors often occur in the form of intense interests which may be considered unusual or atypical in their content (e.g., World War II airplanes; see Asperger, 1991; Attwood, 2003; Winter-Messiers, 2007). These are sometimes called restricted or circumscribed interests (e.g., Klin, Danovitch, Merz, & Volkmar, 2007). Following Winter-Messiers (2007), we use the term “special interests” because it promotes a strength-based approach and it is also the term most frequently used by individuals on the Internet discussion forums from which we recruited survey participants in the current study. We describe and defend the view that special interests are not primarily repetitive behaviors, but reflect information processing styles and cognitive strengths (Baron-Cohen, 2002). The interests and hobbies of neurotypical individuals (i.e., those without ASD, Attwood, 1998; Winter-Messiers, 2007) frequently reflect individuals' cognitive-personality styles, and we thus propose that the special interests of those with Asperger syndrome or on the autism spectrum lie on a continuum with neurotypical hobbies. This leads to two primary hypotheses: (1) that the content of special interests exists on a continuum between neurotypical individuals and individuals with autism spectrum disorder (ASD), and (2) that special interests reflect information processing styles, such that the interests of individuals with ASD are correlated with systemizing ability, and interests of neurotypicals with mentalizing ability, as measured by the Systemizing Quotient (Wheelwright et al.,

2006) and the Reading the Mind in the Eyes Test (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001).

Past research has focused primarily on the special interests of children with autism spectrum disorder (ASD), who develop these interests as early as 1–4 years of age (Attwood, 2003; Bashe & Kirby, 2001; Moore & Goodson, 2003), although some interests cannot be reliably scored on certain assessments until age 4 (Moore & Goodson, 2003). Approximately 75–90% of individuals with mild to moderate autism or Asperger syndrome develop one or more special interests (Bashe & Kirby, 2001; Klin et al., 2007). Other individuals on the autism spectrum, including those with PDD-NOS (Sturm, Fernell, & Gillberg, 2004) and Rett syndrome (Mazzocco et al., 1998), also exhibit intense interests.

Special interests are often manifested in efforts to collect objects or information relevant to the interest area, which can require extensive amounts of time (Bashe & Kirby, 2001). Parents often find special interests the most difficult to accommodate of autistic behaviors due to their intensity (Mercier, Mottron, & Belleville, 2000). Unlike other behaviors, special interests do not lessen with age (Fecteau, Mottron, Berthiaume, & Burack, 2003) and the number of interests may increase as the individual approaches adulthood (Bashe & Kirby, 2001).

Among children with ASD, special interests often reflect exceptional abilities, such as systemizing and heightened attention to detail. Systemizing is the drive to explore, analyze, and construct systems (Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003). Domains that are amenable to systemizing are rule-based and predictable, facilitating detection of input-operation-output relationships (Baron-Cohen, Ashwin, Ashwin, Tavassoli, & Chakrabarti, 2009). The special interests of children with ASD frequently occur in systemizable

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domains, such as in mechanical, collectible, natural, and numerical systems (Baron-Cohen & Wheelwright, 1999).

Neurotypical (NT) individuals also develop special interests. While up to 90% of individuals with ASD develop special interests (Bashe & Kirby, 2001; Klin et al., 2007), about 30% of NT children develop an “extremely intense interest” (DeLoache, Simcock, & Macari, 2007). Special interests in NT children may appear as early as 1–2 years of age. Like children with ASD, the special interests of NT children reflect their cognitive strengths. NT children are often preoccupied by interests in people, imaginative play, and the social environment more broadly (Attwood, 2003; DeLoache et al., 2007). These interests are consistent with strong mentalizing ability (i.e., the capacity to understand and attribute mental states to others, Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Frith, Morton, & Leslie, 1991). While individuals with ASD often have higher systemizing ability than NT individuals (Baron-Cohen et al., 2003), NT individuals generally have higher mentalizing abilities (Baron-Cohen, Wheelwright, Hill, et al., 2001; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). Furthermore, NT females tend to have higher mentalizing ability than NT males (Baron-Cohen, Wheelwright, Hill, et al., 2001; Baron-Cohen, Wheelwright, Skinner, et al., 2001), while NT males generally have higher systemizing ability than NT females (Baron-Cohen et al., 2003).

Little is currently known about special interests in adulthood. Understanding adults' special interests is important for illuminating the positive role that interests play in adult life, such as rewarding careers (Attwood, 2003; Grandin & Duffy, 2008; Jackson, 2002). No studies yet compare the interests of individuals with ASD to those of NT individuals. The current study examines the content of special interests held by adults with ASD and NT adults, with the expectation that individuals with ASD will hold more intense interests in domains previously identified as systemizable, such as machines and technology, sorting, categorizing, and organizing, factual and numerical information, collecting, and the sciences. We also expect that NT individuals will hold more intense interests in mentalizing domains, such as in people and sports and games (as discussion of sports fosters social affiliation, see Mueller, Agamanolis, & Picard, 2003). The current study will also assess participants' systemizing and mentalizing abilities, with the goal of identifying whether interest categories previously identified as systemizable correlate with high systemizing ability, and likewise whether interest categories expected to rely on mentalizing correlate with high mentalizing ability. By identifying cognitive abilities that contribute to special interests, we hope to develop a strength-based continuum model of special interests, where the interests of individuals with ASD and NT individuals coexist and vary depending on systemizing and mentalizing ability (see Fig. 3 and Discussion section). A strength-based model of special interests can inform the development of educational and therapeutic programs that capitalize on individual abilities and use special interests as a medium for learning other important skills.

We also hope to better understand gender differences in special interests. Winter-Messiers (2007) reported that ASD girls were more likely than boys to have more neurotypical interests, such as a 10-year-old girl being interested in horses. Attwood (2003) also noted ASD girls' intense interests in dolls, animals and fiction, but remarked on some aberrant qualities of these interests. Girls didn't use their dolls to play with others, but would self-play with a large doll collection. An interest in animals could become consuming; girls would want to act like animals, or to sleep in a stable. Interests in fiction included collecting and wanting to contact the author. The focus of the writing interest was not related to school success or an anticipated career.

ASD is well known to be less frequent in girls, which has been hypothesized to reflect protective aspects of girls' socialization (e.g., Constantino & Todd, 2003) or lower fetal testosterone (Auyeung et al., 2006). It would be useful to know if systemizing and/or a person's autism traits predicted their type of interests independently of gender.

Gender differences in interests also exist in typically developing children. In the study of DeLoache et al. (2007), half of the intense interests that parents reported for boys were for vehicles, trains, and machines, and another 27% were for balls, dinosaurs, and tools. Girls' intense interests were clothes/dressing up, babies, and tea sets. These gender differences in interests were observed in the youngest children studied (approximately 1 year old). Since knowledge of gender stereotypes, implicit or explicit, does not occur until 18 months or later, DeLoache et al. speculated that biological factors, such as fetal testosterone, play a role.

Gender differences in special interests have not previously been studied in adult persons with ASD. Our secondary hypothesis is that we will see continuity between childhood and adulthood. We thus expect that both ASD and neurotypical males will have interests in more systemizable domains than will ASD and neurotypical females. Understanding gender differences in special interests during adulthood is important, as it can provide a means to adapt skill development in the workplace and higher educational settings to individual cognitive styles.

## 2. Materials and methods

### 2.1. Participants

Participants with ASD were recruited from WrongPlanet.net, a large online discussion forum created for individuals with ASD, and their families, friends, and supporters (Plank & Yellow Sneaker Media, 2004). Among 70 individuals who self-reported themselves as having an ASD, 67 identified themselves as having Asperger syndrome, while only 2 reported autism spectrum disorder and 1 reported PDD-NOS. Slightly more than half (58.6%) of individuals with ASD reported being diagnosed by a clinician (see Table 1 for summary of other demographic and diagnostic variables). The most common disorders reported by both groups were anxiety disorders (including panic attacks, social phobia, generalized anxiety), followed by depression. Less commonly reported was ADHD, followed by OCD.

In the ASD group, 42.9% of participants were female, while 50.4% of the NT group was female. Although ASD is typically more prevalent in males, this gender ratio is similar to that reported in past studies of ASD special interests on Internet discussion forums (Jordan & Caldwell-Harris, 2012).

Neurotypical participants included participants who were forum users from the WrongPlanet.net website ( $n = 68$ ) who identified themselves as neurotypical (i.e., not having an ASD) and students from Boston University who participated for course credits ( $n = 51$ ). Recruitment from a university allowed us to approximately match the age and education level of the ASD and NT groups.

To determine whether participants reporting themselves as NT who were recruited from the WrongPlanet.net forum should be considered neurotypical, we compared their Systemizing Quotient, Autism Quotient, and Eyes Test scores (see Materials) to those earned by NT participants recruited from Boston University. WrongPlanet NT individuals did score slightly higher on the autism quotient than Boston University NT participants (WrongPlanet NT  $M = 22.9$ ,  $SD = 11.1$ , BU  $M = 17.1$ ,  $SD = 7$ ;  $t(79) = -3.1$ ,  $p < .005$ ) and thus some of them may be considered part of the broader autism phenotype (Constantino & Todd, 2003). However, there were no differences between the two NT groups on the Systemizing Quotient or Eyes Test. Furthermore, WrongPlanet NT individuals had lower scores than ASD individuals on the Autism Quotient (WrongPlanet NT  $M = 22.9$ ,  $SD = 11.1$ , ASD  $M = 36.4$ ,  $SD = 7.3$ ;  $t(78) = -7.2$ ,  $p < .001$ ) and the Systemizing Quotient (WrongPlanet NT  $M = 35.1$ ,  $SD = 14.7$ , ASD  $M = 43.8$ ,  $SD = 16.5$ ;  $t(97) = -2.8$ ,  $p < .05$ ), and higher scores on the Eyes Test (WrongPlanet NT  $M = 24$ ,  $SD = 5.4$ , ASD  $M = 18.4$ ,  $SD = 9$ ;  $t(88) = 3.9$ ,  $p < .001$ ). Although the WrongPlanet NT participants were substantially neurotypical, their scores were slightly elevated compared to the Boston University NT students and the NT norms of 16.4 reported by Baron-

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