Why Does Joint Attention Look Atypical in Autism?

Morton Ann Gernsbacher, Jennifer L. Stevenson, Suraiya Khandakar, and H. Hill Goldsmith

University of Wisconsin–Madison

ABSTRACT—***This essay answers the question of why autistic children are less likely to initiate joint attention (e.g., use their index finger to point to indicate interest in something) and why they are less likely to respond to bids for their joint attention (e.g., turn their heads to look at something to which another person points). It reviews empirical evidence that autistic toddlers, children, adolescents, and adults can attend covertly, even to social stimuli, such as the direction in which another person's eyes are gazing. It also reviews empirical evidence that autistics of various ages understand the intentionality of other persons' actions. The essay suggests that autistics' atypical resistance to distraction, atypical skill at parallel perception, and atypical execution of volitional actions underlie their atypical manifestations of joint attention.***

KEYWORDS—*autism; enhanced perceptual processing; gaze dyspraxia; joint attention; intentionality; pointing*

When one person directs his attention to another person's focus of attention, the two people are said to be engaged in joint attention. Of course, attention is an invisible construct, and most people are neither mind readers nor cognitive scientists; therefore, the indisputably covert process of directing one person's attention to another person's attention is assumed by most to occur only when manifested by overt acts of physical behavior.

For instance, if a parent points her index finger toward a stimulus and a child turns his head toward the stimulus, it is believed that the child is not only attending to the stimulus but also aware that he and the parent are attending to the same stimulus. If the child fails to turn his head toward the stimulus, it is believed that the child is unaware of both the stimulus and the parent and child's shared attention.

Similarly, if a child wants his parent to share his attention toward a stimulus—in other words, if the child wants to summon his parent's attention to something in which the child is interested—it is believed that the child must point to the stimulus or alternate his gaze between the stimulus and his parent. If the child physically leads his parent to the stimulus or if the child fails to gaze alternately between his parent and the stimulus, it is believed that the child is unaware of both his own and his parent's intentionality.

Although research on joint attention was conducted originally within typical development, more than half of the 150 articles currently indexed by PubMed on joint attention examine autistic[1] development. These articles almost unanimously suggest that autistic children behave atypically in their responses to bids for their joint attention (e.g., turning their head when an adult points her finger) or their solicitations of others' joint attention (e.g., pointing their finger toward a stimulus of interest).

Assaying such atypical behavior is a primary goal of early screening instruments for autism. For example, four of the five most predictive items on the most popular toddler screening instrument (the Modified-Checklist for Autism in Toddlers; Robins, Fein, Barton, & Green, 2001) probe parents about their child's displays of joint attention. The instrument asks parents, "Does your child ever use her index finger to point, to indicate interest in something?" and "If you point at a toy across the room, does your child look at it?" Because young autistic children are less likely to use their index finger to point and are

Correspondence concerning this article should be addressed to Morton Ann Gernsbacher, Department of Psychology, University of Wisconsin–Madison, Madison, WI 53706; e-mail: magernsb@wisc.edu.

[1]We follow Sinclair (1999; http://web.syr.edu/~jisincla/person_first.htm) in our respectful use of the term "autistic/s" rather than "person/s with autism" because the former is the term by which autistic individuals prefer to be called, and American Psychological Association (APA) style proscribes that authors "respect people's preferences; call people what they prefer to be called" (APA, 1994, p. 48). Indeed, a Google search conducted on March 14, 2007, revealed that 99% of the first 100 Google hits for the term "autistics" lead to organizations run by autistic persons, whereas all the first 100 Google hits for the terms "person/s with autism" or "child/ren with autism" lead to organizations run by nonautistic individuals.

less likely to turn their head in response to another person pointing, these screening items are diagnostic.

This essay answers the question of why autistic children are less likely to use their index finger to point to indicate interest in something and why they are less likely to turn their head to look at something at which another person points. We begin by reviewing empirical evidence that autistic toddlers, children, and adults can attend covertly, without overt manifestations. Autistics attend covertly even to social stimuli, such as the direction in which another person's eyes are gazing. We also review empirical evidence that autistics of various ages understand the intentionality of other persons' actions. We then turn to address why, if autistics are able to attend covertly, even to social stimuli, and they understand intentionality, they atypically respond to bids for their joint attention and they atypically solicit the attention of other people. We suggest that autistics' atypical resistance to distraction, atypical skill at parallel perception, and atypical execution of volitional actions underlie their atypical manifestations of joint attention.

AUTISTICS ATTEND COVERTLY

In 1894, Hermann von Helmholtz demonstrated a fundamental law of attention: It can operate without head movements, much less eye movements (Gazzaniga, Ivry, & Mangun, 2002). Attention can be covert. In the early days of the cognitive revolution, Michael Posner pioneered a laboratory paradigm for measuring covert attention (Posner, Snyder, & Davidson, 1980). A participant, seated in front of a display screen, fixates on a central cross. An arrow cue directs the participant to attend to one area of the display, for example, to the left versus the right of the fixation cross. Very quickly after the arrow cue disappears, a target appears in either the cued location or an uncued location.

To quantify covert attention, experimenters manipulate the validity of the attentional cue. For example, in 80% of the trials, the cue can direct attention to where the target actually occurs, but in 20% of the trials, the cue can direct attention elsewhere. The former is considered a valid trial, the latter an invalid trial, and the difference in response time produces a validity score. The higher the validity score, the greater the covert attention. Similar paradigms for measuring covert attention exist for auditory stimuli (e.g., Benedict et al., 2002), tactile stimuli (e.g., Forster & Eimer, 2005), and even olfactory stimuli (Spence, 2002).

Experiments that measure autistic individuals' covert attention demonstrate that autistic individuals have excellent covert attention. Two-year-old autistic toddlers (Chawarska, Klin, & Volkmar, 2003); autistic preteenagers, whose mental age is measured to be only half their chronological age (Iarocci & Burack, 2004); and middle-age autistic adults (Bird, Catmur, Silani, Frith, & Frith, 2006) all have been empirically demonstrated to possess excellent covert attention.

For instance, the data displayed in Figure 1 illustrate that autistics (with a mean IQ of 82) exhibit more covert attention than same-age nonautistic controls (with a mean IQ of 124; Casey, Gordon, Mannheim, & Rumsey, 1993; see also Greenaway & Plaisted, 2005, Experiment 1, in which autistics responded significantly more accurately than nonautistics to validly cued targets). Such laboratory data support Asperger's (1941/1991) early observation that autistics "seem to see a lot using only 'peripheral' vision, or to take in things 'from the edge of attention.' Yet these children are able to analyze and retain what they catch in such glimpses" (p. 49).

AUTISTICS COVERTLY ATTEND TO SOCIAL STIMULI

How do we reconcile the empirical fact that autistics' covert attention is intact with the clinical judgment that autistics' joint attention is impaired? Lest we assume that the distinction arises from the social nature of joint attention, consider autistics' covert attention to one of the most social of all stimuli—the direction in which another person's eyes are gazing. When covert attention is measured, instead of overt demonstration (e.g., turning one's head or pointing one's finger), autistics—even as young as 2 years of age (Chawarska et al., 2003)—ably attend to the direction in which another person's eyes are gazing (Kylliainen & Hietanen, 2004; Senju, Tojo, Dairoku, & Hasegawa, 2004; Swettenham, Condie, Campbell, Milne, & Coleman, 2003; Vlamings, Stauder, van Son, & Mottron, 2005).

Indeed, another person's eye gaze often summons autistics' covert attention even more powerfully than it summons nonautistics' covert attention (Chawarska et al., 2003; Kylliainen & Hietanen, 2004; Vlamings et al., 2005). Moreover, compared with nonautistics, autistics are particularly sensitive to whether another person's gaze is informative: Whereas nonautistics are more likely to reflexively orient their attention in the direction of another persons' gaze—even when that direction does not predict where a subsequent target will occur—autistics tend to orient only when another person's gaze is predictive (Ristic et al., 2005). As Ristic et al. (2005, p. 717) conclude, autistics

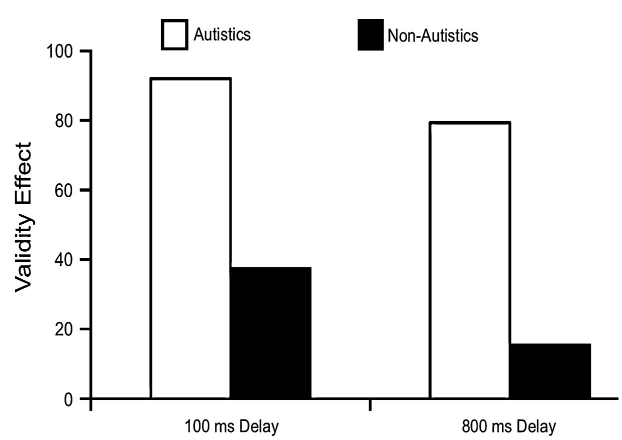

Figure 1. Validity index scores from Casey, Gordon, Mannheim, and Rumsey (1993).

"essentially outperform" nonautistic individuals in covertly attending to eye gaze because autistics are "not 'fooled' by a nonpredictive gaze cue."

A similar conclusion can be drawn from Pelphrey, Morris, and McCarthy's (2005) brain imaging study. Whereas nonautistics show greater task-related activity in the superior temporal sulcus for gaze shifts that are not predicted by a prior cue, autistics are unaffected by such meaningless cues. Although Pelphrey et al. conjecture that this difference is due to autistics' lack of understanding "intentionality of other observed human actions" (p. 1039), substantial empirical data, which directly examine autistics' understanding of intentionality, fail to support this conjecture, as we review next.

AUTISTICS UNDERSTAND INTENTIONALITY

Writing in the *Journal of the American Psychoanalytical Association*, neuroscientist Gallese conjectures that "autistic individuals are relatively unable to understand" the intentions of other persons' actions (Gallese, Eagle, & Migone, 2007, p. 152). However, no empirical evidence exists to support this widely held assumption. Rather, every empirical study to date has shown that autistic individuals across a wide age range are capable of understanding the intentions of other people's actions.

Indeed, young, preverbal autistic children perform "significantly better than the normally developing infants on the Meltzoff intentionality tasks" (Aldridge, Stone, Sweeney, & Bower, 2000, p. 294). In "Meltzoff's test of understanding of others' unfulfilled intentions," autistic preschoolers are not deficient "on any measure involving the understanding of others' intentions" (Carpenter, Pennington, & Rogers, 2001, p. 589). Grade school–age autistic children demonstrate "intact abilities in monitoring basic actions, intact abilities in reporting an intention, both for self and for another agent, and intact ability in reporting intended actions" (Russell & Hill, 2001, p. 317). And autistic adults are "far from action-blind"; they ably represent the intentions of a "co-actor's task, showing the same pattern of results as the matched control group" (Sebanz, Knoblich, Stumpf, & Prinz, 2005, p. 433).

Thus, autistics understand the intentionality of other persons' actions, and they attend covertly, even to social stimuli. Why, then, do they appear to be less responsive to bids for their joint attention and why do they appear to be less likely to initiate joint attention with other people? To answer these questions, we need to clarify how responding to bids for joint attention and initiating joint attention are operationalized. According to the most widely used measure of joint attention (Mundy, Sigman, & Kasari, 1990), responding to joint attention is operationalized as the frequency with which a child stops what he is doing, looks up at the person soliciting his attention, turns his head toward the direction in which the other person is looking or pointing, and turns his head back toward the other person (Lord et al., 2000). Initiating joint attention is operationalized as the frequency with which a child stops what he is doing and either looks back and forth between what he is doing and another person or points to what he is doing.

We propose that autistics' atypical resistance to distraction, atypical skill at parallel perception, and atypical execution of volitional actions underlie their atypical manifestations to bids for their joint attention.

AUTISTICS RESIST DISTRACTION

Autistics are renowned for their atypical resistance to distraction, their atypical persistence in focus. An early observation by Rutter (1965) was that "over a third of the [autistic] children had been thought deaf at some time," most likely because of their greater-than-average resistance to distraction (which is often envisaged as difficulty in disengaging their attention from their immediate focus; Adrien, Rossignol-Deletang, Martineau, Couturier, & Barthelemy, 2001; Zwaigenbaum et al., 2005).

Autistic children's resistance to distraction was quantified by Landry and Bryson (2004). Five-year-old autistic children, mental age–matched typically developing children, and chronological age–matched children with Down syndrome focused on a "very fascinating" centrally placed computer monitor on which brightly colored geometric shapes continuously filled the screen. On one of two computer monitors to the side of the central monitor, a stimulus identical to the one displayed on the central monitor appeared; however, children were told "to look at the screen." Figure 2 shows the average time that the children remained focused on the central monitor without being distracted by the side monitor. Autistic children remained focused more than twice as long as typically developing children matched for mental age and four times longer than children with Down syndrome matched for chronological age (see also Greenaway & Plaisted, 2005).

Autistic children's atypical persistence was also exemplified by their—literally—continued performance on a classic Continuous Performance Task (Garretson, Fein, & Waterhouse, 1990). Whereas autistic children persisted in completing the

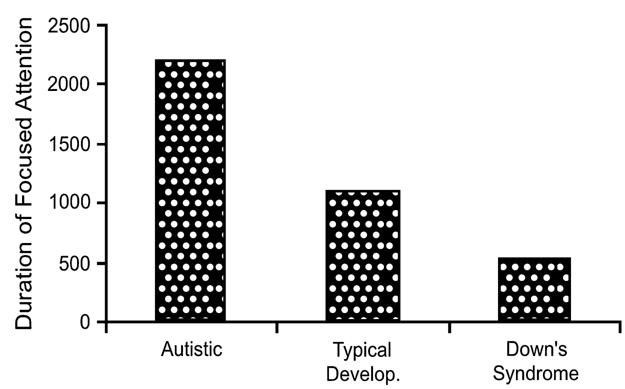

Figure 2. **Duration of focused attention from Landry and Bryson (2004).**

entire task, many of the typically developing children matched for mental age found the continuous performance task "averse" and were "unwilling" to continue beyond the first half of the task (Garretson et al., p. 105). Thus, as in Landry and Bryson's (2004) study, autistic children remained focused more than twice as long as typically developing peers.

Autistics' atypical resistance to distraction most likely also underlies their atypical resistance to eye gaze cues that do not predict where a subsequent target will occur (Pelphrey et al., 2005; Ristic et al., 2005). Indeed, Bayliss, di Pelligrino, and Tipper (2005, p. 646) consider individuals who, like autistics, resist automatically attending to nonpredictive eye gaze cues as having "good focused attention," possessing "a stronger ability to inhibit the influence of [uninformative] social cues," and being "more efficient." In contrast, nonautistics "suffer greater interference" when they "encode gaze in such an automatic manner . . . that they cannot ignore" another person's gaze—even when the direction in which another person is gazing is irrelevant.

AUTISTICS PERCEIVE IN PARALLEL

Complementing autistics' enhanced resistance to distraction is their enhanced perceptual processing (Mottron, Dawson, Soulières, Hubert, & Burack, 2006). For example, autistics' ability to rapidly recognize a visual object amid a complex visual background distinguishes them from nonautistics three times more powerfully than the most studied aspect of social cognition, "theory of mind" (Pellicano, Maybery, Durkin, & Maley, 2006). A heightened orientation to visual stimuli during the first year of life identifies infants who will subsequently be diagnosed as autistic from those whose development will be typical or atypical in other ways (Baranek, 1999). Atypical perception in both the visual and auditory domain characterizes autistics across the life span. Indeed, as Dakin and Frith (2005) have proclaimed, "The idea that [autistic] individuals perceive the world differently, reflected in sometimes superior performance on perceptual tasks, is perhaps the most intriguing of all the puzzles thrown up by autism."

One of the most dramatic laboratory demonstrations of autistics' perceptual skill comes from visual search paradigms and, in particular, conjunctive-feature visual search paradigms (O'Riordan, 2004; O'Riordan & Plaisted, 2001;O'Riordan, Plaisted, Driver, & Baron-Cohen, 2001; Plaisted, O'Riordan, & Baron-Cohen, 1998). For example, if asked to find the striped ball in the left panel of Figure 3, most nonautistics experience a sense of "pop out." They need not exhaustively survey each of the other stimuli (distractors) to locate the striped ball. But if asked to find the white cube in the right panel of Figure 3, nonautistics typically engage in what Treisman termed a serial search; they inspect the array, item by item, until they discern the target (Treisman & Gelade, 1980).

In contrast, autistics of all ages are able to search displays like Figure 3 almost in parallel (O'Riordan, 2004; O'Riordan & Plaisted, 2001; O'Riordan et al., 2001; Plaisted et al., 1998). Autistics are less thwarted by the number of distractors in the array, both when the target is present and when the target is absent. Indeed, when searching displays of as many as 25 elements, autistics are nearly twice as fast as nonautistic controls (O'Riordan et al., 2001). Perhaps, this ability to search the environment almost fleetingly, for stimuli that are so highly similar, renders less valuable the need to have more vernacular stimuli pointed out overtly. Indeed, a recent study, using the "Useful Field of View" paradigm, suggests that autistics are more facile than nonautistics in spreading their covert attention across a wider visual angle (Rutherford, Richards, Moldes, & Sekuler, 2007).

AUTISTICS EXECUTE VOLITIONAL ACTION ATYPICALLY

As Gernsbacher, Sauer, Geye, Schweigert, and Goldsmith (2008) and other researchers have empirically demonstrated (Mandelbaum et al., 2006; Ming, Brimacombe, & Wagner, 2007; Mostofsky et al., 2006), autistics atypically execute volitional action. In the motor control literature, such atypicality is termed *dyspraxia*, and in the eye-motor control literature, challenges with looking where another person is pointing,

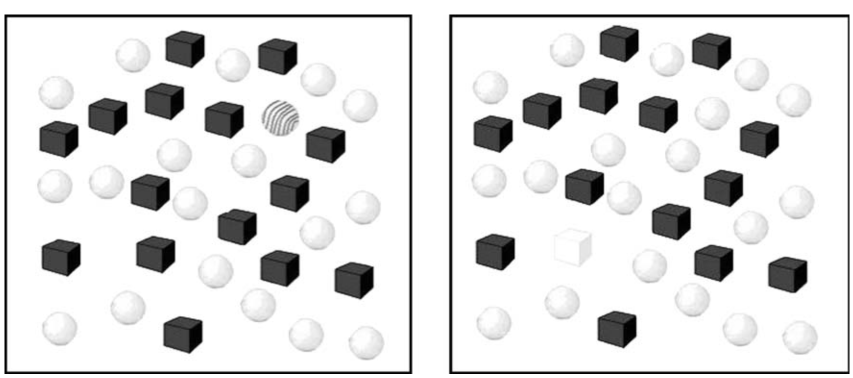

Figure 3. **Example stimuli for a visual search (left-hand panel) and a conjunctive-feature visual search (right-hand panel).**

looking where another person asks you to look, and looking toward the source of an auditory stimulus are termed gaze dyspraxia. As ophthalmology researcher Roberts (1992) advises, "testing for gaze apraxia should involve visual stimuli ('look at my light/hand'), auditory stimuli ('look to where you hear the bell'), and tactile-proprioceptive stimuli ('look at where I touch you')," among other assays (p. 729). Thus, measuring gaze apraxia is identical to measuring response to joint attention.

Although for many of us, skilled head and eye movements feel relatively automatic, they are the result of complex cortical and subcortical orchestration. For example, transcranial magnetic stimulation to the cerebellum disrupts eye–head movement so that rather than the head leading the eyes, the eyes lead the head (Nagel & Zangemeister, 2003), as is seen in the "autistic glance" (Mottron et al., 2007). Vertical head movements, such as those required for nodding the head up and down, as in the cultural expression of *yes*, are controlled by a tecto-reticulo-spinal pathway, and horizontal head movements, such as those required for shaking the head side to side, as in the cultural expression of *no*, are controlled by a tecto-Forel's-field-H-spinal pathway (Isa & Sasaki, 2002). Perhaps, this distinction in cortical–subcortical systems explains the lack of synchrony in the development of the two skills (i.e., autistics ages 2–16 are 20% more likely to be able to shake than nod their heads; Geschwind et al., 2001).

During typical development, overt manifestation of gaze following (i.e., turning one's head in the direction in which one is summoned) is highly correlated with how well a child can produce a gesture but not at all correlated with how well the child can understand a gesture (Carpenter, Nagell, & Tomasello, 1998). In autistic development, gesture production is also dissociated from gesture understanding. Autistics are considerably challenged by gesture production, which relies on action execution, but they are equivalent or even superior to non-autistics in gesture understanding (Attwood, Frith, & Hermelin, 1988; Hamilton, Brindley, & Frith, 2007; Rogers, Bennetto, McEvoy, & Pennington, 1996). Thus, we submit that autistics' challenges in volitional action execution, in addition to their ability to attend covertly, search the environment fluidly, and resist interruption and distraction, contribute to their atypical responses to conventional bids for their joint attention.

AUTISTICS INITIATE JOINT ATTENTION ATYPICALLY

In addition to responding to bids for their joint attention (by turning their heads in the direction of another person's point or gaze), typically developing children are also assumed to initiate bids for other persons' joint attention (by pointing to an object of interest or by turning their head back and forth between an object of interest and another person). Such behaviors are assumed to manifest the "sharing of experiences with others" (Van Hecke et al., 2007, p. 55) and are named protodeclarative behaviors. Protodeclarative behaviors contrast with protoimperative behaviors, which are assumed to solicit another person's attention merely to request, not to "share an experience."

However, 90% of autistic toddlers who are unable to point protodeclaratively (to putatively share an experience) are also unable to point protoimperatively (to merely request), a finding "not predicted from current theories [of joint attention], although this has been noted clinically" (Baron-Cohen et al., 1996, p. 162; see also Robins et al., 2001). Such data suggest that it is the core act of pointing and its underlying motor demands rather than any deficit in intentionality or desire to share experience that underlies autistic children's lower frequency of pointing to initiate joint attention. Shadmehr and Wise (2005, p. 1) highlight the complex motor demands of pointing with the admonition that its etiology "requires knowledge of physics, biology, mathematics, robotics, and computer science."

Moreover, the frequency with which typically developing children initiate joint attention does not increase across early development (Mundy, Sigman, & Kasari, 1994; Sheinkopf, Mundy, Claussen, & Willoughby, 2004; Van Hecke et al., 2007) and has an unstable relationship with the frequency with which they respond to bids for their joint attention (Mundy & Willoughby, 1998; Mundy et al., 2000; Vaughan, Mundy, Block, Burnette, & Delgado, 2003). We submit that autistics do initiate joint attention, perhaps even as frequently as their nonautistic peers, but they do so in atypical and unconventional ways.

Consider as an analogy blind children. Blind children are unlikely to use eye gaze, head turning, or finger pointing to initiate joint attention; however, careful observation reveals that blind children nonetheless "make use of 'sophisticated forms of body play' to attract the attention of their caregivers" (Iverson & Goldin-Meadow, 1997, p. 454). Researchers such as Bigelow (2003) have conscientiously identified atypical ways that blind children initiate joint attention, ascertaining several behaviors that can be both liberally and conservatively construed as indicating joint attention, none of which involve eye gaze, head turning, or finger pointing. To our knowledge, such ingenuity has not been applied toward understanding autistic individuals' atypical initiations of joint attention.

CONCLUSIONS AND RECOMMENDATIONS

More than 50 studies in the child development literature have examined autistic children's ability to turn their head in response to an examiner pointing her index finger; from the perspective of ophthalmology, these studies have confirmed the presence of gaze dyspraxia among autistic children. Numerous other studies have attempted to train autistic children to display more typical joint attention but no intervention to date has demonstrated long-term changes of statistical significance, despite employing up to 45 hr of training (Drew et al., 2002;

Hwang & Hughes, 2000; Kasari, Freeman, & Paparella, 2006; Pierce & Schreibman, 1995; Rollins, Wambacq, Dowell, Mathews, & Reese, 1998; Whalen & Schreibman, 2003; Zercher, Hunt, Schuler, & Webster, 2001).

Perhaps we should acknowledge that joint attention looks atypical in autism, and we should increase our efforts toward joining autistics' attention, similar to increasing our efforts toward acting reciprocally with autistics (Gernsbacher, 2006). Rather than lowering our estimate of autistic children's intentionality, which happens when parents are told children's diagnostic label (Sperry & Symons, 2003), perhaps we should lower our level of intrusiveness, high levels of which contribute to low estimates of children's intentionality (Feldman & Reznick, 1996; see also Aldred, Green, & Adams, 2004).

Rather than soliciting autistic children's attention away from the phenomena in which they are most interested, as mothers of autistic children are prone to do (Watson, 1998), perhaps we should join autistic children's foci of attention, as mothers of typically developing children are more prone to do. And rather than requiring increasingly more dramatic, often leading to problematic, solicitations of our attention, as autistic children are sometimes required to initiate (Keen, 2005; Keen, Sigafoos, & Woodyatt, 2005), perhaps we should dramatically increase our efforts to identify the atypical ways that autistics attempt to solicit our attention.

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