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Journal of Cognition and Development

ISSN: 1524-8372 (Print) 1532-7647 (Online) Journal homepage: https://www.tandfonline.com/loi/hjcd20

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To cite this article: Jacob A. Burack, Natalie Russo, Hannah Kovshoff, Tania Palma Fernandes, Jason Ringo, Oriane Landry & Grace Iarocci (2016) How I Attend—Not How Well Do I Attend: Rethinking Developmental Frameworks of Attention and Cognition in Autism Spectrum Disorder and Typical Development, Journal of Cognition and Development, 17:4, 553-567, DOI: 10.1080/15248372.2016.1197226

To link to this article: https://doi.org/10.1080/15248372.2016.1197226

Published online: 23 Sep 2016.

JOURNAL OF COGNITION AND DEVELOPMENT, 17(4):553–567

ISSN: 1524-8372 print/1532-7647 online
DOI: 10.1080/15248372.2016.1197226

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How I Attend—Not How Well Do I Attend: Rethinking Developmental Frameworks of Attention and Cognition in Autism Spectrum Disorder and Typical Development

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Evidence from the study of attention among persons with autism spectrum disorder (ASD) and typically developing (TD) children suggests a rethinking of the notion that performance inherently reflects disability, ability, or capacity in favor of a more nuanced story that involves an emphasis on styles and biases that reflect real-world attending. We provide examples from behavioral and physiological research in which performance on attention tasks is not solely a function of abilities, or disabilities, per se but rather is also a function of the ways in which they are implemented. Thus, the study of attention both among persons with ASD and in typical development might best be recast in terms of the question of "how" rather than "how well."

As is the case with all populations with developmental disorders, the study of persons with autism spectrum disorder (ASD) has historically been framed within the context of a

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deficit model, in which the emphasis is on what these persons cannot do or accomplish, usually in relation to the standard of the functioning levels of typically developing (TD; or developed) individuals. Even in the cases in which particular strengths are highlighted, the discourse is still around how these examples of islets of abilities are surrounded by a sea of disabilities. Ironically, the defect model is also the de-facto style of discourse on cognition in typical development with the same primary questions of what a child can or cannot do or what abilities they have or do not have at a specific age in relation to older children or to an ultimate standard of adult functioning. Consistent with contemporary perspectives on the development of attention (Ristic & Enns, 2015a, 2015b), we argue that conceptualizations of ability and disability and strengths and deficits among both children with ASD and TD children are more usefully framed as transactional and dynamic. Within this framework, we contend that the emergence and development of attentional and cognitive styles are associated with factors such as personal bias, relevance, motivation, and previous experience, which impact on and are impacted by the individual's functioning in the real world.

We begin by highlighting that these lessons are based on a half-century of essential, but often ignored, theorizing about developmental contributions to the study of developmental disabilities (e.g., Cicchetti & Beeghly, 1990; Cicchetti & Pogge-Hesse, 1982; Hodapp, Burack, & Zigler, 1990; Karmiloff-Smith, 1998; Volkmar, Burack, & Cohen, 1990; Zigler, 1967; 1969; Zigler & Hodapp, 1986; for a recent review, see Burack, Russo, Gordon Green, Landry, & Iarocci, 2016). We then cite examples from attention research among persons with ASD and TD children to demonstrate the centrality of this work to contemporary theorizing and interpretation in research on both typical and atypical development. We contend that this empirical evidence necessitates a rethinking of the common belief that what the individual does or does not do solely reflects ability or capacity.

In the study of persons with ASD, attention provides a unique case as it involves extensive evidence of apparent strengths and deficits across the many different functions of which it is composed and which have been integrally linked to the ASD phenotype (for reviews, see Ames & Fletcher-Watson, 2010; Bowler, 2006). We propose a more nuanced story that extends beyond functioning level and is predicated on styles and biases in attending and on the consideration of how the use of cues and other environmental information guides attentional processing. We provide behavioral and physiological evidence to highlight the essential notion that performance on attention tasks is not solely a function of abilities, or disabilities, per se but is also dependent on the ways in which they are used. In these and other cases, differences in performance among groups, either between persons with ASD and their TD peers, or in developmental studies of persons of different ages do not necessarily reflect core strengths or deficits in abilities or processes, but rather differences in their implementation. These differences are particularly evident when abilities or processes may be in competition or used in coordination with one another, and they may be associated simply with styles and biases or with particular contextual factors such as explicit directions, implicit demands, emotional pressures, and the frequency of certain events.

HISTORICALLY COMPETING WORLD VIEWS IN DEVELOPMENTAL DISABILITIES

The Deconstructivist Defect Approach

In their most traditional forms, the fields of typical and atypical development represent intrinsically disparate world views. Whereas Piagetian, Wernerian, and other mainstream developmental theories were premised on the notion of universal patterns and trajectories with a constructivist framework, the study of atypicality is intrinsically a deconstructivist enterprise in which the identification of patterns and trajectories unique to a specific population or condition are primary. This latter approach is largely identified with the categorical medical model with its emphasis on diagnosis of health problems, including those related to mental health and education. In this context, the question is inevitably about what is different and what is wrong. When used optimally, the goal is, of course, to identify a specific problem in order to treat it. Translated to psychology, this approach was essential to both the subdisciplines of psychopathology and clinical psychology; when translated to education, it resonated with the field of special education. In all these areas of work, this approach led to a discourse of difference that was historically centered on defects and impairments, which reflected a break from normalcy. Even the more tempered approach of a continuum (or the statistically influenced discussion of a bell curve in which persons with intellectual disability would fall within the lower end of a normal—or Gaussian—distribution of intelligence) gave rise to the emphasis on differences between the atypical and typical with little or even no acknowledgement of the common humanity between the groups that is the essence of the developmental approach (Burack, 1997). This deconstructivist medical-type perspective dominated the study of developmental disabilities in the initial emergence of these areas of research.

For example, in his original articulations of the developmental approach to intellectual disability (referred to as *mental retardation* at the time), Zigler (1967, 1969) labeled the prevailing orientation to the study of this population as the "defect" or "difference approach" with its primary focus on identifying the one or a few essential impairments as the cause, or causes, of the significantly depressed IQ scores that characterize intellectual disability. This defect approach dominated the primary resources, including edited volumes and leading texts, with the overwhelming emphasis on theories and evidence of core causes of intellectual disability (for critiques of the defect approach, see Burack, 1990; Zigler & Balla, 1982).

The First Half-Century of the Development of a Developmental Approach to Developmental Disabilities

The prevailing defect approach was challenged by Zigler and colleagues (Zigler, 1967, 1969; Zigler & Balla, 1982; Zigler & Hodapp, 1986), who argued that the empirical evidence upon which it was based was inherently flawed. The most damning criticism was that the typical strategy of finding deficient performance among persons with intellectual disability as compared with TD persons of the same chronological age simply led to the confirmation of the obvious point that persons with lower measured intelligence (IQ) perform worse on a task of cognition than persons with higher intellectual ability. The implications of the findings of defects were further compromised by the prevailing notion that persons with intellectual disability represented a meaningfully homogenous group. In contrast, Zigler and colleagues advocated for a

developmental approach in which they both highlighted the importance of the notion of mental age and differentiated between persons with the so-called familial type of intellectual disability, which is thought to simply be the result of the genetic transmission of low IQ from the parents, and those for whom intellectual disability stemmed from some organic or physiological etiology (e.g., Down syndrome, fragile X, hydrocephaly, Phenylketonuria, Williams syndrome).

The persons with familial intellectual disability were thought to represent the naturally occurring lower 2% to 3% of the population, as reflected in a bell curve, in terms of IQ rather than as a break from normalcy. Accordingly, their development would be considered intact as it would follow the same developmental pathway or trajectory as the general population but would just proceed at a slower rate and ultimately with a lower level of attainment. Within these parameters, differences between persons with familial intellectual disability and TD children were rarely found when the groups were matched appropriately on mental age, and the evidence for the various theories of specific defects as essential to all forms of intellectual disability was largely discredited (for discussions, see Burack et al., 2012; Burack, Evans, Klaiman, & Iarocci, 2001; Mundy, Sigman, & Kasari, 1990; Weiss, Weisz, & Bromfield, 1986; Weisz, Yeates, & Zigler, 1982). Consistent with the notion of similar developmental trajectories and patterns as opposed to defects or differences, Zigler (1967) argued that "many of the reported behavioral differences between normals and retardates of the same mental age are seen as products of motivational and experiential differences between these groups, rather than as the result of any inherent cognitive deficiency in the retardates" (p. 298). He and his colleagues (e.g., Merighi, Edison, & Zigler, 1990; Zigler & Balla, 1972; Zigler & Hodapp, 1986) would effectively argue that these differences would be particularly exacerbated in experimental studies of persons with intellectual disability who, like many other groups of disadvantaged persons who consistently experience failure, take on personality characteristics, such as heightened outerdirectedness and social wariness but lowered self-esteem, which typically detract considerably from optimal performance in lab settings in which children are asked to perform a novel and task with an unknown adult in an unfamiliar place.

Cicchetti and colleagues (e.g., Cicchetti & Ganiban, 1990; Cicchetti & Mans-Wagener, 1987; Cicchetti & Pogge-Hesse, 1982; Cicchetti & Schneider-Rosen, 1986; Cicchetti & Sroufe, 1978; Wagner, Ganiban, & Cicchetti, 1990) soon extended Zigler and colleagues' developmental approach to encompass persons with intellectual disability with any type of etiology (for a discussion, see Burack et al., 2016). Although they specifically discussed persons with Down syndrome, Cicchetti and Pogge-Hesse (1982) made a case for the application of developmental principles to any population, even including those who were, and continue to be, thought of as different, defective, and impaired. They argued poignantly that the deficit approach "overlooks the possibility that the behavior and development of retarded children is organized, adaptive, and integrated—just as is the case for nonretarded children and infants. We know that they are retarded; the important and challenging research questions concern the developmental process" (p. 279). In rethinking the discourse in the field, they argued that the orientation of the discussion about abilities needs to be changed so that "we should study not 'does X have Y' but rather 'in what way does X use Y?'" (p. 313). Although Cicchetti and colleagues (e.g., Cicchetti & Beeghly, 1990) further developed this idea throughout the 1980s in their discussions in the general developmental literature on the organization of developmental processes within and across the domains of social, affective, and cognitive functioning among infants and young children with Down syndrome, it was largely ignored in the more specific literatures on

developmental disabilities at that time and for decades to follow. Rather, within the context of prevailing defect approaches at the time, even the emergent emphasis on the unique patterns of relative strengths and weaknesses among individual etiological groups with intellectual disability (e.g., Down syndrome, Williams syndrome; Burack, 1990; Burack, Hodapp, & Zigler, 1988, 1990; Dykens & Hodapp, 2001; Dykens, Hodapp, & Finucane, 2000) was still based on the "Does X have Y?" question.

The other temporally coinciding development in the study of developmental disabilities was the phenomenal growth of research on ASD, largely fueled by Baron-Cohen, Leslie, and Frith's (1985) reports of a deficit in theory of mind (ToM) in this group and to a somewhat lesser extent by Shah and Frith's (1983) report of islets of abilities. These accounts would quickly lead to both a rapid growth in deficit-based research and theories of ASD and to the use of ASD as a model for a modular approach to development that stands in contradiction to the notion of the developmental organizational perspective espoused by Zigler, Cicchetti, and their colleagues.

Defect Theories of ASD

Following from the medical model, the discourse around ASD from its initial identification as a clinical diagnosis (e.g., Asperger, 1944; Kanner, 1943) was inevitably around that of difference, with many examples of impairment but also some of islets of abilities including the incredible ability to focus on details and the prodigious knowledge of some persons with ASD. The early dichotomously opposing accounts of overarousal and underarousal theories of ASD reflected the ethos of the time as researchers sought to find some distinct cause of ASD (Hutt, Hutt, Lee, & Ounsted, 1964). The emphasis on defect was highlighted publicly in 1973 by Nikolaas Tinbergen (1992) in his lecture to commemorate his receipt of the Nobel Prize for Medicine in which he highlighted how ethology, his field of study, could be applied to the relief of "human suffering" as in the case of ASD. He highlighted that "it is clear, even to those who have not themselves seen these unfortunate children, how crippling this affliction is. In various degrees of severity, it involves, among other things: a total withdrawal from the environment; a failure to acquire, or a regression of overt speech, and a serious lagging behind in the acquisition of numerous other skills; obsessive preoccupation with a limited number of objects; the performance of seemingly senseless and stereotyped movements; and an EEG (electroencephalogram) pattern that indicates high overall arousal" (p. 113).

In this climate of a deficit approach, Baron-Cohen et al.'s (1985) finding of an impairment or excessive developmental delay in ToM resonated with the prevailing views of ASD. ToM was soon widely cited as a—or even the—core deficit (Frith, Morton, & Leslie, 1991). This notion of a ToM deficit both fueled and was fueled by philosophers' interest in it as a window into understanding how people's thinking about others' thinking can break down and their interpretation of it as evidence for the modularity (or separability) of ToM in contrast to the basic developmental tenet of organization across domains of development. This notion that extreme deficits in this module was disconnected from other aspects of functioning was consistent with the just-published account by Shah and Frith (1983) of islets of abilities, a few specific areas of relative strengths in a sea of disabilities, among persons with ASD. These accounts led to a discourse focused almost entirely on deficits and a few strengths in a modular or fractionated way of development, with development in specific areas of functioning unrelated to that in others. Soon thereafter, other theories of deficits, especially those

related to weak central coherence (WCC), executive function, face perception, and eye gaze joined them as central to the research on ASD. As in the case of persons with intellectual disability, the ubiquitous deficit models overwhelmed the discourse on persons with ASD, thereby largely removing from the discussions the integrity of the individual as a whole person.

The Case of Weak Central Coherence and Attentional Styles

Even as the general rush toward identifying deficits reigned, some evidence and even theory to the contrary began to be cited by the mid-to-late 1990s. Much of this early discussion was around the WCC model (Frith, 1989; Frith & Happé, 1994), which was premised on the idea that persons with ASD focus on details and have difficulty integrating information into a coherent and integrated whole. Whereas the notion of deficient holistic processing was the most obvious extension of the "Does X have Y?" thinking, the concomitant WCC hallmark of enhanced local processing also fits this orientation. Similar to the deficit model, the notion that people with ASD show enhanced performance compared with TD individuals reflects a focus on capacity rather than process. For example, following from the articulation of WCC, specific strengths in visual attention and perception were offered (Mottron, Belleville, & Ménard, 1999; O'Riordan, 2004; O'Riordan, Plaisted, Driver, & Baron-Cohen, 2001; Plaisted, O'Riordan, & Baron-Cohen, 1998) to explain the apparently enhanced performance of people with ASD on visual tasks that require attention to detail, such as those involving embedded figures (Jolliffe & Baron-Cohen, 1997; Shah & Frith, 1983), impossible figures (Mottron et al., 1999), and block design (Rumsey & Hamburger, 1988).

In contrast to the initial notion that WCC reflects a deficit in big-picture global processing, the discussion around WCC led to the process question, "How does X use Y?" which was eventually formalized in the enhanced perceptual functioning (EPF) model (Mottron & Burack, 2001; Mottron, Dawson, Soulieres, Hubert, & Burack, 2006). Contrary to expectations based on WCC, persons with ASD did not show particular deficits in the area of global, or holistic, processing, nor did they consistently show relative strengths in the area of local, or detailed, processing with either the traditional hierarchical global–local stimuli or with other stimuli used to tap into related processes (Mottron et al., 1999; Mottron, Mineau, Décarie, & Jambaqué, 1997; Ozonoff, Strayer, McMahon, & Filloux, 1994). These findings were interpreted as evidence against the WCC's deficit approach to global attending and strength-based approach to local, detailed processing and suggested that the differences in performance between persons with ASD and others might be due to style of processing rather than to actual differences in abilities at either level of processing. This point was highlighted by Plaisted, Swettenham, and Rees (1999), who found that intellectually able persons with ASD showed lower levels of global processing on a divided attention task, in which the global and local processing were presented in competition with each other, but not on a selective attention task, in which global and local processing could be undertaken independently of the other. The findings of apparently intact global processing in the selective attention task were interpreted as more evidence against the prevailing notion of a global deficit and a possible local strength that emanated from the WCC model. Concordantly, Plaisted et al. (1999) suggested that the source of the lower level of global processing on the divided attention task is not one of ability or defect, but rather simply one of style, or bias, of processing. When either one or the other of the levels can be used, the de-facto

processing of TD persons seems to be one in which global processing is prioritized, whereas for persons with ASD, it is a local level of processing.

In response to the empirical evidence from the studies of global–local processing that appeared to challenge the WCC model, Happé (1999; Happé & Frith, 2006) proposed a revised model in which weak coherence was considered a characteristic rather than a cause of autistic behavior and as a bias rather than a deficit. With this revision, the conceptualization of WCC was no longer based on a deficit model of "Does X have Y?" or "Do persons with ASD experience deficits in global processing?" but rather on a model of the use of available abilities—"How does X use Y?"—in which they are capable of processing information globally but appear to prefer to engage in local processing when either level may be used.

At the same time in which Happé and Frith (2006) reconceptualized WCC, Mottron and colleagues (Mottron & Burack, 2001; Mottron et al., 2006) proposed a model of EPF originally intended as an alternative to the original WCC hypothesis. The iteration of the EPF could be seen as the converse of the WCC. Rather than global processing leading to an enhanced ability to process the local elements of stimuli, individuals with ASD were proposed as having an enhanced perceptual processing ability that made it possible, but not inevitable, for the gestalt to be processed. Although this distinction seems subtle, the EPF has been central to the reconceptualization of the discourse from questions concerning what an individual can or cannot do to a discussion of how those with ASD process information and use it to guide behavior.

RETHINKING DEVELOPMENTAL FRAMEWORKS: EXAMPLES FROM ATTENTION RESEARCH

The Use of Cues in the Environment and Attentional Flexibility by Persons With ASD

The notions of bias and style are helpful in delineating the idea that level of performance or behavior in a given situation is not necessarily the function of abilities per se or their proficiency, but rather of the way in which they are used. However, these notions both suggest that the utilization of abilities is dependent on the individual in an intrapersonal way, whereas real-world functioning occurs in interpersonal ways—in relation to information and events in the surrounding environment. Certainly, the attentional extension of "how X uses Y"—"How does X attend?" rather than "How well does X attend?"—is premised on and necessitates the consideration that real-world attentional abilities and skills are used in complex, dynamic environments in which events and information have meaning. Accordingly, the efficacy of attentional functioning and processes cannot be judged without context and without an understanding of the individual's understanding of that context.

For example, Pellicano and Burr (2012) suggested that prior experiences with the environment may influence current behaviors to a lesser extent among persons with autism than among TD persons. Thus, everyday attending may differ between these groups due to differences in expectations and the meaningfulness of environmental cues that provide information about the nature and location of the stimuli and events to which attention needs to be focused to accomplish the individual's desired goal. Similar to the ways in which discrepancies in styles affect processing, different interpretations of, levels of interest in, and the subsequent salience of these cues can lead to the presumption that skills differ, even when the level of ability per se is similar.

The role of context and cues as factors associated with differences in performance between persons with and without ASD is evident from examples in both the social and nonsocial domains. We suggest that across a variety of studies, the theme that seems to emerge from the data may be an ironic one—that persons with ASD, for whom the clinical criterion of perseverative behaviors and restricted interests implies particularly rigid cognitions and behaviors, may in certain circumstances even be considered more flexible in their use of environmental cues. We provide two cases, one each from nonsocial and social attention studies, in which persons with ASD appear to better take advantage of or ignore information or cues in the environment that allow them to attend more efficiently than TD persons. As these examples are based on studies on areas of functioning thought to be sources of deficit for persons with ASD, we challenge prevailing myths, or at least misconceptions, about attentional deficits among persons with ASD.

In an example of nonsocial visual processing, Iarocci, Burack, Shore, Mottron, and Enns (2006) used a hierarchical-figures reaction-time task to examine local–global bias among participants with autism (M_{age} = 7;10) and two groups of TD children, one matched on verbal mental age and the other on nonverbal mental age. The participants were presented with an array of stimuli that consisted of either target squares or diamonds and distracter circles and were asked to identify whether the target was a square or a diamond. The global targets were a large diamond (or a square) made up of circles, while the local targets were smaller diamonds (or squares) that comprised a circle. The primary manipulation related to the bias regarding the likelihood of presentation at the global or local levels. In the global bias condition, the targets appeared at the global level 70% of the time (30% local), whereas in the local bias condition, this probability was reversed (70% local, 30% global). In the neutral condition, the probability of targets appearing either at the global or the local level was 50/50. The participants were not informed about these probabilities.

This implicit biasing of attention to the global or local level of processing based on the relative frequency of the target did not affect the performance of the group of TD participants, who, consistent with the notion of a typical global precedent, displayed slower reaction times to local targets than to global targets across blocks of trials that were biased in frequency to the global, local, or neutral levels. In contrast, the participants with ASD, whose accuracy rates were similar to those of the TD participants, showed response times that varied with the implicit biases of the task, with faster reaction times to the global targets in the global bias condition and no differences in reaction times between the global and local targets in the local bias condition. These findings are evidence that differences in performance between persons with and without ASD are more complex than deficits in performance per se and further suggest that persons with ASD may even be able to more effectively "tune" their performance to information from the environment than can TD persons.

In an example from a social attention study, Ristic et al. (2005) presented intellectually able participants with ASD and age- and IQ-matched TD participants with a centrally presented schematic face whose pupils cued the location of a target. This study was intended to contrast the notion of the "social power" of eye gaze among TD persons, who inherently follow eye movements in all faces even clearly unrealistic faces such as schematic ones (e.g., Friesen & Kingstone, 1998; Ristic, Friesen, & Kingstone, 2002), with the characteristically 'gaze avoidant' behaviors of individuals with ASD. It also challenged the accounts of deficits in following eye gaze among persons with ASD that are first linked to atypicalities in joint attention during

infancy and to other manifestations (e.g., social communication) during the life span (American Psychiatric Association, 2013). The paradigm included two conditions: a predictive gaze condition in which the cue direction predicted the location of the target 80% of the time and a nonpredictive condition in which the cue only predicted the location on 50% of trials.

Contrary to expectations, the participants with ASD, like the TD participants, displayed faster reaction times for congruent cue-target trials than for incongruent cue-target trials in the predictive condition, suggesting that both groups used the cue in an advantageous way to guide their anticipation of where the target would appear. However, this effect was also found among the TD participants in the nonpredictive condition, indicating that, consistent with the notion of the salience of eyes in the general population, eye gaze automatically captured their attention even when it did not provide any information about the subsequent location of a target. In contrast, the participants with ASD displayed no differences between reaction times to congruent and incongruent cue-target trial types in the nonpredictive cue condition, suggesting that they seemingly ignored the salient social cue and waited for the appearance of the target. Again, these findings point both to a more flexible and efficient use of information from the environment among persons with ASD and to the ways in which differences in performance may be related to how abilities are used rather than to their level of ability.

Neurophysiological Evidence of Processing Styles of Persons With ASD

In addition to behavioral data, measures of underlying neurophysiological processing also provide insight into ways that processing styles and the use of information from the environment affect the allocation of attentional and other abilities among persons with and without ASD. Tools such as electroencephalography, particularly event-related potentials (ERPs), and functional magnetic resonance imaging (fMRI) allow us to glimpse when and where in the brain information-processing differences might occur. They are particularly useful when experimental paradigms are not sufficiently sensitive to elicit behavioral differences. We provide examples from studies in which neurophysiological tools were applied to behavioral paradigms of semantic and perceptual processing that are associated with attention.

In one example from ERP research, Russo, Mottron, Burack, and Jemel (2012) addressed the accepted notion that persons with ASD do not display an N400 response, a negative ERP component that occurs 400 ms after the presentation of the stimulus that is observed among TD persons on tasks in which button presses are made to reflect a congruent response. On this task, the participants were asked to determine, via button press, whether an image of an animal (e.g., a dog) matched or did not match an animal sound (e.g., a bark, a congruent response; or a meow, incongruent response). Russo et al. found a clear N400 among the TD participants that was not observed among the age- and performance IQ-matched adolescents and young adults with ASD, despite similar reaction times and accuracy rates between the groups. However, Russo et al. identified a much earlier ERP response, at around 100 ms, that differentiated between congruent and incongruent trial types among the participants with ASD, indicating that they had detected whether or not the picture and sound matched much earlier than their peers. These findings suggest a very different style of processing on this type of task as neurophysiological responses that occur before 300 ms are thought to reflect perceptual responses, whereas those that are slower are thought to reflect higher-order processes such as attention. Thus, the lack of an N400 response among persons with ASD did not indicate a lack of a meaningful neurophysiological

response, but rather that they processed the same information much faster and in a different way (perception) than their matched TD peers (attention).

The notion that individuals with ASD rely on their perceptual processes more than their TD peers, and at times, in lieu of higher-order processes is also supported by fMRI work. For example, Sahyoun, Belliveau, Soulières, Schwartz, and Mody (2010) asked participants to choose which image (of three choices) best completed a 2 × 2 or 3 × 3 matrix in three categories of problems: a visuospatial category in which the correct answer required reasoning based on visual transformation alone; a semantic category in which determining the correct answer required participants to draw semantic relationships between items; and a mixed category in which semantic inference was available and informative but not necessary to solve the task. Sayhoun et al. found no differences in the behavioral performance between intellectually able adolescents and young adults with ASD and age- and IQ-matched TD participants with respect to either reaction time or accuracy, yet clear differences were found in the brain regions activated by the two groups across the different experimental conditions. The TD participants activated fronto-temporal networks in the two conditions in which semantic information was available (even if it was not needed to solve the task), whereas the participants with ASD tended to rely on more posterior occipito-temporal and ventral brain regions associated with visual processing. Consistent with the evidence from Russo et al. (2012), Sayhoun et al.'s findings reflect the reliance of persons with ASD on more basic perceptual processes to solve tasks that are widely considered to be those of higher-order reasoning and that involve the activation of semantic, frontal networks among TD persons.

The findings from both the ERP study and the fMRI study reported here are neurophysiological evidence that individuals with ASD generally attend differently than TD peers and rely more on what are traditionally considered visual and perceptual areas and less on frontal networks traditionally considered higher-order cognition and attention areas. Although the implications for these differences with regard to typical day-to-day activities might only be highlighted in more nuanced and complex real-world tasks, the findings of similar key indexes of behavior including accuracy and speed highlight the contention that the essential question is how, rather than how well, individuals with ASD process information on any given task.

Emerging Trends in the Study of Attention in Typical Development

Ironically, the defect and difference accounts of attention and virtually all aspects of functioning that pervade the field of intellectual disability and ASD are also evident in the study of typical development as the research questions are typically framed as "Does X have Y?" at a particular age or stage of development, relative to the maturational pinnacle of performance in adulthood. Accordingly and not surprisingly, empirical accounts of attention inevitably reflect improvements in attentional abilities with age (Ristic & Enns, 2015b). Based on their extensive review of the developmental literature on attention, Ristic and Enns (2015a) argued that decades of developmental attention research across multiple paradigms have led to a simple unsatisfying conclusion—that voluntary control over attention improves during childhood. In response, they argue that the focus of the study of attention in development needs to be reconsidered and that tasks of reaction time—the primary dependent variable in studies of attention—are limited because either the youngest children fail to access the task or adults plateau. Furthermore, when paradigms are adapted to control for this issue, often the effect size of the independent

variable correlates with speed of performance, which also changes with age. However, following from Bronfenbrenner's (1977) critique that "much of contemporary developmental psychology is the science of the strange behavior of children in strange situations with strange adults for the briefest possible periods of time" (p. 513), even the voluntary control of attention has been found to be similar to adults' attention in some situations when paradigms enable children to attend as they would in real life (e.g., Fletcher-Watson, Collis, Findlay, & Leekam, 2009).

The nature of the images used as stimuli seems to play a particularly essential role. Enns and Ristic (2015a) cited several studies to highlight that attention appears to "operate differently" on paradigms in which the traditional use of geometric shapes as stimuli was forsaken in favor of the presentation of everyday images with social and emotional content. They noted that many of the previously documented age-related changes that had been found in studies with the traditional arbitrary geometric shapes were no longer found when real-world and likely more salient displays were used as the stimuli. Accordingly, Ristic and Enns concluded that age-related differences in attention must be considered in relation to the social, emotional, and evolutionary demands of the task and stimuli.

The understanding of typical developmental trajectories of global and local perception has also been shaped by these issues concerning the nature of the task and stimuli that may be independent of actual developmental differences in ability. In an early example, Prather and Bacon (1986) found that children aged 2 to 5 years old were able to name parts and wholes of simple—age-appropriate—pictures but displayed difficulty naming both parts and wholes in more complex drawings. They concluded that the coordination, but not the detection of global and local attention, was most influenced by developmental processes. Moreover, Kimchi, Hadad, Behrmann, and Palmer (2005) found that when elements of a display contained either tightly spaced many-element groupings at the local level or sparse few-element groupings at the global level, children as young as 5 years old performed at adult levels. Using stimuli with an intermediary number between Kimchi et al.'s many- and few-item displays, Kovshoff, Iarocci, Shore, and Burack (2015) found that in a selective attention task, explicit instruction to attend to either the global or local level of analysis influenced performance on the task so that children were able to use this information to direct and focus their attention, and performance was similar to adult levels at younger ages. However, when children were required to attend to both the global and local levels simultaneously in a divided attention task, more robust developmental trajectories were found.

SUMMARY

This rethinking of the development of attention and the relevant research questions and paradigms are consistent with the emerging emphasis in the field on the dynamic interactions between the developing individual, their developing brain, and the environment (Ristic & Enns, 2015a, 2015b). Rather than a focus on the abilities per se and how well they function, the more meaningful question is how they function within the context of the environment in relation to the individual's developmental status—as different environments and even different aspects of the same environment are relevant or salient to children at different ages, or from different backgrounds, or with different interests. Concordantly, Krauzlis, Bollimunta, Arcizet, and Wang (2014) argued that attention is not a cause predetermined by external sensory inputs

that are transmitted through brain circuits, but rather that the individual must interpret and evaluate many different sources of information—"not only the sensed features of the external world but also the internal status of the subject, their prior knowledge and their ongoing needs" (p. 457). The implication is that attention may not be as fixed a state as is reflected in colloquialisms such as, "He has a short attention span" or "She is distractible," but rather, it is more fluid and likely to involve value-based decision making. Thus, it may be more accurate to say under X, Y, and Z conditions, his focus is sustained for a longer period of time or she is focused on the task at hand. From a developmental perspective, this view of attention predicts that attentional styles or biases are learned over time and reflect personal experience and rewarding outcomes.

Echoing Zigler's (1967, 1969) argument that performance among persons with intellectual disability must be considered in light of their own learning history and motivation, Ristic and Enns (2015a) contended that research on the development of attention must take into account "how that individual's history, motivation, preferences, traits, and cultural roots might interact with, influence, and ultimately change their ability to pay attention" (p. 159). Here, attention is not the end point of a matured adult-based attention system that has increased in capacity over time, but only one component of a maturing system that transacts with the environment and experience. This reconceptualization of attention throughout development as a dynamic process enables the establishment of the theoretical concept of attention as both trait and state that can lead to a more ecologically valid real-world understanding that is focused on how people attend and process information in different contexts rather than on reductionist monolithic questions of "have or have not," "can or cannot," or even "How well?"

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