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Sensory, Motor and Attention Characteristics of Autistic Children

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Introduction

In contrast to the common notion of autism as simply a disorder of social development with one or more specific impairments related to understanding and participating in reciprocal social interactions, more current conceptualizations are based on the notion of a condition that involves complex patterns of atypical processes, especially in the areas of perception, attention and motor development.[1] Associated in some cases with relative strengths and in others with weaknesses, the processing and production of information and action across these systems are altered among persons in such general ways that it suggests “hard-wired” neurological differences.

Subject

Autism is increasingly conceptualized and even diagnosed in relation to attention, sensory and motor characteristics. For example, in the realm of attention, fewer than typical instances of spontaneous initiations of *overt joint attention* and unusual overt responses, such as reduced instances of alternating gaze, in joint attending opportunities in naturalistic settings have

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become essential features of diagnostic instruments that are based on direct observations of preschoolers. In the realm of perception, perceptual atypicalities are now highlighted in the diagnosis of autism by the inclusion of “sensory issues” in the working drafts of the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders, which will soon be adopted as the standard for classification and diagnosis in North America. The centrality of manifestations of atypical motor development, such as the occurrence of repetitive movements, to the autism phenotype has long been acknowledged in virtually all diagnostic systems.

Problems

The earliest and most striking aspects of autism include significantly diminished overt and spontaneous attention to voices and faces that are associated with increased attention to non-social, as opposed to social, aspects of the world. These types of behaviours, which involve many of the “negative symptoms’’ – behaviours that are never or rarely seen in this population although they are common in the general population – are central to social models of autism or to more general models of atypical attention and perceptual processes, such as those related to atypicalities in the selection of attention target and the processes of the voluntarily planning of this selection. This could also indicate that the series of process by which humans detect, recognize, store and mentally manipulate representations of socially relevant patterns are uniquely and intrinsically different from the norm in autism.

Research Context

Atypical attention in autism was initially, in the 1960s and 1970s, discussed in terms of “overselectivity,” an excessive focus on certain features of a stimulus or the environment, or in terms of problems in “arousal” modulation, with both over-arousal and under-arousal suggested as the source of attention and other basic atypicalities in autism. By the 1980s, models of autism were based on evidence of deficits on parameters of attention (e.g., switching of attention from one focus to another), “joint attention’’ and competition between social and non-social targets in the triggering of attention behaviours. Perception is studied in the context of “sensory hypersensitivity” – the search for specific auditory and visual patterns, perceptual peaks, impaired face perception, and generally enhanced low-level perceptual encoding. The study of motor cognition is still in its infancy.

Key Research Questions

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The study of attention in autism is largely focused on disentangling the potential sources of impairments – do they emanate from a problem in one or more attention mechanisms per se (e.g., control, switching and filtering), in their relation with goal-related executive mechanisms, or as secondary effects of atypical processes in other domains such as perception?

The study of perception includes considerable emphasis on enhanced perceptual processing – at which level of processing does it occur (i.e., early encoding, pattern formation and manipulation or both)? Is it more evident in *basic (bottom up) or higher-order (top down) systems of processing*? And, is it an example of a category-specific perceptual abnormality, such as social stimuli for example?

The study of motor development is focused on individual differences among the subgroups of autism spectrum disorders. Why do some autistics display some kind of *motor apraxia* while most others are proficient at this level? Do the sub-groups of autism spectrum disorders differ (autism versus Asperger's) in motor development? And to what extent are differences found across subdomains of functioning (gross versus fine motor skills; speech versus other motor abilities)?

Recent Research Results

Attention

The notion of a primary deficit of general attention functioning is incompatible with recent evidence of faster than average detection of non-social patterns,[2] including multimodal ones, and superior detection of targets that are peripheral to faces.[3] With regard to selective attending to social information, the relevant mechanisms of attention appear to be intact, although without the typical category-specific bias to faces. Similarly, the abilities to switch attention from one target to another and to disengage attention from one target in order to attend to another are intact, although initial suggestions were that they were impaired due to high levels of rigidity. In contrast, autistics show an atypical interaction between perception and attention in the form of a "local bias'' or attentional orientation toward parts over wholes, that contrasts with the typical bias in favour of global targets.[4]

The interaction of atypical mechanisms of attention and perception in autism are also manifested in characteristically "random" face-scanning strategies, in which the focus on eyes is diminished considerably – despite all the possible information that can be extracted from the eyes. However, this is not just a case of "gaze avoidance'' as the focus on eyes tends to be replaced by efforts to

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scan other face parts. Similarly, the long-held notion of the lack of any gaze following gives way to more fine-tuned understanding as autistics are able to follow other peoples' gaze, especially when gaze orientation reliably predicts the presence of an object.

In the auditory modality, the diminished overt attention and body orientation to caregivers' voices is an essential aspect of the autistic phenotype in toddlerhood. Whereas brain indices of attention toward speech-like stimuli are diminished, those involved in the detection of non-social auditory targets are fast and accurate.

Perception

Perception includes the selection, organization, interpretation and the construction of the representations of external stimuli within the sensory system. Perceptual processes range from low-level perception, such as the extraction of elementary features from within a figure, to higher level perception, such as the identification of representations of an object representation. The perception of social information becomes increasingly distinguished from non-social information as the development of the mechanisms for social information entails increasing specialization that is distinct from that of other types of information.

Some perception-related behaviours among persons, such as atypical visual, random exploratory behaviours and lateral glance when exposed to periodic motion are relatively specific to autism. In addition, children with autism appear to fixate from an early age on audio-visual synchrony, as in the case of non-arbitrary coincidence between a visual and auditory event, and recurrent geometric patterns.[5] Examples of superior visual and auditory low-level perceptual processing are common, including pattern detection, construction, manipulation, and the discrimination of luminance, pitch[6] and symmetry. Although the integration of mechanisms appears intact under some experimental conditions, the typical spontaneous bias in favor of global aspect of information is diminished in autism. In contrast, the frequent suggestion that the perception of motion is impaired is not well supported by the scientific evidence.

Autistics are better on tasks requiring detection of embedded targets as early as three years of age. The finding of an enhanced manipulation of two-dimensional (block design) objects is one of the most replicated cognitive finding in autism, and extends even to three-dimensional (mental rotation) objects. However, this strength is partly, but not entirely, a methodological artifact that arises from the use of verbal tests that underestimate the intelligence of autistics and therefore

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leads to matching procedures with less intelligent non-autistic comparison participants.[7]

Despite the early notions of a face processing deficit, the evidence is now more nuanced. Autistics show typical levels of performance on face perception tasks that involve facial images, although their scanning, sampling and later processing of faces are atypical.[8] In the auditory modality, the enhanced processing of the physical aspect of speech may be associated with speech delay, a characteristic that is unique to autistics. All aspects of perception in autism appear to be less influenced by verbal, emotional, and generally by non-perceptual aspects of cognition. Rather, perception appears to play a prominent, if not always beneficial, role across a range of areas of functioning including language and problem-solving and reasoning.[9] This is supported in the visual modality by compelling evidence from a functional imaging meta-analysis of all tasks of visual stimuli in which autistics were found to consistently display superior activity across brain regions involved in visual perception and expertise.

Motor abilities

Motor atypicalities include difficulties in basic motor control, coordination, posture, speed of execution and gait, movement planning and anticipation of motor responses. Several aspects of atypical motor development are found in subgroups of ASD, and not across the entire population. Whereas oral apraxia is not common to all autistics, the limitations of motor impairment to speech in some children raises questions. Atypicalities in visuo-motor coordination or "clumsiness," are more often associated to Asperger syndrome, who do not present with visuo-spatial and auditory peaks, than to autism per se. Conversely, among autistics per se, those with histories of speech delay, but not those without speech delay, display profound peaks of visuo-spatial processing.

Research Gaps

One promising line of research is to bridge the well-established evidence of enhanced attention orientation toward perceptual regularities like auditory and visual patterns to initiatives in early intervention, in order to favour speech, literacy and improved understanding of the non-autistic world. At a fundamental level, we need to fill the gap between our understanding of behavioural and electrophysiological indices of attention and perception and the relation to cellular and genetic contributors. The role of the social and non-social aspects of the stimuli in perceptual skill and expertise needs to be better understood.

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Conclusions

The visual and auditory systems of autistics provide the rest of the brain with qualitatively and quantitatively different information than typical persons, yet that does not necessarily imply deficit.[10] For example, attention is not biased to prioritizing social information, but socially-relevant material may still be processed effectively. Perception is more autonomous with regard to emotions, expectations and language-mediated processes. It is also more truthful and less distorted by top-down influences among autistics than among typical individuals. Although autism is characterized by a distributed, multilevel alteration of neuro-cognitive mechanisms, it is especially unique with regard to specifics of attention, perception processing and motor cognition.

Implications for Parents, Services and Policy

Parents' understanding of atypical attention, perception and related behaviours, particularly in relation to the development of speech, should be addressed psycho-educationally. For example, aversive reactions due to auditory hypersensitivity, and positive emotions related to visual contemplations, may be a major element of daily interactions with an autistic toddler. In developing services and policy for early intervention, parents and professionals should consider that it might be more ethical and effective to present young children with autism information within a format that triggers their attention instead of forcing them to follow programs based on typical development and painful conditioning procedures.[11]

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