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COMMENTARY ON "MOTION PERCEPTION IN AUTISM"
(E. MILNE, J. SWETTENHAM, & R. CAMPBELL)

Science in motion: The quest for coherence in emerging research on autism

Jacob A. Burack[1,2], Natalie Russo[1], Anna Matejka-Grivas[1], Anna Bonnel[1], and Grace Iarocci[3]

1. McGill University, Montréal, Canada
2. Hôpital Rivière-des-Prairies, Montréal, Canada
3. Simon Fraser University, Burnaby, Canada

The recent commemorations of the 50th year since Albert Einstein's death and the 100th anniversary of the publication of his seminal paper on relativity led to considerable discussion about the characteristics and origins of great science. Among other issues, scholars and lay persons alike asked, "What distinguishes a 'great' theory or scientific finding from others?" and "What are the sources of these foundational ideas?". Einstein's work provides a useful model for understanding the characteristics of great research as the essence of his contributions is typically described in the context of a "big theory" with considerable explanatory power for understanding the physical world in which we live. Clearly, scientific theories and findings that are far-reaching and broadly informative are more valued than those that can only be applied to very

Correspondence should be sent to Jake Burack, Department of Educational Psychology, McGill University, 3700 McTavish Street, Montréal, Québec, H3A 1Y2, Canada (e-mail: jake.burack@mcgill.ca)

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circumscribed phenomena. The high regard for big-picture theories is manifested, especially when they are espoused by prominent scholars or are about intuitively interesting topics, in their publication in high impact journals of general interest where they are most visible to both the scientific and lay communities. However, this quest for a "big story" is rarely attained as it is almost inevitably constrained by the methodological minutia of the smaller stories of which it is comprised and of competing theoretical accounts.

Milne, Swettenham, and Campbell's (2005) analysis of the initial studies of motion perception among persons with autism highlights some of the difficulties and complexities of establishing a big theory in the study of populations with developmental disabilities, such as autism or Asperger syndrome. Their paper includes a review and analysis of the few articles on the topic and the articulation of Milne et al.'s contention that motion perception may play an important role in understanding autistic symptomatology through its link to the functioning of magno- and parvocellular pathways. The topic is intuitively appealing and the cited articles are all provocative, thoughtful, informative, and published in high-impact and much respected journals, yet Milne et al. introduce many of the problems inherent in providing order to the story. Our goal is to extend Milne et al.'s concerns about methodological inconsistencies and theoretical underpinnings in developing a coherent understanding of this, or any, nascent area of research in the study of autism. In addition, we provide a possible alternative account for understanding atypical motion perception among persons with autism that arises from a different reading of the prior work in relevant areas. Neither the methodological nor theoretical critiques should be construed as criticisms of either Milne et al.'s article or the initial studies of motion perception, or as implying a message of despair in autism research, but rather simply as an articulation of some thoughts on the intrinsic messiness of essential story construction.

Conceptual concerns

In attempting to integrate findings from across studies, Milne et al. (2005) highlight a series of conceptual and methodological discrepancies that relate to the operationalization and testing of motion perception in the study of persons with autism. In the current response, we follow-up on and attempt to extend this discussion by highlighting these difficulties as

examples of empirical and theoretical challenges to developing a nascent area of research in autism.

Conceptualizations of motion and the potential implications

Motion perception is not a unitary phenomenon, and is conceptualized with respect to coherence or thresholds of perception, complexity (such as first vs. second order), and differences between the perception of social/biological and non-social motion (Milne et al., 2005). Each of these different frameworks of motion perception are associated with specific theories, paradigms, and, most important, implications for understanding autism. For example, impairments in motion coherence and perceptual salience, as cited by Milne, Swettenham, Hansen, Campbell, Jeffries, and Plaisted (2002) and Bertone, Mottron, Jelenic, and Faubert (2003) may be related to prevailing ideas about the relation between characteristics of autism and impairments in basic bottom-up aspects of dynamical perceptual processing (Mottron & Burack, 2001). Alternatively, Moore, Hobson, and Lee's (1997) use of a paradigm that involved conscious control and categorization abilities reflect a distinction between object and biological motion that is consistent with more top-down approaches to social cognition (e.g., Klin, 2000). Although the discussions about atypicalities in top-down versus bottom-up processing and the emerging notions of motion perception may be mutually informative, the differences across conceptualizations and frameworks pose a challenge to attempts to synthesize the literature into a single story.

The nature of the tasks and the dependent variables of interest. The disparities in task demands, despite the use of similar stimuli, between the Moore et al. (1997) and Blake, Turner, Smoski, Pozdol, and Stone (2003) studies highlight methodological difficulties in providing a cohesive literature. Moore et al. asked typically developing participants and persons with Autism Spectrum Disorders (ASD) to state whether each animation presented in brief video sequences of point-light displays portrayed an object or a person and to describe "what you think the person is doing". The dependent variable was the amount of stimulus exposure needed by participants to correctly identify the nature (human or object) of the stimulus represented in the light display. In contrast, Blake et al. (2003) used a 2-alternative forced-choice task, designed to be amenable to signal detec-

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tion analysis, that entailed measuring the ability to correctly determine whether a point-light stimulus was or was not a person. Blake et al. (2003) suggest that one possible reason they found group differences but Moore et al. did not was that they used precise signal detection methodology, whereas the other group's verbal report paradigm was more susceptible to response bias, as it was based on the participants' verbal report of whether a stimulus was a person or an object rather than timing and sensitivity of detection. Although this type of explanation indicates that evidence of a phenomenon is often contingent on the choice of task, it also highlights the potential usefulness of comparing findings across tasks. Clearly, convergent evidence from different tasks indicates a more robust phenomenon but fine-tuned differences across studies can be informative with regard to the phenomenon of autism, theoretical constructs, tasks, and some combination of them.

Task difficulty and complexity. As is often the case in the comparison of different groups, especially between those with and without atypicalities, the ability to generally detect differences between groups is largely dependent on the level of task difficulty or complexity (Bishop, 1997). Milne et al. (2005) highlight that the inconsistent findings between Bertone et al. (2003) and others (e.g., Milne et al., 2002; Spencer, O'Brien, Riggs, Braddick, Atkinson, & Wattam-Bell, 2000) may be explained by the different levels of difficulty of the stimuli. Milne et al. contend that when more complex first-order stimuli are used, such as in a random dot kinematogram, individuals with ASD display impaired coherent motion perception in comparison to typically developing participants (Milne et al., 2002; Spencer et al., 2000). When tasks such as random dot kinematograms are used to establish a *threshold* for coherent motion, participants with ASD do not show motion blindness, but rather some evidence of a denser signal to detect coherent motion (Milne et al., 2002). Alternatively, Milne et al. (2005) suggest that the differences between first and second order motion perception may be related to the complexity of the latter as suggested by the finding that both groups were more sensitive to first than second order motion. Only sufficiently difficult or complex tasks may be sensitive enough to highlight such an impairment (Milne et al., 2002) although excessively difficult tasks may obscure differences as well. Thus, as with virtually all areas of functioning, task difficulty and complexity need to be considered both in within group

performance on different tasks in a single study and in comparisons of findings across different studies.

Diagnostic issues and symptom severity. The implications of diagnostic issues and symptom severity are highlighted by Milne et al.'s conclusion that the initial findings in motion perception are neither consistent across the continuum of ASD nor within any single category of ASD. Cross study comparisons are complicated by the use of different groups from across the continuum of ASD. For example, Avikainen, Kulomaki, and Hari (1999) and Gepner and Mestre (2002) only included children with autism of average IQ or Asperger syndrome, whereas the other researchers included children with autism regardless of level of functioning. The potential impact of group differences is exemplified in Gepner and Mestre's (2002) findings that three children with autism with developmental delay showed decreased postural reactivity while three children with Asperger syndrome showed increased postural reactivity to visual motion. These group differences are certainly preliminary and need to be interpreted cautiously due to the small number of participants and the differences in MA between the two groups, but highlight essential issues of homogeneity-heterogeneity of the population of persons with ASD, optimal grouping in relation to diagnostic category or IQ level, and the appropriateness of generalizing from one subgroup to another.

In addressing the potential differences in motion perception in relation to differences in diagnosis, symptomatology, and severity, Milne et al. (2005) raise the issue of group composition and the relation between motion perception and clinical features of ASD. The ADOS and ADI-R are generally considered the gold standards of diagnosis and the time appears ripe for the inclusion of symptom makeup as a methodological consideration, at least at the descriptive level. The simple noting that autism was diagnosed according to the ADI-R criteria may not be particularly informative about the specific criteria that were met. For example, some children may meet all of the diagnostic criteria under each of the categories specified for autism and others may only meet criteria under certain categories. Although, both children are on the spectrum, they may present very differently with regard to symptomatology. Correlations with ADOS scores may provide some exploratory leads for understanding the ways that task performance is related to clinical features of autism, but the complexity and variability in symptom patterns severely restricts the likelihood of a universal notion of autistic performance. These considerations

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allow for questions as to whether impairments in motion perception are universal to autism or are related to the presence and intensity of a specific symptom or cluster of symptoms.

Inevitably, the participant groups are likely to vary considerably across studies for any number of reasons including conceptual ones, such as the relevance of a specific variable to a given subgroup, or practical ones, such as the availability of specific types of participants. These differences typically muddy comparisons across studies, and can preclude the development of a foundation of studies with which to develop a story. Yet, the use of different groups may facilitate the piecing together of a mosaic of information based on differences and even similarities across groups. The precise reporting of the diagnosis of each participant, and of the tools that are used, allow for more meaningful and accurate comparisons and conclusions among and across groups and research studies.

Developmental level. The range of developmental levels of the participants plays a complex role since a more constrained range allows for more confidence in the finding but limits the scope of implications. Thus, the consistency in the developmental levels, between 7 and 12 years, of the participants across the various studies reviewed by Milne et al. (2005) is helpful but also limiting. The primary benefit is that the findings across studies can be, at least somewhat, compared with regard to the participants' developmental level, however the restricted age range provides a circumscribed understanding of the phenomenon of motion perception. Findings of intact or impaired performance at one developmental level do not necessarily imply that differences will be present either at earlier or later developmental levels (e.g., Burack, Iarocci, Flanagan, & Bowler, 2004). One argument for the primary role of deficits in motion perception as central to autism would entail that they, or some precursors, would be seen early in development and that the developmental implications would be apparent. Although evidence of impairments at specific developmental levels is useful to understanding general findings of impairment, a developmental perspective is needed to assess the role of the deficits in motion perception the development of autism and related behaviors.

Matching issues. Due to the unique profile of marked strengths and weaknesses in cognitive, linguistic, and social domains that are evident among persons with autism and other developmental disabilities, the findings from comparisons between groups are often contingent upon the

strategies used for matching groups (e.g., Burack et al., 2004; Mervis & Robinson, 1999; Mervis & Klein-Tasman, 2004; Mottron, 2004). The choices of the group or groups to which the target group is matched, the variables on which the groups are matched, and the tests with which the variables are measured can all significantly affect the extent to which differences or similarities are found between groups (Burack, Iarocci, Bowler, & Mottron, 2002; Russo, Flanagan, Berringer, Iarocci, Zelazo, & Burack, 2005). This necessitates the need for researchers to clearly identify the matching strategies and address the extent to which they are concordant with those of other studies (as well as how they might affect between-study difference). In some cases, similar findings, despite the use of different matching strategies, may reflect evidence of a relatively robust phenomenon, as it suggests the presence of differences regardless of matching measures. For example, Milne et al. (2002) and Spencer et al. (2000) found similarly impaired thresholds of motion coherence among persons with autism as compared to typically developing children, although the former group matched on both chronological age and nonverbal ability (as measured by the Raven's) and the latter on verbal mental age. However, the use of different groups or measures can also preclude a systematic knowledge base regarding strengths or weaknesses as the points of reference vary across studies.

Historical contributions to theory

One way to describe the importance of motion perception, or any emerging area of research, is to place it within the context of the scientific literature. This type of historical perspective can certainly inform both the foundational theories, and the methodologies used to test them. Whereas the complexity of emerging research generally precludes a precise delineation of the historical origins of an idea, the researchers' choice of historical starting point clearly shapes their conceptualization and testing of the relevant hypotheses. For example, Milne et al.'s (2005) attribution of the origins of research on motion perception in autism to Gepner, Mestre, Masson, and de Schonen's (1995) finding of differences between persons with ASD and those with typical development on postural reactivity to visual motion influences their analysis of the empirical findings and theoretical framework. However, even earlier works might be particularly informative to developing theories of motion perception in autism.

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In one early and relevant paper, Ornitz (1970) found atypicalities in vestibular regulation among persons with autism relative to typically developing participants with a paradigm in which participants were rotated in a chair and then stopped. Atypicalities in nystagmus reactions, involuntary eye movements, were noted for the participants with autism, suggesting that adjusting to their own 'physical', or endogenous motion, may be typical in autism. This is supported by Molloy, Dietrich, and Bhattacharya's (2003) findings of increased postural reactivity among persons with autism but not persons with Asperger syndrome relative to typically developing participants matched on gender, age, and ethnicity. In their paradigms, participants stood on either a flat or raised platform with eyes open or closed, and body movements reflecting adjustment to motion were noted. Individuals with autism swayed and demonstrated greater movement patterns than typically developing participants. These findings are suggestive of atypicalities in endogenous motion and may be related to impairments in the perception of visual, or exogenous, motion perception.

The link between exo- and endo-genous motion perception is evident from the historical literature on the typical development of motion perception. The attempt to understand the perception of motion among typically developing persons can be found as far back as the early 1700's with Berkeley, and 1800's with Lotze and Helmholtz. In early theories of motion perception, the way in which the human body moves is the "default frame of reference for representing dynamic events, and places centrifugal information as a contributor to the genesis of perceptions" (e.g., Viviani, 2002). The central axiom of these early motor theories that arose at the same time that afferent and efferent pathways were discovered is that the spatial organization of visual sensations results from the integration of visual inputs and muscular feelings originating from some 'muscled sense' (Viviani, 2002). Thus, the mere act of intending or engaging in a motor act changes perception of motion, suggesting that exo- and endogenous motions are intimately linked. Accordingly, findings of impaired endogenous motion perception may clarify our understanding of impairments in exogenous motion perception.

Conclusion

In summary, Milne et al. provide a thoughtful review and analysis of the early research on motion perception among persons with autism. Their

discussions of the difficulties in synthesizing the few studies that have been published on this potentially essential area of research are informative both about the phenomena itself and about the challenges to developing a bigger story of autism. Differences in the conceptualization and operationalization of the construct, task demands and complexity, developmental levels and symptomatology of the participants, and matching strategies can all lead to unique insights about the about the phenomena but also to quite different understandings of it. Similarly, the retelling of the story through a different historical lens can affect both the ways that studies are developed and that findings are interpreted. In the case of motion perception in autism, the historical lessons regarding the essential links between exo- and endogenous processes are useful guides for an integrated study of the phenomenon. As in all areas of research on autism and other specific populations of persons, the challenge is to find meaning across the mosaic of different studies and findings in order to better understand the population and the observed phenomenon.

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