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Do children with autism spectrum disorders have motor learning difficulties?

Jin Bo[a,*], Chi-Mei Lee[a], Alison Colbert[a], Bo Shen[b]

[a] Department of Psychology, Eastern Michigan University, 341 MJ Science Building, Ypsilanti, MI 48197, United States
[b] Division of Kinesiology, Health and Sport Studies, Wayne State University, 441 Education Building, Detroit, MI 48202, United States

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ABSTRACT

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by social and communication impairments as well as a wide range of behavioral symptoms. For years, motor disturbance reported in ASD has not been treated as a core deficit because of the overwhelming problems in sociability and communication. Recent studies, however, reveal that motor deficits are also fundamental to ASD presentation and contribute to the core symptoms of ASD. Untreated motor problems can persist well into adolescence and adulthood, resulting in long-term physical, psychological, and behavioral issues in individuals with ASD. Thus, the ability to understand and address the overall picture of a child with ASD, including motor dysfunction, has become a critical need. This review focuses on sensorimotor adaptation and motor sequence learning in children with ASD and presents related evidence that compromised motor learning may play a critical role in motor dysfunctions of ASD. It addresses possible factors that explain controversial findings in the literature and discusses potential strategies for facilitating motor learning. Future intervention studies should address the importance of motor learning beyond social and language domains in ASD.

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* Corresponding author. Fax: +1 734 487 1155.
E-mail address: jbo@emich.edu (J. Bo).

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1. Introduction

Children with autism spectrum disorders (ASD) are characterized as having limitations in social interactions and communication, as well as restricted interests and stereotyped or repetitive behavior patterns (APA, 2013). Although clumsiness and delays of fundamental motor skills are commonly observed among individuals with ASD, motor disturbance is not traditionally considered to be one of the core deficits of ASD (Downey & Rapport, 2012). Recently, however, motor impairment has been identified as a fundamental deficit that contributes to the core symptoms of ASD (Bhat, Landa, & Galloway, 2011; Cossu et al., 2012), and insufficient ability to acquire fundamental motor skills has been proposed as the core for the motor dysfunctions in ASD (Gidley Larson, Bastian, Donchin, Shadmehr, & Mostofsky, 2008). It is estimated that the prevalence of Autistic Disorder [based on the Diagnostic and Statistical Manual of Mental Disorders, 4th edition, Text Revision (DSM-IV-TR; American Psychiatric Association, 2000) diagnostic criteria] is around 0.1–0.2%, and Pervasive Developmental Disorder (PDD, based on DSM-IV-TR dianostic criteria) is around 0.51–0.76% (Chakrabarti & Fombonne, 2001; Chakrabarti, Haubus, Dugmore, Orgill, & Devine, 2005). It is estimated that 21–100% of children with ASD display a number of different motor deficits (Green et al., 2009; Pan, 2009), suggesting that motor impairment is a significant but under-estimated deficit among individuals with ASD.

Based on the most current version of *Diagnostic and Statistical Manual of Mental Disorders, 5th edition* (DSM-5; APA, 2013), there are two core areas of impairment in ASD: "social interactions/communications" and "restrictive, repetitive patterns of behaviors, interests, and activities." Although this new diagnostic system may provide a better overall description of the disorder, one main concern raised by both clinicians and researchers is that it does not highlight the importance of motor difficulties among the ASD population. Studies suggest that individuals with ASD not only experience motor coordination difficulties, they also show delays in various aspects of motor development at an early age (e.g., David, Baranek, Wiesen, Miao, & Thorpe, 2012). While DSM-IV-TR (American Psychiatric Association, 2000) suggested that Asperger's disorder, but not Autism, is associated with motor clumsiness, current evidence reveals that both clinical groups are uncoordinated and exhibit motor deficits (e.g., Jansiewicz et al., 2006). A recent study even suggests that motor difficulties should be considered a "cardinal feature" of ASD (Fournier, Hass, Naik, Lodha, & Cauraugh, 2010). In DSM-5 and earlier DSM-IV-TR criteria, however, minimal description of motor impairment has been addressed. The absence of motor impairment criteria and the lack of awareness on motor deficits may prohibit appropriate diagnosis and intervention.

Thus, in this review, we focus on the "motor" aspect of ASD, especially the ability to acquire motor skills (i.e., motor learning). The purpose of this review is to present a synopsis of the current literature on the motor deficits in ASD and their relationships with social communication and behavioral issues, address a possible hypothesis implicating the role of implicit motor learning, and suggest directions for future research and intervention strategies.

2. Motor dysfunctions—another core feature of ASD

Since Kanner (1943) and Asperger (1991) proposed the descriptions of ASD, motor dysfunction of individuals with ASD has focused on stereotyped and repetitive movements, such as hand flapping or body rocking (American Psychiatric Association, 2000). Although stereotyped and repetitive motor behavior is the diagnostic criterion for ASD, parents and mental health providers have often described a wide range of motor problems, such as delays of motor milestones in early development and appearance of atypical motor patterns of both fine and gross motor skills (Lloyd, MacDonald, & Lord, 2013). It has been reported that infants with ASD often display delays in supine, prone, and sitting skills in the first year of life (Lane, Harpster, & Heathcock, 2012). Significantly less static and dynamic symmetry supine position (Esposito & Paşca, 2013) and identifiable sensorimotor symptoms can be clearly demonstrated between 9 and 12 months of age (Baranek, David, Poe, Stone, & Watson, 2006). Toddlers with ASD often display difficulties in reaching, clapping, and pointing (Gernsbacher, Sauer, Geye, Schweigert, & Goldsmith, 2008), as well as crawling, walking, and other motor milestones (Lloyd et al., 2013). Children with ASD also show significant developmental delays in accurately moving hands, wrists, fingers, toes, lips, and tongue (Bhat et al., 2011; Ming, Brimacombe, & Wagner, 2007). Difficulties on these fundamental motor skills often persist well into childhood, affecting motor coordination on a wide range of tasks, such as drawing, typing, writing, speaking, and playing (Jansiewicz et al., 2006).

Clumsiness and atypical motor patterns (such as akinesia/dyskinesia) have been commonly used to describe individuals with ASD. Loh et al. (2007) reported that non-functional arm wave and awkward "hand-to-ear" posture occurred more often among children with ASD compared to their matched peers. Individuals with ASD also display poor postural control (e.g., less static and dynamic symmetry standing position), abnormal gait (e.g., swing leg, waddling gait, etc.), and atypical motor planning and sequencing (e.g., slow preparation in simple goal-directed motor tasks) (Bhat et al., 2011; Downey & Rapport, 2012; Dziuk et al., 2007). School-aged children with ASD demonstrate poor limb coordination and postural instability compared to the age-appropriate norms. Specifically, individuals with ASD show poor upper-limb coordination on visuomotor tasks (Ghaziuddin & Butler, 1998).

With the commonality of motor symptoms (also see extensive reviews in Downey & Rapport, 2012; Fournier et al., 2010) reported in ASD, there is reason to think that general motor difficulties, beyond stereotyped and repetitive behavior, should be considered as one of the core features of ASD. Provost, Lopez, and Heimerl (2007) reported that more than 60% of individuals with ASD demonstrated clear motor symptoms that qualified for early intervention. Thus, evaluation of motor activity may play a significant role in early identification of and intervention for ASD. Furthermore, studies reveal that delays