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The intersection of gross motor abilities and participation in children with autism spectrum disorder

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Abstract

Many children with autism spectrum disorder (ASD) demonstrate movement difficulties in addition to problems with social communication and interactions, and repetitive or restrictive behaviors. The goal of early intervention for children with disabilities is to promote participation in routines and activities, but little is known about the role gross motor abilities contribute to participation for young children with ASD. The purpose of this study was to examine relationships between gross motor abilities and participation in preschool-aged children with ASD. Twenty-two children with ASD participated in the study. Gross motor skills were measured using the Peabody Developmental Motor Scales, Second Edition. Participation was measured using the Preschool Activity Card Sort. Children who had greater gross motor skills also demonstrated greater participation in self-care, high demand leisure, and social interaction activities. Results also identified activities that may be difficult for preschoolers with ASD. Findings suggest that early childhood intervention providers consider the impact of gross motor deficits within the context of participation in daily routines and activities.

Keywords

Autism spectrum disorder; Gross motor skills; Participation

Defined by the International Classification of Functioning-Children and Youth framework (World Health Organization, 2007) as “involvement in life situations,” participation is a multidimensional concept that involves independence, engagement, and social interaction in meaningful and preferred activities (Holloway & Long, 2019). Participation in a host of self-care, family life, individual, and community leisure activities is critical for developing the physical and social skills to become independent adults (Chiarello, 2017). For example, self-care includes the ability to groom oneself, use the bathroom, prepare and eat meals, etc. Family activities include planning family activities/vacations, household chores, and eating

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at restaurants. Individual leisure activities may include reading, watching TV, and computer games, while community leisure activities include age-appropriate activities such as team supports, attending parties with friends, or riding a bike in the neighborhood. Although these types of skills and activities are important and critical for independently living, participation requires engagement in the social context in which the events are taking place.

Research exploring patterns of participation in children with autism spectrum disorder (ASD) has shown that participation in leisure and recreation activities is generally decreased compared to same age peers (Askari et al., 2015). Children with ASD tend to participate in activities in the home rather than in the community and are more likely to participate in solitary activities or with a familiar adult rather than with a peer (Askari et al., 2015; Kreider et al., 2016; Simpson, Keen, Adams, Alston-Knox, & Roberts, 2018). They are less able to perform self-care tasks independently (Jasmin et al., 2009) and tend to participate in fewer social activities, job chores, and physical activity tasks than same age peers (Ratcliff, Hong, & Hilton, 2018). Gaps in participation between children with ASD and typically developing peers widen with age (Ratcliff et al., 2018). Although research indicates that participation may be limited in children with ASD there is a concern that limitations in measurement tools available may not be able to capture the full sense of participation in this population (Yee et al., 2017).

Children with ASD, like other children with disabilities, benefit from a comprehensive intervention approach that builds on a child's strengths to facilitate participation in daily activities. This includes understanding the role motor skills and ability contribute to a child's participation. Although gross motor skills have been identified as an associated characteristic of ASD, interventions to address motor deficits have historically been addressed independent of other domains. Research suggests that children with ASD frequently demonstrate difficulty in attaining and using motor skills in addition to the core deficits of social communication and interaction, and atypical patterns of repetitive behaviors (Paquet, Olliac, Golse, & Vaivre-Douret, 2016). Delays in attainment of fine and gross motor skills (Lane, Harpster, & Heathcock, 2012; McPhillips, Finlay, Bejerot, & Hanley, 2014), difficulties with coordination and balance (Chen et al., 2019; Fournier, Hass, Naik, Lodha, & Cauraugh, 2010; Morris, Foster, Parsons, Falkmer, & Rosalie, 2015), and differences in walking pattern (Kindregan, Gallagher, & Gormley, 2015) are common in this population. The impact of motor skill deficits on children with ASD is largely unknown, however, several studies have suggested potential relationships between motor and other areas of development. For example, early motor delay is predictive of later communication delay in infants at high-risk for ASD (Bedford, Pickles, & Lord, 2016; Bhat, Galloway, & Landa, 2012). Gross motor ability has also been linked to overall severity of ASD (MacDonald, Lord, & Ulrich, 2014). Children with higher gross motor ability have higher social function and specific components of motor skills, ball skills and stationary balance skills, have been shown to be associated with an ASD diagnosis and predictive of social function in this population (Ament et al., 2015; Holloway, Long, & Biasini, 2018).

Previous work has focused on the impact of fine motor skills and sensory processing on participation; however, in light of the growing evidence of gross motor impairments in this population, we chose to look at gross motor specifically. It is possible that gross motor

ability relates to participation in this population in addition to social and communication development. Thus, the purpose of this study was to examine relationships between motor skill ability and components of participation in preschool-aged children with ASD. We also aimed to describe patterns of participation in preschool-aged children with ASD to identify specific components of participation linked to motor abilities.

Methods

Participants:

Children with a diagnosis of ASD were recruited from local clinics, schools, and community organizations. Children were included in the study if they met the following criteria: 1) parent report of diagnosis of ASD by an appropriate licensed healthcare professional, 2) 48–71 months of age, 3) able to participate in standardized tests of motor skills, and 4) without uncorrected vision or hearing impairments. Children who had an additional diagnosis of a condition that was also known to impact motor abilities, such as Down syndrome or cerebral palsy were excluded from the study.

Measures

Childhood Autism Rating Scales, Second Edition (CARS-2):

The CARS-2 (Schopler, Van Bourgondien, Wellman, & Love, 2010) was administered to confirm the diagnosis and describe the severity of ASD. The CARS-2 is a 15-item rating scale of behavior observations that is used to assist in identifying children with ASD. The CARS-2 also includes an unscored parent/caregiver questionnaire to help gather additional information for scoring the scale. The CARS-2 classifies children into one of three symptom severity categories: minimal to no, mild to moderate, or severe. The CARS-2 has been shown to have high agreement with clinical diagnosis made using diagnostic criteria in the *Diagnostic and Statistical Manual of Mental Disorders* (Dawkins, Meyer, & Van Bourgondien, 2016).

Peabody Developmental Motor Scales, 2nd Edition (PDMS-2):

Gross motor ability was measured using the PDMS-2 (Folio & Fewell, 2000). The gross motor quotient is determined by scores on three subtests: Stationary, Locomotion, and Object Manipulation. Individual subtest scale scores and an overall gross motor quotient (GMQ) are calculated from raw scores. The PDMS-2 is a reliable and valid measure of motor skills in children who are typically developing as well as children with disabilities such as cerebral palsy (Wang, Liao, & Hsieh, 2006), intellectual disabilities (Wuang, Su, & Huang, 2012), and ASD (Bremer, Balogh, & Lloyd, 2015; Holloway, Long, & Biasini, 2019; Provost, Heimerl, & Lopez, 2007; Provost, Lopez, & Heimerl, 2007).

Preschool Activity Card Sort (Preschool ACS):

The Preschool ACS (Berg & LaVesser, 2006) was used to measure each child's function and participation in the following domains: domestic life, self-care, mobility, education, interpersonal interactions and relationships, and community. The scale has been shown to have good content validity (Berg & LaVesser, 2006). Parents of the participants are shown

pictures of everyday activities in each domain and are asked if the child participates in the activity. If the child participates in the activity, the parent selects a response that provides information on the amount of assistance the child needs (independent, with adult assistance, or with environmental modification). If the child does not participate in the activity, the parent indicates one of three reasons (child is unable, parent has not offered it, or not available in the environment). The test yields a raw score for each domain based on the parents' answers about the child's participation and assistance required. The Preschool ACS has been used previously in children with ASD (Ajzenman, Standeven, & Shurtleff, 2013; LaVesser & Berg, 2011).

Procedures

This study was part of a larger study to investigate relationships between motor ability and social function. Parent consent was obtained prior to beginning the study. All testing was completed during a single visit at one of two sites. The PDMS-2 was administered by the same physical therapist with 12 years of experience in pediatrics. The parent/caregiver accompanying the child to the visit completed a demographics form and the CARS-2 Parent Rating Form. The Preschool ACS was administered via interview with the caregiver. One of two pediatric occupational therapists and an undergraduate student assisted with administration of the tests as needed, however, final scoring decisions were made by the first author. The CARS-2 was scored at the end of the visit to provide sufficient time for observations of the child's behavior. Information from the parent form was used to inform scoring decisions about behaviors that were not observed during the visit. This study was approved by the Institutional Review Board at the University of Alabama at Birmingham.

Data were analyzed using IBM SPSS version 24. Overall motor scores and participation subdomain scores were summarized using means and standard deviations for the entire group. Pearson correlation coefficients were used to describe the relationships between motor skills and participation subdomains for normally distributed data. Criteria for interpreting correlation coefficients were as follows: low (r<.50), moderate (r=.50–.69), and strong (r>.69) (Carter, Lubinsky, & Domholdt, 2011). Participation subdomains with moderate to high associations with gross motor skills were investigated to determine specific activities with high and low participation.

Results

Participants

Participant demographics for all 22 children in the study are provided in Table 1. Ages of children in the study ranged from 48 to 68 months (M=56 months; SD=6.5). All children had a diagnosis of ASD confirmed by the CARS-2. Most of the children in the study were classified by the CARS-2 in the mild to moderate range (n=14).

Table 2 provides a summary of motor scores and participation subdomain scores for the group overall. The PDMS-2 gross motor quotient score (GMQ) is reported as a standard score (M=74.1; SD=9.7) and gross motor subtests are reported as scaled scores. To calculate the Preschool ACS subdomain scores we followed a method similar to Ajzenman,

Standeven, and Shurtleff (2013) in which 1 point was given for each item the child was able to participate in independently (without adult assistance or environmental modification). Half a point was given for items in which the child required adult assistance or environmental modification to participate. If a child was unable to participate in the task, the child received zero points, regardless of whether it was due to child, adult, or environmental reasons. Maximum possible points for each subdomain were as follows: Self-care, 15; Mobility, 16; High demand leisure, 10; Low demand leisure, 10; Social interaction, 12; Domestic, 11; Education, 10.

Relationships between Motor and Participation Subdomains

Table 3 summarizes the correlations between overall GMQ and Preschool ACS participation subdomains. Moderate correlations were found between overall GMQ and self-care ($r=0.513$, $p=.015$), high demand leisure ($r=0.540$; $p=.009$), and social interaction ($r=0.652$; $p=.001$).

Descriptions of Participation

Frequencies of participation in selected activities from the 3 subdomains that were most associated with gross motor development, self-care, high demand leisure, and social interaction, are shown in Table 4. Only weak correlations were observed between gross motor skills and other subdomains, thus they are not discussed here.

Self-Care: The self-care subdomain evaluated participation in common self-care activities such as dressing, eating with utensils, and tying shoes. Parents reported high frequencies of independent participation in drinking from a straw and putting on shoes. Four children were able to care for their hair (e.g. brushing) independently while an additional eight more were able to do so with adult assistance. None of the children in the study were independent in shampooing their hair, however, parents reported that 12 of them were able to participate with adult assistance. Only three children were able to tie shoes with or without adult assistance. Parents of nine children reported that their child was unable to tie shoes, however, 10 parents noted that the child had not been given an opportunity to tie shoes.

High Demand Leisure: The high demand leisure subdomain evaluated participation in motor activities such as riding a bike, climbing, and skating. Parents reported high frequencies of independent participation in running, throwing a ball, climbing, playing on playground, and kicking a ball. Six children with ASD were able to ride a bike independently while ten were able to ride a scooter. Eight children played with a baseball bat independently and eleven children engaged in playing with a pet independently. Only two children were able to skate independently with 17 parents reporting they have not provided the opportunity for their child.

Social Interaction: The social interaction subdomain evaluated participation in a variety of activities such as taking turns, playing a team sport, and talking with friends. Parents reported high frequencies of independent participation in rough housing with others, looking at books, hugging, going for walks, and gathering with family. Four children participated in playing a team sport, only one of which was able to do so without adult assistance or

prompting. Fourteen children did not have an opportunity to participate in a team sport for parent or environmental reasons. Thirteen children were able to play games with children, however, 10 of the children required adult assistance or prompting in order to participate in the activity. Nine children were unable to engage in play activities with friends.

Discussion

This study found moderate, yet significant positive correlations between overall motor performance and participation in self-care, high demand leisure, and social interaction tasks. Findings indicate that children with ASD who had higher gross motor scores on the PDMS-2 demonstrated greater participation in these tasks. The study also highlighted patterns of participation across different subdomains, indicating activities that children with ASD frequently participate in with and without assistance as well as activities in which participation is more difficult.

The strongest association in this study was between gross motor skill ability and social interaction. This finding is consistent with previous studies that have reported moderate associations between motor and social skills. Children with ASD who have diminished gross motor skills have been found to have lower overall social skills (Holloway et al., 2018), lower socialization skills (Pusponegoro et al., 2016) and decreased general social interaction (Mody et al., 2017). In a sample of older children, moderate correlations between motor and social function were found, however, they did not reach significance (Hirata et al., 2014). That study included children 7–16 years of age, however, the current study focused on younger children who may still be developing gross motor abilities. While previous studies have used tools that measured isolated skills, the current study looked at participation in a variety of activities within contextual activities. For example, instead of asking about whether a child is able to engage in the skill of back and forth conversation, the measure used in this study asks about participating in visiting or gathering with family or friends.

Our findings that gross motor skills and participation in high demand leisure activities are related are also consistent with other literature. Difficulties with motor skills may contribute to decreased participation in leisure and recreation activities for children with ASD (Kheirollahzadeh, Alizadeh Zarei, Amini, & Dehghan Tarzhani, 2018; Potvin, Snider, Prelock, Kehayia, & Wood-Dauphinee, 2013). The current study supports that finding by demonstrating that children with greater motor skills participated in more leisure activities than children with fewer motor skills. Children with ASD are at greater risk for obesity when compared to same age peers (McCoy, Jakicic, & Gibbs, 2016). Exercise has been shown to help maintain a healthy weight in all children, including those with ASD, thus it is important for all children to participate in regular physical activity such as bike riding or team sports (Curtin et al., 2020). It is possible that improvements in motor skills may help decrease risk for obesity by encouraging children with ASD to make healthier choices regarding physical activity and may lead to better weight management.

This study reports moderate correlations between gross motor skills and participation in self-care. Previous work has also reported an association between fine and gross motor performance and self-care in 3–4 year olds with ASD (Jasmin et al., 2009). In addition to

gross motor skill performance, other aspects of sensory-motor behavior such as sensory processing and fine motor skills have also been linked to participation in self-care activities by young children with ASD (Jasmin et al., 2009; Mattard-Labrecque, Ben Amor, & Couture, 2013), thus it is possible that fine motor skill performance and sensory processing may have contributed to our findings.

This study also describes patterns of participation in subdomains, highlighting the role motor development may play in overall participation, a factor to be considered in planning comprehensive functional intervention. Children with ASD in our sample frequently participated in simple, single-step tasks such as throwing a ball or drinking from a straw rather than more complex tasks such as skating or riding a bike. Many tasks with high frequencies of participation were tasks that can be performed alone. For example, many children were able to kick a ball, however, very few played a team sport such as soccer in a community recreation league. This finding is critical for planning comprehensive intervention. If the goal of intervention is to promote participation, opportunities to participate in age and developmentally appropriate activities within the appropriate context are critical.

Another theme that was highlighted in our study was that children with ASD may not always be given opportunities to participate in activities, either due to parent restrictions or environmental availability. For example, 18 children in our study did not play a team sport, however, parents for 14 of those children indicated parent or environmental factors as the reason the child did not participate. Likewise, 9 children in our sample did not ride either a bike or a scooter. Among children who did not ride a scooter, parent factors were given more frequently (8/11) than child reasons. The opposite was true for children who could not ride a bike. Only 2 of the 13 instances in which the child did not ride a bike were due to parent (1/13) or environmental reasons (1/13), indicating that parents may provide opportunities to begin bike riding more readily than riding a scooter. Previous studies have suggested that parents limit participation in physical activities for a variety of reasons including, frustration over child's previous lack of success with the activity, perception or attitude that participation in such activities is not important, and lack of available time or financial resources (Nichols, Block, Bishop, & McIntire, 2019; Obrusnikova & Miccinello, 2012).

Implications for Professionals

Findings from this study highlight multiple implications for practice. First, this study adds to the growing literature that gross motor development is an area of difficulty for children with ASD. Most available interventions for children with ASD focus on the primary areas of deficit, social communication and interaction and atypical behaviors, however, difficulties with motor skills are also common in this population. Research shows interventions designed to target skill acquisition, balance, and coordination in children with ASD can improve motor skills (Healy, Nacario, Braithwaite, & Hopper, 2018; Ruggeri, Dancel, Johnson, & Sargent, 2020; Srinivasan, Cavagnino, & Bhat, 2018). This study identifies routines in which participation may be impacted by motor deficiencies and provides perspective for contextualization of motor skill intervention.

This study also highlights several associations between motor abilities and specific components of participation. The interdependence between the motor domain and other areas of development has been highlighted in previous research (Holloway & Long, 2019) and suggests that practitioners need to take a comprehensive approach when working with children with ASD. Like all individuals with developmental disabilities, the needs of children with ASD are complex and are unlikely to be met by a single practitioner from a single discipline. Research has shown that movement-based interventions may benefit other areas of development such as social, communication, and behavior (Bremer, Crozier, & Lloyd, 2016; Holloway & Long, 2019; Lee, Lambert, Wittich, Kehayia, & Park, 2016). Thus, comprehensive intervention programs should include the appropriate integration of multiple domains. This study adds to those findings by highlighting specific routines that may be impacted by deficits in gross motor skills in this population.

Findings in this study also indicate the need for parents, caregivers, and the community to include children with ASD in community-based activities, such as non-competitive team sports and recreational activities such as soccer, teeball, dance, or bike riding. Some children in this study received limited opportunities to participate in age-appropriate activities. Parental attitudes, financial resources, and available time are significant factors in participation in physical activity for children with ASD (Nichols et al., 2019; Obrusnikova & Miccinello, 2012). While parents report many strategies they use to enhance participation, they also report that most strategies limit quality participation, leading families to avoid involvement in challenging activities, especially community activities (Schiavone, Szczepanik, Koutras, Pfeiffer, & Slugg, 2018). Parents also report that lack of community programs with adequate staff training and accommodations impact participation (Must, Phillips, Curtin, & Bandini, 2015; Nichols et al., 2019; Obrusnikova & Miccinello, 2012; Thompson & Emira, 2011). Supporting parents and community activity leaders to identify strategies to enhance community participation is a critical role of professionals. Unfortunately, few providers assume responsibility to work with community agencies and organizations to promote inclusive practices in leisure activities.

Limitations

This study is not without limitations. No comparison group is available to compare responses for the participation measure. It is possible that parents may be hesitant to involve their 4- or 5-year-old child in team sports or riding bikes, regardless of whether or not the child has ASD. Also, the current demands on parents of children with or without ASD to manage busy work and home schedules may lead them to lower their expectations of self-care skills in the interest of time. While previous studies using the Preschool ACS have demonstrated lower participation in all domains for children with ASD when compared to typical peers, the similarities and differences to participation between children in our sample and same-age peers is unknown (LaVesser & Berg, 2010). Also, results may have been affected by the parents' interpretation of the meaning of participation. Finally, the Preschool ACS asks if parents/environment influence participation in certain activities. Thus, in some situations a parent may be hesitant to have a child participate, in another it may be that inclusive or adapted activities are not available or the activity leaders are not sensitive to the needs of children with ASD or unwilling to have them participate.

Conclusion

Many children with ASD demonstrate difficulties in gross motor skill development. This study is one of a few to link gross motor skill development and performance with participation in children with ASD and highlights the importance of a comprehensive approach to services to support this population. This information could be helpful to therapists and early childhood professionals by providing a description of participation in children with ASD in order to make recommendations for future research and clinical practice.

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Table 1.

Participant Demographics

	Number (%) N=22
Race	
White	15(72%)
African American	4 (18%)
Asian	1 (5%)
More than 1 Race	1 (5%)
Ethnicity	
Non-Hispanic	22 (100%)
Gender	
Male	21 (96%)
Female	1 (5%)
ASD Severity	
Mild to Moderate	14 (64)
Severe	8 (36%)

Table 2.

Summary of Scores

	Mean (SD) n=22	Range
Peabody Developmental Motor Scales Second Edition		
Stationary	5 (1.3)	3–9
Locomotion	6.5 (1.9)	4–11
Object Manipulation	6.5 (1.9)	2–10
Gross Motor Quotient	74.1 (9.7)	57–94
Preschool Activity Card Sort		
Self-Care	8.8 (2.0)	4.5–12.5
Mobility	10.3 (2.6)	4–16
High Demand Leisure	6.8 (1.5)	4–9.5
Low Demand Leisure	8.5 (1.4)	5.5–11
Social Interaction	8.0 (2.0)	3.5–12
Domestic	5.1 (2.7)	0.5–9
Education	7.0 (1.6)	4–9

Table 3.

Pearson Correlations between Gross Motor Ability and Participation Subdomains

	GMQ	Self	Mob	HDL	LDL	Soc	Dom	Edu
GMQ	1	0.513*	0.206	0.540*	0.357	0.652*	0.298	0.286
Self		1	0.569*	0.436*	0.633*	0.638*	0.592*	0.400
Mob			1	0.286	0.338	0.604*	0.455*	0.369
HDL				1	0.615*	0.535*	0.634*	0.291
LDL					1	0.438*	0.477*	0.199
Soc						1	0.541*	0.573*
Dom							1	0.044
Edu								1

Abbreviations: GMQ, PDMS-2 gross motor quotient; Self, self-care; Mob, Mobility; HDL, high demand leisure; LDL, low demand leisure; Soc, social interaction; Dom, domestic; Edu, education

Table 4.

Frequency of Participation in Selected Activities

	Total Yes No. (%)	Without Assistance	With Assistance	Total No No. (%)	Child Reasons	Parent/ Environment Reasons
Self-Care Subdomain						
Caring for hair	**12 (55)**	4	8	**10 (45)**	8	2
Tying Shoes	**3 (14)**	1	2	**19 (86)**	9	10
Shampooing hair	**12 (55)**	0	12	**10 (45)**	8	2
Drinking from a straw	**21 (95)**	21	0	**1 (5)**	1	0
Putting on shoes	**21 (95)**	17	4	**1 (5)**	1	0
High Demand Leisure Subdomain						
Riding a bike	**9 (41)**	6	3	**13 (59)**	11	2
Climbing	**22 (100)**	21	1	**0 (0)**	0	0
Skating	**3 (14)**	2	1	**19 (86)**	1	18
Running	**22 (100)**	22	0	**0 (0)**	0	0
Throwing a ball	**22 (100)**	22	0	**0 (0)**	0	0
Playing on playground	**22 (100)**	21	1	**0 (0)**	0	0
Kicking a ball	**21 (95)**	20	1	**1 (5)**	1	0
Riding a scooter	**11 (50)**	10	1	**11 (50)**	3	8
Playing with a bat	**13 (59)**	8	5	**9 (41)**	2	7
Playing with a pet	**13 (59)**	11	2	**9 (41)**	5	4
Social Interaction Subdomain						
Rough housing	**22 (100)**	20	2	**0 (0)**	0	0
Looking at books	**21 (95)**	20	1	**1 (5)**	1	0
Hugging	**22 (100)**	20	2	**0 (0)**	0	0
Playing a team sport	**4 (18)**	1	3	**18 (82)**	4	14
Going for walks	**21 (95)**	19	2	**1 (5)**	0	1
Playing games with children	**13 (59)**	3	10	**9 (41)**	9	0
Gathering with family	**21 (95)**	19	2	**1 (5)**	0	1