Using Constraints to Design Developmentally Appropriate Movement Activities for Children with Autism Spectrum Disorders

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Individual, environmental, and task constraints all influence how children move.

High-quality teachers constantly reflect on what lessons and activities work best in their classrooms, and they are always trying to develop better teaching methods in order to reach the diverse community of students enrolled in their classes. The Individuals with Disabilities Education Improvement Act of 2004 mandated that all children have access to a free and appropriate public education, including physical education, adapted to meet their needs. In order to achieve this, physical educators need to find appropriate strategies and techniques for teaching students with and without disabilities.

One of the fastest-growing student populations in schools today is children with autism spectrum disorder (ASD). The term ASD includes autistic disorder, Asperger’s disorder, and Pervasive Developmental Disorder, Not Otherwise Specified (American Psychiatric Association [APA], 2000). The Centers for Disease Control and Prevention (CDC, 2010) estimated that approximately one in 110 children have ASD (2010). These disorders are characterized by a triad of core symptoms and stereotypical behaviors: (1) qualitative impairment in social interaction (e.g., failure to develop peer relationships, avoiding eye contact), (2) delays in the development of communication (e.g., limited or total lack of spoken language), and (3) restrictive interests or repetitive body movements (e.g., arm flapping, body rocking, floor pacing; APA). Children with ASD may also engage in unusual behaviors such as playing with a piece of string, staring at their own hands, organizing or spinning objects, or manipulating a toy for hours at a time (APA; Richler, Bishop, Kleinke, & Lord, 2007; Rinehart, Bradshaw, Breton, & Tonge, 2001, 2002). Other characteristics associated with ASD include resistance to environmental changes and changes in daily routines, and unusual responses to sensory stimuli (Kern et al., 2006; Stoner, Angell, House, & Bock, 2007).

All of the characteristics associated with ASD can influence a child’s experiences in a physical education setting, as well as challenge the physical educator to find effective ways to engage the child in group activities, games, skill practice, and physical fitness exercises. Planning is critically important for physical educators who work with children with ASD. Newell’s (1986) constraint model offers an effective tool that can help physical educators plan activities and lessons that will improve the motor proficiency of children with ASD.

Newell’s Constraint Model

Karl Newell (1986) first introduced the notion of constraints in his article, “Motor Development In Children: Aspects of Coordination and Control.” Newell theorized that actions emerged out of the interdependent relationships among people who move in a particular environment and perform a particular task. In such a context, three specific types of constraints exist: individual, environmental, and task. Each type of
constraint influences movement as a whole by encouraging certain types of movement and discouraging others (Gagen & Getchell, 2004, 2006; Newell, 1986).

From a constraints perspective, individual, task, and environmental constraints reciprocally interact with one another to influence movement at any given time. In a movement such as catching, individual factors such as hand size and vision can interact with task factors like the size and weight of the ball and with environmental factors such as outdoor lighting and wind. The combination of all these constraints influences how a person moves. These constraints are dynamic in nature and constantly changing (Gagen & Getchell, 2004, 2006; Newell & Jordan, 2007; von Hofsten, 1989). Figure 1 depicts the interactions between individual, environmental, and task constraints as they relate to children with ASD.

**Individual Constraints.** Individual constraints refer to the individual’s emotional and physiologic state (Haywood & Getchell, 2009; Newell, 1986). These constraints influence how an individual moves by facilitating or inhibiting motor skills. Two types of individual constraints exist. First, there are structural constraints, which are related to the anatomical structure of the person, such as height, weight, limb length, and body composition. Second, there are functional constraints, which relate to specific functions, such as balance, coordination, and cognitive factors (e.g., fear, motivation, attention, or memory). Individual constraints interact with one another to inhibit or facilitate a movement pattern. For instance, a child who possesses sufficient strength and coordination may fail to walk across a line on tiptoes because of the functional constraint of poor balance or because the child does not understand the teacher's instructions.

**Environmental Constraints.** The environment in which the individual moves also plays an important role in encouraging or discouraging certain movements. This constraint relates to either physical or social-cultural characteristics outside of the individual's body (Gagen & Getchell, 2004, 2006; Haywood & Getchell, 2009; Newell, 1986), such as ground surface, air temperature, ambient light, or gymnasium dimensions. For example, a child will move quite differently if asked to run in a gymnasium, as opposed to on stones across a stream. The social-cultural environment includes social or cultural norms, values, or ideals that dictate how an individual should act within a group (Gagen & Getchell, 2004, 2006; Haywood & Getchell). For example, a physical educator may ask a seventh-grade girl to gallop or skip in the gym, and she can successfully elicit the motor skills. However, if the social situation is changed to a shopping mall where peers are watching, nothing will get that child to gallop or skip.

**Task Constraints.** Task constraints relate to specific, intentional motor activities or tasks. These tasks generally have a pre-defined structure, set forth by goals, rules, or equipment (Haywood & Getchell, 2009; Newell, 1986). For example, if a physical educator is asked to skip, he or she will easily perform the task of skipping. Most physical education teachers define skipping as a step-hop, alternating between legs. In a sense, that definition represents the rules of the task of

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**Figure 1. Newell’s Model of Constraints as It Pertains to Children with ASD**

- **Individual**
  - Sensory integration disorder
  - Motor-planning issues
  - Anticipatory deficits
  - Overweight status
  - Social dysphoria

- **Environmental**
  - Number of people within space
  - Loud sounds
  - Bright colors
  - Bright lighting
  - Temperature

- **Task**
  - Verbal instructions
  - Number of steps involved
  - Interaction with others

*Modified from Newell (1986)*
skipping. In most actions and all sports, a very specific rule structure exists, and the interaction between goals and rules dictates the movement forms. For example, one goal of the game of basketball is to put the ball in the hoop as quickly as possible. Specific rules inform players that they cannot run with the ball in their hands and must dribble with one hand and not two. The goal and rules are demonstrated by the various ways in which players get the ball down to the basket as quickly as possible (e.g., one long pass, dribbling full court, a series of dribbles and passes).

Newell’s (1986) constraint model has been used to guide developmentally appropriate practices for elementary and early childhood physical education (Gagen & Getchell, 2004, 2006), as well as with children with disabilities (Burton & Davis, 1996; Davis & Burton, 1991; Getchell & Gagen, 2006). This model is particularly useful because, even though the physical educator cannot change the children’s individual structural constraints (e.g., height or body size) that influence action and may discourage certain desired movement forms, they can modify the task or the environment to enhance and encourage movement. From a theoretical perspective, Newell’s model is important for physical education teachers because it can help them understand movement patterns in children with ASD. Many physical educators do this intuitively; however, using this model allows for a more systematic, structured approach to lesson planning. The purpose of this article is to explain how to apply Newell’s model of constraints to the development of appropriate physical education lesson plans for children with ASD.

**Addressing Individual Constraints**

Children with ASD have a variety of individual constraints that may manifest differently from person to person. There is no one specific individual structural or functional constraint that all children with ASD have, so there is no single modification of the environment or task that will help all children with ASD. However, physical educators may recognize several structural and functional constraints that appear more frequently and that affect the ways in which children with ASD move in and outside of the physical education setting. Some of the structural constraints frequently observed among children with ASD include overweight, toe walking, and low muscle tone (Akshoomoff, Farid, Courchesne, & Haas, 2007; Barrow, Jaworski, & Accardo, 2011; Calhoun, Longworth, & Chester, 2011; Curtin, Anderson, Must, & Bandini, 2010; Curtin, Bandini, Perrin, Tybor, & Must, 2005; Ming, Brimacombe, & Wagner, 2007). Commonly observed functional constraints include sensory integration issues, anxiety, and issues with motor planning (Hughes, 1996; Jansiewicz et al., 2006; Ming et al., 2007; Rinehart et al., 2001, 2002; Stephenson & Carter, 2009). As these constraints are commonly observed in children with ASD, and many of them cannot be changed, physical educators can use Newell’s model to identify ways of modifying environmental and task constraints in order to accommodate students’ individual structural and functional constraints.

**Structural Constraints.** Fundamental gross motor skills such as kicking, throwing, catching, and striking are often difficult for children with ASD (Berkeley, Zittel, Pitney, & Nichols, 2001; Jansiewicz et al., 2006; Minshew, Sung, Jones, & Farman, 2004; Vilenksy, Damosio, & Maurer, 1981). Underlying structural constraints are important factors when considering fundamental motor skills. For instance, toe walking may make skills such as kicking very difficult for a child with ASD (Barrow et al., 2011; Ming et al., 2007). Similarly, the overweight status of a child with ASD can negatively affect fundamental motor skills that involve locomotion, such as running, hopping, or jumping. It is beneficial for physical education teachers to be cognizant of these structural constraints so that they can plan on providing activity modifications to meet children’s individual constraints.

For instance, it may take considerable time and effort for a physical educator to help an obese child with ASD to lose weight. However, he or she can effectively modify the task constraints by, for example, requiring the child to engage in lower-impact activities such as marching, rather than higher-impact activities like jumping jacks. Similarly, overweight children should be allowed to perform modified push-ups on their knees or standing against a wall, rather than traditional push-ups on their toes against the floor. Modifying the task constraints in this way will decrease the strain on the child’s joints, possibly easing some of the discomfort from performing push-ups. Further, these modifications can increase the child’s likelihood of success in motor skill performance and improve his or her motivation for being physically active. Over time, this may result in weight loss. By modifying the task constraint (the criteria that must be met for the student to be successful in completing a push-up), the physical educator is able to meet the individual structural and functional constraints of the student’s overweight status and motivation to complete the task.

Toe walking—bearing weight on the toes during the stance phase of walking—is fairly common, occurring in 12 to 24 percent of children with ASD (Barrow et al., 2011; Calhoun et al., 2011; Ming et al., 2007). Therefore, physical educators can adjust the task constraints to modulate the child’s tactile sensitivity in walking, such as walking on different surfaces or stomping the feet (Barrow et al.; Williams, Tinley, & Curtin, 2010). Similarly, physical educators can also modify environmental constraints to safely challenge the child’s balance (e.g., walking or producing other locomotor patterns on grass, sand, pavement, wood, foam, balance beams, or balance boards), which will allow the child to experiment with different gait patterns and develop leg strength.

Figure 2 shows a child with ASD challenging his balance by walking along a piece of tape on the floor instead of a balance beam. Since the child may be fearful or uncomfortable walking on a balance beam suspended above the floor (functional constraint), the physical educator modified the task to allow the child with ASD to replicate the locomotor pattern required to successfully walk on a suspended balance beam.
Children with ASD may also exhibit low muscle tone (Akshoomoff et al., 2007). A physical educator should design activities that can help the child develop muscle tone by modifying task constraints to meet the individual structural constraints of low muscle tone. For example, during transition times, the child could be instructed to sit on a large exercise ball (instead of on the floor) while awaiting further instruction. This challenges the child’s sense of balance and develops muscle tone by exercising the core stabilizing muscles of the abdomen and back. It also provides the child with ASD a routine for transition times between activities in the physical education setting.

Functional Constraints. Functional constraints are behavioral, rather than physical, in nature (Haywood & Getchell, 2009; Newell, 1986). Sensory integration issues involve an impairment to the ability to understand, interpret, and integrate visual, auditory, and other sensory information (Stephenson & Carter, 2009). Children with ASD may experience a magnification of sensations. For instance, loud sounds such as shouting or clapping, which may be tolerable or even enjoyable to typically developing children, may lead to sensory overload for a child with ASD. In addition, most children with ASD express discomfort with and avoid bright lights. Understanding that children with ASD may experience difficulties with sensory integration, the physical educator can try to address environmental constraints to eliminate negative sensory experiences for children with ASD by reducing the amount of loud noises, for example, and by providing environmental cues explaining what is to happen next in a situation.

Motor planning is an individual functional constraint that has also been identified as an issue for children with ASD (Hughes, 1996; Jansiewicz et al., 2006; Rinehart et al., 2001, 2002). For example, many typically developing children become involved in team sports, which require social interaction and the ability to predict situational motor behaviors in others and respond accordingly. However, if a child is to play outfield successfully in a softball activity, for example, he or she must be able to predict where a base runner will go next, where the ball will be thrown depending on where it is hit, and what to do if an error occurs. In short, the child must plan actions depending on what happens. For a child with ASD, these complex predictions are difficult, or even impossible. This difficulty may result in the child refusing to participate. Hence, the physical educator must think creatively to determine ways to meet the functional constraint of motor planning for a child with ASD by providing modifications to the task constraints or by modifying the environment to provide additional cues about what to do next. For example, the physical educator could allow a child with ASD to hit the baseball off a tee and allow a peer to run the bases for the child.

Students who have difficulty in motor planning may also benefit from the use of visual aids in the physical education setting. A visual aid can be a pictorial representation or a written list of the daily activities to be completed (Bryan & Gast, 2000). The child’s reading comprehension level will dictate what kind of visual aid would be most beneficial. A “first-then board” might be used in an elementary physical education unit on baseball, for example. The first-then board displays pictures of the first activity in a sequence (e.g., batting) and the second activity in the sequence (i.e., running to first base). The teacher could manipulate the environment by taping this first-then board to home plate. This simple visual aid can address the child’s individual functional constraint of information processing. In addition, if a child with ASD tends to run out of the gymnasium during physical education class when experiencing emotional upsets or sensory overload, the teacher can post a “stop sign” (the red traffic sign) on the door. The teacher should let the child know that he needs to wait in front of the stop sign for a teacher before he can walk outside. Using the visual aid (stop sign) as an environmental constraint can address individual functional constraints related to motor planning and information processing and help to reduce problem behaviors.

Children with ASD often feel a general anxiety when they are exposed to novel situations (Gillott, Furniss, & Walter, 2001). This anxiety can make new situations unpleasant or difficult for them. As a result, many children with ASD have trouble transitioning between activities in a physical education or classroom setting (Dettmer, Simpson, Myles, & Gantz, 2000; Dooley, Wilczenski, & Torem, 2001; Stoner et al., 2007). Asking a child with ASD to stop performing a skill and transfer to a new activity can result in the child becoming confused and exhibiting a disruptive or self-injurious behavior (Hodapp, 1987). A teacher can assist a child with ASD by teaching the child a series of transitions that lead from one activity to another, such as “stop sign,” “next,” “right,” and “next.” These visual cues can help the child to understand the transition to the next activity. This can be especially helpful during transition times, such as during the end of a class, when the child may have difficulty understanding that he or she is expected to leave the gym and head to recess. By using visual cues, the child can be guided through the transition, reducing the child’s anxiety and making the transition more manageable.
rious behavior. Therefore, the task of transitioning should be carefully planned and implemented to meet the child’s needs. Providing a routine for children with ASD to help ease them into transitions between activities can help. The teacher should give plenty of warning before transitions occur, such as telling the child, “We will start the next activity in 5 minutes...4 minutes...3 minutes...2 minutes...1 minute.” When implemented appropriately, these techniques serve as a modification of a task constraint to meet the individual student’s needs.

**Addressing Environmental Constraints**

When considering children with ASD, structuring the physical environment to meet the individual’s constraints is a key to success. A crowded gymnasium may not discourage participation in a typically developing child; however, a child with ASD may quickly experience sensory overload due to the sound, or become uncomfortable with the close physical proximity of other students (Fittipaldi-Wert & Mowling, 2009). Gymnasiums are bright, noisy, and often crowded. Therefore, a teacher should have access to a quiet and low-light room where a child with ASD can calm down when experiencing sensory overload. Physical educators should consider allowing students with ASD to wear sunglasses or a hat indoors to help reduce light sensitivity. Another environmental modification to consider is to limit the use of auditory cues such as bells, whistles, and music during physical education. For children with ASD who have sensitive hearing, this environmental modification could significantly reduce the occurrence of problem behaviors.

Physical educators who teach children with ASD should also consider the social context in which a lesson or activity will be implemented. The social context includes the number of children participating in an activity and the type of social interaction required. The social context can be either a task or an environmental constraint. Some children with ASD usually spend the school day in a classroom with only a few other students, so the large class sizes in physical education can be intimidating to them. Even though the child may be placed in a physical education class with his or her peers, the child may need smaller-group activities to cope with anxiety and sensory overload. One strategy is to pair the child with ASD with a peer or to reduce the size of the group in a physical education setting (Ayvazo & Ward, 2010; Ward & Ayvazo, 2006). In doing so, the physical education teacher will be modifying a sociocultural environmental constraint.

Similarly, physical educators should consider socialinteraction limitations for children with ASD. The type of interaction relates to the amount of cooperation or competition required with others. From a developmental perspective, children first learn to self-compete before competing or cooperating with partners or within a larger group. Teachers can provide activities that include various levels of competition, cooperation, or even independent participation in motor skill stations that children choose in the gymnasium. By providing activities with various levels of cooperation and competition, the physical educator modifies the task constraint of learning a skill to address the functional constraints of children with ASD. As difficulties with social interactions are one of the hallmark behaviors of children with ASD, this task modification can help make physical education much more enjoyable for these children. Many children with ASD may prefer independent activities such as walking, running, yoga, or stretching activities. For students who become overwhelmed by the traditional physical education environment, the teacher can address the child’s functional constraint of anxiety by modifying the environmental constraints (e.g., using a quiet area so the child can participate in relaxation activities).

**Addressing Task Constraints**

Children with ASD may possess a limited range of interests, perseverating on a select group of topics and showing lack of motivation to engage in other activities or interests. Coupled with their other individual constraints, this presents a challenge for physical educators. For example, a young child with ASD may be interested in superheroes. That same child may not like running laps around a track during physical education class and may be prone to emotional upsets and tantrums when presented with that task. The physical education teacher can change the presentation of the task by providing a large fabric square to be worn around the child’s shoulders as a cape, and instruct the child that the cones the child needs to run around is “kryptonite.” When the child observes his or her “cape” flowing in the wind and changes his perception of the cones, he may start to like running.

![Figure 3. A Girl with ASD Practicing Dribbling Skills](image-url)
<table>
<thead>
<tr>
<th>Individual Constraint</th>
<th>Modification to Improve Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low muscle tone and reduced muscle strength</td>
<td>• Use lightweight equipment (foam balls).</td>
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<tr>
<td></td>
<td>• Systematically increase weight as child increases in strength.</td>
</tr>
<tr>
<td>Overweight status</td>
<td>• Provide low-impact activities (i.e., marching in place instead of jumping jacks).</td>
</tr>
<tr>
<td></td>
<td>• Provide opportunities to increase sustained activity.</td>
</tr>
<tr>
<td>Low motivation in physical activity</td>
<td>Modify activities to relate to interests (i.e., rather than running, “train for space flight” if child is interested in rockets).</td>
</tr>
<tr>
<td>Light sensitivity</td>
<td>Allow sunglasses or a cap to be worn to decrease light sensitivity.</td>
</tr>
<tr>
<td>Auditory sensitivity</td>
<td>Allow ear mufflers to be worn to decrease auditory sensitivity.</td>
</tr>
<tr>
<td>Difficulty in transitioning between activities</td>
<td>Provide a challenging task (such as balancing) for the child during transitional periods, and inform the child of the transition ahead of time.</td>
</tr>
</tbody>
</table>

around the track. The modification of this activity may motivate the child to participate more, thus addressing the child’s functional constraint of motivation.

Figure 3 shows a child with ASD practicing her dribbling skills. The child pictured understands that the task criteria for dribbling require her to bend her knees and dribble with one hand. However, she appears to be dribbling the ball above the waist with a rigid wrist. To modify the task constraint to help her to dribble the ball with a more relaxed wrist, the physical educator could provide a smaller ball, just larger than her hand, that she could “palm,” and ask her to dribble while perched on one knee. This way, the girl will be required to contact the ball closer to the floor, and the smaller ball would lend itself to a more relaxed grip, as the girl’s hand could better handle the bounce of the ball while dribbling.

Sometimes the task and the environment both need to be modified. For example, a child with ASD may become frustrated or overwhelmed with a unit on tennis conducted on the school’s outdoor courts. Normal environmental stimuli of an outdoor setting, such as traffic and other students departing school with parents, can override the child’s ability to concentrate on physical education class. Similarly, the tennis ball may move so quickly that the child with motor planning issues is unable to make successful contact with the ball. If the child were to play with a slower moving ball or balloon, perhaps on the paved part of the playground away from the parking lot, the child may be more successful. If the unit includes tennis game activities, keeping score in a numerical fashion instead of with the traditional scoring system used in tennis may help the child with ASD to understand better how the game is scored. By modifying the rules associated with scoring, the equipment used, and the location of the lesson, it is possible to meet the needs of the child with ASD to be successful at the skill.

**Implications and Conclusions**

When working with children with ASD in a physical education setting, educators must remember two important points. First, the child will have specific individual constraints that inhibit his or her ability to perform in a typical physical education setting. Although many individual differences exist, a practitioner will often see sensory integration and motor-planning issues, as well as anxiety, along with structural constraints such as toe stepping, poor motor planning, overweight status, and low muscle tone. Second, these individual constraints interact with the environmental conditions and task demands, and all of these three constraints are constantly changing.

Table 1 provides examples of common individual constraints among children with ASD and suggested modifications to meet those constraints and produce desirable behaviors. The table can be used as a starting point for using the constraints model in developing appropriate lesson plans for children with ASD, as every child with ASD is unique and has different abilities, strengths, and needs. If the physical educator can modify the environment or tasks to accommodate individual constraints, he or she will be able to provide successful movement experiences for children with ASD.

**References**


