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Andrew M. Colombo-Dougovito & Martin Block

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Teaching Object-control Skills *to Students with Autism Spectrum Disorder*

Andrew M. Colombo-Dougovito
Martin Block

Autism spectrum disorder (ASD) is characterized by deficits in social communication, repetitive and restricted behaviors, and hyper- or hypo-sensory traits (American Psychiatric Association, 2013). Social communication difficulties caused by ASD may include challenges in social reciprocity, nonverbal social behaviors, and difficulty establishing social relationships. Additionally, restrictive/repetitive behaviors include such things as stereotypic behavior or speech (e.g., hand flapping, echolalia), excessive adherence to routines, and highly fixated interests (Wong et al., 2013). These behaviors make for unique challenges when teaching students with ASD; moreover, these challenges are amplified when students are placed in a general physical education setting. Physical education teachers have reported difficulties related to inattentive and hyperactive behaviors, social impairment, emotional regulation difficulties, difficulties understanding and performing tasks,

Andrew M. Colombo-Dougovito (amcd@virginia.edu) is a doctoral candidate, and Martin Block is a professor, in the Department of Kinesiology in the Curry School of Education at the University of Virginia in Charlottesville, VA.

narrow focus, and inflexible adherence to routines and structure (Obrusnikova & Dillon, 2011).

When combined with possible social communication deficits and repetitive/restricted behaviors, teaching students with ASD can be difficult for teachers. Recent research has also shown children with ASD to have motor development issues (Ming, Brimacombe, & Wagner, 2007), and they may be significantly delayed when compared with their typically developing peers (Liu, Hamilton, Davis, & El Garhy, 2014). Moreover, as autism severity increases, per the Autism Diagnostic Observation Schedule (ADOS–2), fine and gross motor performance scores decrease (MacDonald, Lord, & Ulrich, 2014), further evidencing the uniqueness of the challenges faced when teaching students with ASD in physical education.

Many students with ASD do not respond well to verbal cues (Breslin & Rudisill, 2011), as they tend to have very little receptive verbal language and have difficulty attending to key parts of a verbal cue. For example, if a teacher says, "John, I want you to take a big step and step with your opposite foot when you throw the ball," John most likely attended to his name and the motion of the ball but did not attend to the demonstration of the throwing pattern. Additionally, students with ASD have trouble attending to a demonstration and then focusing on the key part of that demonstration (Breslin & Rudisill, 2011). For example, a teacher might demonstrate stepping when throwing to help John understand the component of shifting weight by stepping. However, even if he was attending to the demonstration, did he know he was supposed to focus on stepping with the opposite foot when he throws?

Finally, many students with ASD are tactually defensive and do not like being touched (Hyman & Levy, 2013). As a result, trying to provide physical assistance to students with ASD is often not effective and can even lead to unwanted behaviors. How can a physical educator present information and feedback on how to perform a motor skill such as throwing or kicking to students with ASD without using verbal cues, demonstrations or physical assistance? The answer may be through the use of dynamic systems theory or a constraint model that focuses on altering the task and environment in order to "constrain" the student into the correct movement pattern (Newell & Jordan, 2007). Constraints often have a negative connotation when spoken in the traditional sense (e.g., a restraint or limitation). However, this article offers the definition of constraints as neutral qualities or characteristics that encourage certain movements while discouraging others (Gagan & Getchell, 2006; Getchell & Gagan, 2006). In utilizing the principles of dynamic systems theory and Newell's constraint model (1986), the focus of this article is to present possible constraints for object-control skills in a way that best promotes certain movements while discouraging others.

Dynamic Systems Approach

Dynamic systems theory states that all movement stems from the body's collaborative effort to *constrain* certain degrees of freedom within and without the body, in order to cause a certain motor pattern to emerge (Davids, Glazier, Araújo, & Bartlett, 2003; Kamm, Thelen, & Jensen, 1990). Since movement patterns are labeled as emergent and not preprogramed, they are subject to variability within the environment, task and person, and therefore are able to be shaped by the manipulation of constraints (Davids et al., 2003). As mentioned previously, constraints can have a negative connotation. However, constraints are neither negative nor positive; they shape movement patterns by encouraging certain patterns over others. For example, the task of trying to throw a dart to a small target constrains the throwing pattern to a short, quick arm pattern with very little shoulder or body action. In contrast, the task of trying to throw a baseball as far as possible constrains the child into a pattern that promotes full arm action including the shoulder, body rotation and stepping to shift weight.

Newell (1986) suggested that movement arises from an interaction between environment, task and individual constraints. Therefore, in order to understand movement, as seen in Figure 1, consideration must be given to the relationships between the characteristics of the mover, the unique qualities of their surroundings, and the purpose of the movement (Haywood & Getchell, 2014).

Environmental constraints can be anything within the individual's environment such as gravity, light within the space, temperature or barriers in the space. For example, the surface of the play

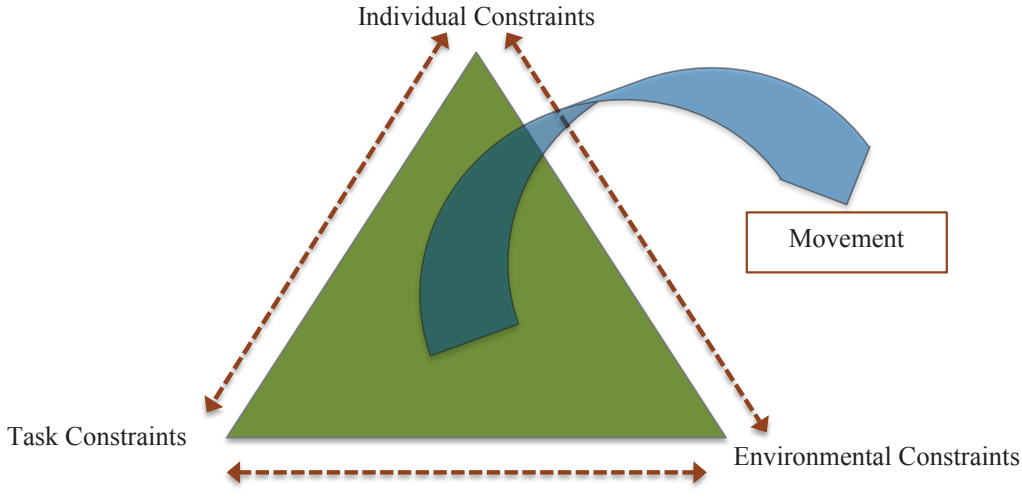

Figure 1. Newell's model of constraints

Table 1.
Constraints Faced by Individuals with Autism Spectrum Disorder

Individual	Environmental	Task
Sensory integration disorder	Number of people within space	Verbal instructions
Motor-planning issues	Loud sounds	Number of steps involved
Anticipatory deficits	Bright colors	Interaction with others
Overweight status	Bright lights	
Social dysphoria	Temperature	

Modified from Pope, Liu, Breslin and Getchell, 2012.

area (e.g., wood, tile, blacktop, grass) would promote different patterns of running. Typically, environmental constraints focus on the "immediate" interactions, not on factors creating or influencing it (Gabbard & Krebs, 2012). Constraints within the person, or *individual constraints*, are things such as the person's height, strength, weight, balance or eye–hand coordination. Individual constraints are difficult to manipulate or change quickly (e.g., how long it would take to increase a student's balance). Therefore, when using the constraint model for teaching motor skills, individual constraints are accounted for and accommodated as opposed to manipulated. For example, a child who has limited upper-body strength might be presented with task constraints, such as a lower basket when shooting baskets. This child would be encouraged to stand closer to the target when throwing, in order to account for their individual constraints. Lastly, a *task constraint* is anything having to do with the task itself. Newell (1986) divided task constraints into three categories: (1) the goal of the task without any specific rules on how to perform the task (e.g., getting a ball into an elevated basket or using your feet to get a ball into a goal), (2) rules specifying a response or way to perform a skill (e.g., a cartwheel or somersault has to be performed a specific way), and (3) implements that constrain a movement pattern (e.g., having to strike a ball with a golf club versus a baseball bat).

Changes in individual, environmental and task constraints can lead to different patterns, and the interaction among these three types of constraints will lead to unique patterns as well. In the throwing example above, a child with balance deficits (individual constraints) may not demonstrate stepping when throwing. Similarly, trying to throw on a windy and rainy day on a slick surface (environmental constraint) may prevent or "constrain" even skilled throwers to take shorter steps and not demonstrate as much body rotation. When considering students with ASD, additional constraints should be considered in each category. Pope, Liu, Breslin and Getchell (2012) identified several factors within each constraint that are unique to students with ASD, which are shown in Table 1.

Breaking Down the Skill

Before applying the constraint model to teaching motor skills, it is important to break the movement pattern into teachable components. Typically, this is done through an ecological task analysis that provides strategies to individualize instruction, provide students with choices, enhance decision-making, increase teacher observation, and foster discovery (Balan & Davis, 1993). With a task analysis, the first step is to identify the task goal (e.g., catching a ball, skipping). The skill is then broken into teachable components that, when put together, lead to the task goal (i.e., performing a movement using a particular pattern). It is then important to identify individual, environmental and task constraints that might affect the performance of each of these components (Stergiou, Jensen, Bates, Scholten, & Tzetzis, 2001).

For example, with a task of skillful leaping, the skill can be broken into the following components: (1) take off on one foot and land on the opposite foot; (2) period when both feet are off the ground, more than running; and (3) forward reach with arm opposite to the lead foot. Once the components or steps for the skill are defined, individual constraints that might affect performance of the components are identified (e.g., balance to take off on one foot, strength to push body up so that both feet are off the ground), and task and environmental constraints are manipulated to accommodate for individual factors and to constrain or prompt the student into the correct pattern for a particular component. With the first component of the leap, a teacher can constrain the task by placing two spots a short distance apart (far enough that the child cannot just step from one to the other, but not too far that he or she cannot reach it) or place a low hurdle or rolled towel between them. The spots could then be color-coordinated for each foot: red is for the right foot, blue is for the left. By providing task constraints so that the child can put only one foot or the other on the color spot, and by placing the towel or low hurdle, the student is "constrained" to produce the component. By understanding the movements needed to build a certain task, it is more possible to figure out how a movement can be constrained so as to produce the desired outcome.

Influence of Constraints

The interaction of constraints is essential for the emergence of movement (Newell, 1986). However, if a teacher can constrain just one variable (e.g., provide a lighter ball or lower basket for shooting), it interacts with the other variables (e.g., limited strength) and increases the likelihood of a student producing the desired outcome (e.g., shooting using a skillful pattern). With students with ASD, considerations of all constraints should be addressed. As noted above, individual constraints are often difficult to manipulate. Adjusting the task or the environment can accommodate these individual constraints to movement. Using structured teaching (i.e., visual supports) may also accommodate these constraints. For example, distinct visual boundaries such as cones with ropes

strung across may help a child with autism better understand the space, and using picture cues and video modeling may help children with ASD be better prepared for when many children are moving around in the gym during a tagging game.

Using Constraints to Teach Fundamental Motor Patterns

Children with ASD often have difficulty understanding how to move their body to perform a skill in a particular pattern. Carefully manipulating a task may be effective in helping cue and force the child into the correct pattern. Through constraining the environment and task, a physical educator can influence the movement pattern of a skill. Six object-control skills were chosen to break down based on the Test of Gross Motor Development (TGMD–2; Ulrich, 2000). The skills are striking a stationary ball, stationary dribble, catching, kicking, overhand throw and underhand roll. These skills were selected because they are foundational movement patterns utilized in many different activities and are accompanied by a validated assessment tool, the TGMD–2 (Ulrich, 2000). Each motor skill is broken down into 3–4 teachable components. See Table 2 for an example of how to break down the necessary components of each task.

The following task constraints are presented for each component to ensure the desired, skillful movement pattern for each skill. The goal for each task constraint is to influence the student to produce that specific component of the skill. In most cases components should be taught as part-whole—that is, teach parts individually and then build them together into the whole movement. Trying to teach and to add constraints to all the components at once could cause confusion and frustration. Mastered components then can be chained together to form the complete pattern.

Striking a Stationary Ball. Beginning with the first component for striking a ball, in order to attain the dominant hand above the non-dominant hand a teacher can utilize colors for an easier visual cue. To make it evident where each hand should go, teachers can use colored tape on the bat handle. For example, red tape on the bottom, then green above. This also provides the teacher with the ability to quickly assess the position before moving onto the next skill.

In order to address the next component of side orientation, a teacher can place two spots on the ground next to the tee to constrain a student into standing in the proper position. To further ensure correct positioning, the teacher can match the colors of the spots to the colors of the bat tape. Such color matching, for example, would allow a student to always know his or her left side (non-dominant) is on the red and right side (dominant) is on green. Another way to constrain side orientation is to place the tee stand next to a wall. Then put footprints down in such a way that the student's back is touching the wall, cuing the child into the correct position.

To account for hip and shoulder rotation, one must understand where the hip and shoulder rotation begin. An individual can turn their shoulders, which may or may not cause their hips to rotate, but this is a difficult task to constrain. However, if you rotate one leg inward, hips and shoulders follow that motion. So in order to constrain the student's movement to demonstrate proper hip and shoulder rotation, one must constrain the movement so the rear leg rotates inward. To do this a teacher can constrain the task by using the verbal cue of "squish" and demonstrating moving in a motion of "squishing a bug with your foot." Additionally, a teacher can place a pin near the student's foot that they can knock over only with the outside of their heel. The pin should be placed far enough away from the foot to constrain the student to move his or her foot in the right motion to knock over the pin. Lastly, to cause a stepping motion with the front foot, a teacher can place a third spot next to the front (non-dominant) foot and prompt "step." In order to produce a step and not just a slide, the teacher may have to put a low hurdle that the student must step over in order to reach the spot.

Stationary Dribble. First, a teacher should consider utilizing a playground ball rather than a basketball to account for limited strength and effort in the dribbling pattern. In order to ensure dribbling is performed with only one hand, a teacher can have the student place the non-dribbling hand on her side or in her pocket, thus constraining the movement to only one hand. Alternatively, the teacher could have the student hold an object in the non-dribbling hand, in order to constrain the movement to dribbling with just one hand. To constrain dribbling to only belt high and not any higher, the teacher could set up a "limbo" bar slightly above the student's waist and instruct the student to dribble with the ball under the bar. Another way to constrain height is by the teacher placing his hand at the correct height and asking the student to bounce the ball so her hand touches the teacher's hand. Next, in order to constrain the student to dribble only with her finger pads, a teacher can put a spot on each of the student's fingertips with a marker; the teacher can then instruct the student to touch the ball only with the spots on her fingers. This also works with chalk on the hand, so the student can see the chalk on the ball for immediate knowledge of performance. As tactile issues are common among students with ASD, teachers must know their students before trying any modification. Lastly, to attain dribbling on the preferred side, a teacher can place a spot on the ground and instruct the student to dribble only on that spot.

Catch. To begin the catching pattern, a teacher can prompt a student to touch their pinkies or their thumbs together, thus constraining the student to place her hands together in preparation to catch. Next, instead of tossing the ball at the student, a teacher should stand next to the student and toss a ball up in front of student so that they are forced to reach out and grab the ball. A ball that is tossed directly to the student promotes a "scooping" and "trapping" pattern, which does not satisfy the second or third components of catching. By tossing the ball in front of the student, the

Table 2.
Example of Breakdown for Overhand Throw

Task	Components
Overhand Throw	1. Wind-up is initiated with downward movement of hand/arm 2. Rotates hips and shoulders to a point where the non-throwing side faces the target 3. Weight is transferred by stepping with the foot opposite the throwing hand 4. Follow-through beyond ball release diagonally across body toward non-preferred side

Modeled after Ulrich, 2000.

student is constrained to reaching out in front of them to catch the ball. Finally, balloons, scarves or a Wiffle ball swinging on a string are great ways to constrain the use of hands only when catching.

Kick. For kicking, it is better to teach the first two components last after the basic kicking components (third and fourth steps) are taught and mastered. Starting with the third component (opposite foot next to the ball), a teacher can set up two spots, one directly behind the ball and one to the student's non-kicking side next to the ball. The student would begin with both feet on the spot behind the ball, and with a prompt of "step" the student will step to the spot next to the ball, before kicking the ball with their foot. In order to constrain the student to kick with the side of their foot or toe (step four), a teacher can place a dot or sticker on the student's shoe, prompting the student to kick by touching the spot to the ball. This constraint forces the student to be aware of what part of their foot touches the ball. Kicking to knock over bowling pins, two-liter soda bottles or small traffic cones using the same color-matching technique is also a nice way to motivate the student to kick hard.

After the student has satisfactorily completed the third and fourth components, the teacher can then move back to the first component. To constrain the component of rapid approach to the ball, a teacher can simply move the beginning spot a few paces from the ball, thus forcing the student to take a few steps forward before stepping on the spot next to the ball. To further constrain this movement, a teacher could place a series of footprints all the way to the ball, thus controlling the number of steps and how far apart they are. Lastly, once a student has a firm understanding of the approach, a teacher can add a low hurdle or towel before the ball, constraining the student to leap over the barrier to the spot next to the ball, then kick. A student should have an understanding of the leap before this task is introduced. A student may practice this component without the ball to become efficient at the leap, and then the teacher may reintroduce the ball.

Overhand Throw. For the overhand throw, the second task (side orientation) should be taught first. Similar to striking, a teacher can place two spots so that the student's body is positioned sideways. Another way to constrain side orientation is to have the student stand with his back to a wall. Next, the teacher can prompt the student to touch the ball to something behind him, such as a pool noodle or playground ball. This will constrain the student to demonstrate the correct overhand and extension motion in the preparation position of the throw. Third, and again similar to striking, the teacher can place a spot in front of the front foot cuing and constraining the student to step with his non-throwing side foot. As with striking, if the student is shuffling or sliding his feet, a towel or low hurdle can be used to constrain the student to step to the spot. Lastly, in order to prompt a follow-through across the body, a teacher could place a bucket or basket of balls next to the student's front foot, so that he is forced to reach across his body for the next ball. Another constraint to promote following through is to place a piece of tape on the student's knee and cue him to touch his hand to his knee after

throwing the ball. This task constraint limits the movement so that the student must follow through across the body.

Underhand Roll. For this task a student should begin with feet standing on two spots, about shoulder-width apart; those spots should be placed so that the student is facing the intended target. To produce the first component (reaching backward), a teacher can do one of two things. Similar to striking, the student can have the ball in hand and reach back to touch a wall or hit a small cone or bowling pin before beginning the next step. Another option is to place a bucket of balls behind the student's preferred side, so that he must begin the movement by reaching backward. To constrain stepping, a spot can be placed in front of the student's nonpreferred side to prompt a step. As noted with other skills that require stepping, a piece of rope or a rolled-up towel can be used to constrain lifting the leg and stepping as opposed to sliding the foot. In order to constrain the next step (bending the knees so that the hand is 4 inches or less from the floor), a teacher may prompt the student to touch his knees to the floor before rolling the ball. By prompting the student to kneel, it is constraining him to get close enough to the ground so that when he releases the ball, it does not bounce. Another simple constraint is to put tape on the student's knuckles and then have him slide the taped knuckles across a colored tapeline on the floor. A teacher might also try putting a chair in between the student and the target, thus constraining the student to lower his level and release the ball close to the ground to get the ball to go under the chair.

Conclusion

Teaching motor skills to students with ASD presents unique challenges to physical educators, including limiting verbal cues, demonstrations and physical assistance. By utilizing the principles of dynamic systems theory and incorporating a task-constraint model when teaching motor skills to children with ASD, physical educators can build skill independence one component at a time (Haywood & Getchell, 2014). However, teachers must first break skills into teachable components or steps, then create constraints that force the student into the correct pattern for each component. While this can be a time-consuming process, utilizing constraints is the best way to teach motor skills to students with ASD. As a reminder, constraints are utilized to influence movement, and by controlling for one constraint (task) and altering the influence of other constraints to movement, teachers can increase the likelihood of the skill being performed properly.

This approach demonstrates how dynamic systems theory can be utilized to develop constraints for object-control skills; this model can be easily adapted to any skill taught in the physical education setting. For example, when teaching a locomotor skill such as sliding, a teacher needs to break that skill into teachable components or steps. The teacher would then consider a constraint that will produce that component, such as keeping one's back to the wall or toes on a line. These constraints allow for a simplification of a skill, helping the student to focus only on that specific component and creating a greater chance for success.

ORCID

Andrew M. Colombo-Dougovito http://orcid.org/0000-0002-5671-8826

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