In this chapter we define the concept of disability from a biopsychosocial perspective. Disability is not limited to the person but is a complex phenomenon that encompasses constraints within the body and interactions with the environment. A person who cannot stand independently is limited in certain motor skills, for example, downhill skiing. With the use of a sit ski, however, she can successfully ski down a mountain. Adapting the task to accommodate individual constraints does not change the disability, but permits the person with the disability to move successfully. We will present current disability-specific research with the hope that educators will apply the concepts to those who will benefit. More information on specific disabilities can be found on the U.S. Department of Education website (http://idea.ed.gov).

We present Gentile’s two-dimensional taxonomy of motor skills, where the environmental factors and function of the actions are essential to understanding the demands that a task places on a child (Gentile, 1987). For example, objects and people in the environment might be stable or move, and there may or may not be a change in condition between trials. The second part of the taxonomy is related to the function of the action and is divided into two broad categories; body orientation, still or moving, and object manipulation, which may or may not be present. Understanding the progression of difficulty within the taxonomy helps educators prepare skill progressions that are appropriate to the individual. For example, when teaching a child to play tee ball, he might start with hitting a ball off a tee with his hand, and, when successful at looking at the ball and aiming, advance to using a bat.

In this chapter we also define motor behavior and present a brief explanation of the most accepted theories to explain changes in motor performance. Finally, six key elements of motor behavior are discussed: (a) attention and (b) motivation as part of the person’s intrinsic characteristics, (c) demonstration, (d) feedback, (e) amount and distribution of practice, and (f) variability and specificity of practice. These last three elements are critical components in the preparation of practice conditions. For example, if a child with cerebral palsy [CP] wants to improve her throwing pattern, the teacher can increase the child’s attention and motivation levels by making the task relevant to the child using either a game or a functional goal. Similarly, teachers may offer demonstrations prior to the child initiating the practice as well as during the practice as needed. As practice progresses, the practitioner can offer instructions to improve performance together
with demonstrations while encouraging peer observation of performance when possible. Further, practitioners can facilitate instruction by drawing the child’s attention to the number of repetitions and total practice time to avoid fatigue, permitting sufficient practice to improve performance. Finally, teachers can sequence tasks, such as progressions of throwing difficulty, to emphasize variability of practice by introducing different target distances, target sizes, and weight and/or shape of the throwing object. If the purpose of instruction is to enhance a specific movement pattern or objective, then practitioners can emphasize more practice in the desired specific conditions.

Disability and categories

Teaching students with disabilities may appear a daunting task; however, understanding how disability affects movement and applying that knowledge to modify instruction and the environment will help ensure success. Individual constraints can be taken into consideration and provide the basis for modifications to the environment, task, and instruction to ensure student success. An example would be slowing the tempo of a game by changing equipment, for instance, a beach ball instead of volleyball, to accommodate children who require additional time for motor planning.

Disabilities can be broken down into several broad categories based on functionality. Over the past two decades there has been a move away from the medical model to biopsychosocial models (World Health Organization [WHO], 2013). The current biopsychosocial model proposed by WHO focuses on the individual’s functional abilities and the role of contextual factors in facilitating or creating barriers to optimal function. This chapter does not go in depth into specific disabilities, as diagnostic labels do not provide in-depth information about a child’s functional ability. For instance, two children with the same diagnostic label may require vastly different supports. Consider these two children, each with a physical disability; one student has a significant impairment in all four limbs and uses a power wheelchair; the other student had a below-the-knee amputation of the left leg, was fitted with a state-of-the-art prosthetic, and is able to walk, run, and hop unassisted. Each student has a physical disability but requires very different supports to function successfully. Diagnostic labels provide a starting point, and more information about the 13 categories of disability outlined by IDEA can be found in http://idea.ed.gov (see Table 15.1). Practitioners can obtain guidance on evidence-based practices for specific disabilities, but this information must be applied on an individual basis matching each person’s abilities and constraints. For instance, a teaching or intervention strategy researched for individuals with a physical disability may also work well for a child with autism spectrum disorder who moves unsteadily.

Understanding the impact of structural and/or functional impairment is important when planning a PE lesson. Disability is a complex phenomenon that always includes a problem within a person’s body and interaction with features of the person and their environmental context (WHO, 2013). Recognizing the differences in body function or structure and the malleability of contextual factors sets the scene for adapting activities for success (King, Rigby, & Batorowicz, 2013). Variability of motor abilities is very large in children with disabilities. Children may not follow typical trajectories of motor development. However, all children can learn motor skills and benefit from physical activity. Educators need to evaluate each child’s abilities and limitations and adapt the task and environment accordingly (Block, 2000).

Task analysis and motor skill classification

One of the first things one might want to consider when preparing motor skill instruction to a diverse group of students is how to analyze the skill. Task analysis in APE is used primarily for
<table>
<thead>
<tr>
<th>Category</th>
<th>IDEA definition</th>
<th>Functional impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Autism</td>
<td>A developmental disability significantly affecting verbal and nonverbal communication and social interaction, generally evident before the age of 3. Other characteristics include engaging in repetitive activities and stereotyped movements, resistance to environmental change or change in daily routines, and unusual responses to sensory experience.</td>
<td>Difficulty in social communication and interaction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Generally poor motor skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Atypical attention patterns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resistance to environmental change</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High prevalence of sensory seeking or avoiding behaviors</td>
</tr>
<tr>
<td>2. Deaf-blindness</td>
<td>Concomitant (simultaneous) hearing and visual impairments, the combination of which causes such severe communication and other developmental and educational needs that cannot be accommodated in special education programs for children with deafness or children with blindness.</td>
<td>Difficulty in receiving information from the environment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Imitation is difficult</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Modification to instruction is necessary</td>
</tr>
<tr>
<td>3. Deafness</td>
<td>A hearing impairment so severe that a child is impaired in processing linguistic information through hearing that adversely affects a child's educational performance.</td>
<td>May not receive auditory cues</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Verbal instructions may be inadequate</td>
</tr>
</tbody>
</table>
| 4. Emotional disturbance | A condition exhibiting one or more of the following characteristics over a long period of time and to a marked degree that adversely affects a child's educational performance:  
  a) inability to learn that cannot be explained by intellectual, sensory, or health factors;  
  b) inability to build or maintain satisfactory interpersonal relationships with peers and teachers;  
  c) inappropriate feelings under normal circumstances;  
  d) a general pervasive mood of unhappiness or depression;  
  e) tendency to develop physical symptoms or fears associated with personal or school problems.                               | Difficulty interacting with peers                                                        |
<p>|                      |                                                                                                                                                                                                                                                                                                                                                 | Difficulty following instructions                                                        |
|                      |                                                                                                                                                                                                                                                                                                                                                 | May have strong reactions during team activities                                         |
|                      |                                                                                                                                                                                                                                                                                                                                                 | May be reluctant to participate in activities, alone or in groups                       |
| 5. Hearing impairment | An impairment in hearing, whether permanent or fluctuating, that adversely affects a child's educational performance but is not included under the definition of “deafness.”                                                                 | Difficulty or inability to hear verbal instructions and cues                            |
|                      |                                                                                                                                                                                                                                                                                                                                                 | May not hear cues, such as whistles or buzzers, during activities                        |
| 6. Intellectual disability | Significantly subaverage general intellectual functioning, existing concurrently with deficits in adaptive behavior and manifested during the developmental period that adversely affects a child's educational performance.                                            | Motor skill development lags behind same age peers without disabilities                  |
|                      |                                                                                                                                                                                                                                                                                                                                                 | Difficulty comprehending instruction, especially multi-step                              |
|                      |                                                                                                                                                                                                                                                                                                                                                 | May require more practice and instruction to learn a new skill or activity              |</p>
<table>
<thead>
<tr>
<th>Category</th>
<th>IDEA definition</th>
<th>Functional impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Multiple disabilities</td>
<td>Concomitant impairments, the combination of which causes such severe educational needs that they cannot be accommodated in special education programs solely for one of the impairments.</td>
<td>Small group or 1:1 instruction for best results</td>
</tr>
<tr>
<td>8. Orthopedic impairment</td>
<td>A severe orthopedic impairment that adversely affects a child’s educational performance. Includes impairments caused by a congenital anomaly, disease, and other causes (cerebral palsy, amputations, fractures, or burns that cause contractures).</td>
<td>Difficulty with locomotor activities, possibly object control, also May use mobility devices such as wheelchairs, walkers, crutches Modifications to activities and the environment aid accessibility and success</td>
</tr>
<tr>
<td>9. Other health impairment</td>
<td>Having limited strength, vitality, or alertness, including a heightened alertness to environmental stimuli, which results in limited alertness with respect to the educational environment, that: a) is due to a chronic or acute health problem; b) adversely affects a child’s educational performance.</td>
<td>May fatigue easily May be limited in the type of activities in which the child can participate Environmental stimuli (e.g., pollen) may need to be reduced by changing environments</td>
</tr>
<tr>
<td>10. Specific learning disability</td>
<td>A disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations.</td>
<td>Great variability in individual characteristics May have difficulty comprehending instructions, especially in group situations Use of multimedia presentation of information recommended</td>
</tr>
<tr>
<td>11. Speech or language impairment</td>
<td>A communication disorder such as stuttering, impaired articulation, language impairment, or voice impairment that adversely affects a child’s educational performance.</td>
<td>May need extra time when communicating with instructor or teammates May use a communication device</td>
</tr>
<tr>
<td>12. Traumatic brain injury</td>
<td>An acquired injury to the brain caused by an external physical force, resulting in total or partial functional disability or psychosocial impairment, or both, that adversely affects a child’s educational performance.</td>
<td>Great variability in individual characteristics depending on location and extent of damage to the brain May exhibit physical, cognitive, and/or behavioral deficits</td>
</tr>
<tr>
<td>13. Visual impairment, including blindness</td>
<td>An impairment in vision that, even with correction, adversely affects a child’s educational performance. The term includes both partial sight and blindness.</td>
<td>May not receive visual cues and demonstration May have poorly developed spatial skills, including body awareness and laterality Intrinsic feedback may not be available</td>
</tr>
</tbody>
</table>

Definitions are taken from U.S. Department of Education Individuals with Disabilities Education Act (IDEA) http://idea.ed.gov/Sec.300.8.
three purposes: (a) to analyze complex skills to identify component parts; (b) to provide instructional content for skill acquisition (Goodwin, 2003); and (c) to assess motor skill performance (Seaman, DePauw, Morton, & Omoto, 2007). When analyzing a skill, it is helpful to remember that the skill performance does not occur in a vacuum. A complex person in a particular environment is performing the task. The characteristics and interplay between three elements: the person, the environment, and the task, are critical to better understand the motor learner’s performance (Newell, 1991). When teaching children with differing abilities, Newell’s model can provide a structure for adapting movement, activities (Pope, Breslin, Getchell, & Liu, 2012). Teachers should consider the learner’s individual characteristics, including structural features like neuromuscular development and level of maturation; as well as functional aspects, such as attention capability and level of motivation, among others. Similarly, teachers should pay attention to environmental characteristics of the instructional setting, assessing whether the environment will facilitate the learning process. Finally, the demands that the task imposes on the learner also should be carefully evaluated. To do so, one can use Gentile’s taxonomy to define the degree of complexity and organization of the task at hand. With time, all three components: person, environment, and task, may change, and, therefore, different expressions of movement performance may be observed (see Figure 15.1). Teachers can design and implement optimal practice conditions when they understand these person, environment, and task characteristics.

Gentile (1987) developed a two-dimensional taxonomy of motor skills that provides a useful way to analyze motor skills taking into account environmental context and function of the action. The taxonomy is a helpful tool in identifying logical sequences when developing a progression of skill instruction. Gentile identified two environmental factors that often change in physical activity settings: regulatory conditions and inter-trial variability. Regulatory condition refers to objects or other people in the environment that can be stationary or in motion. This environmental condition regulates how the mover adapts to be successful. Inter-trial variability, defined as change from one trial to the next, is either present or absent. Combining these two factors results in four categories: closed tasks, consistent tasks, variable tasks, and open tasks. Batting a ball off a tee is

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**Figure 15.1** Model of individual characteristics, task, and environment across time. These three elements change over time, and, together shape the observed performance characteristics of an individual. The three elements, their interactions, and how they change across time need to be considered in the design of the practice conditions.
an example of where the environment is stable and inter-trial variability is absent, representing a closed task. An example of an open task would be a football player catching the football while avoiding his opponents. Consistent and variable tasks have one stationary and one changing factor. Difficulty increases as the environmental factors become less stable.

The second part of Gentile’s (1987) taxonomy is related to the function of the action. Gentile defined action as “the observable outcome resulting from the performer’s purposeful interaction with the environment” (Gentile, 2000, p. 113). Gentile recognized two broad categories of action that vary within a task: body orientation and object manipulation. Body orientation can vary between being still (body stability) and moving (body transport). Manipulation refers to all actions “on objects to change or maintain their positions” and is present or absent. Hitting a golf ball off a golf tee requires body stability plus manipulation; swimming 50 yards requires body transport and no manipulation. When the two functions are combined, four categories are created: body stability no manipulation, body stability plus manipulation, body transport no manipulation, and body transport plus manipulation. Gentile’s taxonomy has been used successfully in physical therapy and rehabilitation settings for individuals with a variety of disabilities (Niemeijer, Schoemaker, Bouwien, & Smits-Engelsman, 2006; Wüest, van de Langerberg, & De Bruin, 2014). With practice this model can become a viable framework to create skill progressions in PE for any developmental level (Adam, 1999).

When both of these factors are placed into a table, 16 categories emerge (see Figure 15.2). Difficulty increases from upper left to the lower right-hand corner of the taxonomy. This table can aid instructors in preparing skill progressions and planning a variety of activities to meet multiple skill levels. Categories in the top left-hand side are suitable for beginners and students with low skill. The framework is also helpful in sequencing activities to move from a closed

<table>
<thead>
<tr>
<th>Function of Action</th>
<th>Environmental Context</th>
<th>Stationary</th>
<th>In Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stability</td>
<td>No ITV</td>
<td>ITV</td>
</tr>
<tr>
<td></td>
<td>No Manipulation</td>
<td>1A</td>
<td>1B</td>
</tr>
<tr>
<td></td>
<td>Manipulation</td>
<td>2A</td>
<td>2B</td>
</tr>
<tr>
<td></td>
<td>Transport</td>
<td>No Manipulation</td>
<td>3A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manipulation</td>
<td>4A</td>
</tr>
</tbody>
</table>

Figure 15.2 Classification of motor tasks based on Gentile's taxonomy. This classification system has two dimensions (function of the action and environmental context), which in turn are subdivided into two levels each, originating a total set of 16 levels of motor skills (adapted from Gentile, 1987)
environment to more open game situations. In the first category (1A) the regulatory conditions are stationary, inter-trial variability absent, stable body, and no manipulation. The student has an opportunity to attend to body position and task execution. As the child becomes more confident, teachers can manipulate the environment or function of the task to incrementally increase difficulty. For instance, kicking a ball at a target while moving is an example of decreasing environment stability and increasing demands of the action.

PE teachers will find this taxonomy extremely helpful when designing multi-level instruction within a lesson. Stations may be set up which include a variety of categories. For instance when practicing throwing, one student may stand still and throw at a stationary target with the same size ball each trial (1B), while another student may be still and throw to another student who is wheeling across the gym (4B); at another station both the thrower and catcher may be moving, as in wheelchair basketball (4D). Each student is practicing throwing at a level that provides him or her optimal challenge and learning. Teachers using this framework can accommodate learners with different ability levels, permitting them to participate simultaneously in the lesson. A child with mobility impairment may be more comfortable throwing at a stationary target while another child in the class chooses the station with both thrower and catcher moving.

Key elements in motor behavior

Motor behavior, as a discipline, encompasses both theoretical and applied studies. Although theoretical perspectives are important to practitioners working with children with disabilities because they provide a foundation that guides and justifies some practice decisions, the studies that focus on applied aspects of motor behavior will be more directly related to their pedagogical applications. In the following section of this chapter we will focus on six key aspects that a practitioner should consider when designing the practice conditions for a child with disability: (a) attention, (b) motivation, (c) demonstration, (d) augmented feedback, (e) amount and distribution of practice, and (f) variability and specificity of practice.

Attention

Attention is defined as “(a) the act or state of applying the mind to something; (b) a condition of readiness for such attention involving, especially a selective narrowing or focusing of consciousness and receptivity” (Merriam-Webster's online dictionary, n.d.) and is an important part of learning and performing motor skills. The ability to selectively attend to pertinent cues and disregard irrelevant cues in the environment develops throughout early childhood and is often established by the time children begin formal education (Ruff & Capozzoli, 2003). However, some children struggle with establishing and maintaining attention. Motor performance of children with attention deficit hyperactivity disorder (ADHD), autism spectrum disorders (ASD), intellectual disabilities (ID), and other developmental delays may be affected by an inability to establish and maintain selective attention to environmental cues relevant to the task (Belmonte & Yurgelun-Todd, 2003; Gligorovic & Durović, 2014; Tamm et al., 2010).

The importance of attention to motor performance is sometimes not completely recognized or taken into full consideration. It is important that practitioners evaluate a student’s ability to attend while giving instruction and to maintain attention to relevant cues in the environment while completing the task (Cratty, 2004). Once this information is established, Gentile’s model can be used as a guide to successfully design the task and environment for success. In a case study of a 5-year-old child with cerebral palsy, Kenyon and Blackington (2011) applied Gentile’s model to the task of ascending a playground slide ladder. In their
research the occupational therapist reported that the child was easily distracted and required multiple cues to stay on task. The treatment team systematically modified the task and the environment to provide increasing demands until the child was able to climb the ladder safely in a busy playground full of visual and auditory events that could be distracting. At the start the team had the child practice in a controlled environment with no distractions and no manipulation, simply stepping in place (1B). When the child was successful, they initiated the task of climbing a slide ladder. When the child was successful, the team moved the activity to an environment with more distractions until eventually the task was performed at the busy playground. This is one example of how Gentile’s model can be applied to a specific task for a student with attention problems.

Certain problems with attention are prevalent for children with specific types of disabilities. ADHD is characterized by the core symptoms of inattention, impulsivity, and hyperactivity (American Psychiatric Association [APA], 2014). Inattentiveness is the limited ability to remain attentive for the time needed to perform or understand a certain task (APA, 2014). Children with ADHD have difficulty paying attention long enough to understand how to perform a task or activity and then experience challenges staying on-task long enough to complete the activity. Children with ADHD are typically behind their peers in motor performance and it has been hypothesized that skill acquisition is hampered by a deficit in sustaining attention (Burden & Mitchell, 2005). Short, direct bouts of instruction can be advantageous for children with ADHD. Additionally, individuals with ADHD may require less immediate repetition to learn a movement (Adi-Japha, Fox, & Karni, 2011) and benefit from repeating the movement at a different time.

The majority of children with ASD show atypical attention. A recent study of over 350 youth with ASD revealed significant impairments in both focused and sustained attention (Chien, Gau, Chiu, & Tsai, 2014). Additionally, individuals with ASD experience difficulty when shifting attention from one stimulus to another (Ozonoff, South, & Miller, 2000) and allotting attention in expected ways (Afshari, 2012). Problems with attention are thought to contribute to the core features of ASD and should be taken into consideration when choosing the task and environment. A variety of instructional strategies have been developed to enhance attention such as decreasing distractions in the environment, emphasizing relevant cues, using short instructional periods interspersed with frequent breaks, and teaching self-monitoring techniques to stay on task. Motor performance can be negatively affected by poor attention (Breslin & Rudisill, 2013).

When providing instruction and feedback to students with intellectual disability (ID) it is beneficial to emphasize an external focus of attention to enhance motor skill acquisition. A recent study by Chiviacowsky and colleagues compared the effect of instructions that directed attention to internal (movement of the body) versus external (movement of the object) elements of a throwing task for children with ID (Chiviacowsky, Wulf, & Avila, 2013). The children whose attention was directed towards the object, in this case where the beanbag landed, performed better than the group who were told to focus on their throwing limb.

Motivation

Motivation to engage in the physical activity presented to the learner is critical to success. Though it is widely known that children and adults with disabilities are less active than the non-disabled population, research on motivation and physical activity for individuals with
disabilities is relatively scarce (Saebu, Sorensen, & Halvari, 2013). For the past two decades, Wehmeyer and colleagues have supported a self-determination framework to explore motivation for individuals with ID and other developmental disabilities (Wehmeyer & Abery, 2013). Self-determination theory is a metatheory which purports that three psychological needs are directly related to motivation: autonomy, competence, and relatedness (Deci & Ryan, 1985; also see Chapters 41 & 44, this volume). When individuals perceive that their needs are met, intrinsic motivation increases, leading to greater levels of participation. Wehmeyer and colleagues provide a framework of skills and attitudes that increase self-determined behavior. For instance realistic goal setting, self-monitoring, and self-reinforcement are all skills that can increase self-determined behavior and motivation (Wehmeyer & Abery, 2013). This framework offers promise when applied to the motor domain. Several theories of self-determination exist and all have a common basis: self-determination is a person–environment interaction. As people are able to act autonomously in a self-regulated and psychologically empowered manner their intrinsic motivation increases.

The self-determination framework was recently tested (Saebu et al., 2013) with young adults with physical disabilities and proved robust. Forty-four clients of a rehabilitation program answered a questionnaire based on self-determination theory in relation to the physical activity program provided by the rehabilitation clinic. The clients participated in the physical activity program three to five hours per day, six days per week. Clients indicated that autonomy support, optimal challenge, and social benefits increased intrinsic motivation, which, in turn, resulted in more physical activity.

Educators can provide opportunities for self-determined action by promoting choice, goal setting, problem solving, and self-regulation. Todd and Reid (2006) included individual goal setting and self-monitoring during a snowshoeing/jogging program for high school students with ASD. Participation in the program increased as students worked to meet their goals. Individual, task, and environmental constraints must be taken into consideration when setting attainable goals; this will increase the chance of student success.

Demonstration

Demonstration and imitation are important motor learning elements. Children learn motor skills by watching others, and teachers rely on demonstration to teach motor skills to their students. Children with ASD in particular have deficits in imitation and rarely imitate actions (Ingersoll, 2008; Williams, Whiten, & Singh, 2004) and thus do not benefit as much from demonstrations. However, demonstrations can be modified to be more effective. Cueing children to attend to specific movements, for instance, asking a child to look at your hands when demonstrating how to hold a bat will help children focus their attention on the task you want to demonstrate.

Imitation tasks can be divided into three categories: postural movements, actions on objects, and oro-facial movements; children with ASD show impaired imitation in all areas (Rogers, Hepburn, Stackhouse, & Weiner, 2003). However, children with ASD have greater success imitating tasks that involve actions on objects (Zachor, Ilanit, & Itzchak, 2010). This pattern also has been seen in children without disabilities and those with developmental delays (Stone, Ousley, & Littlefore, 1997). There is consensus in the literature that children with autism show fewer imitation deficits when tasks are goal-directed, meaningful, and have object-related actions. Custance, Mayer, Kumar, Hill, and Hearton (2014) recently conducted an experiment that added extrinsic, non-social rewards to object-related imitation tasks. Results suggested there was
no difference between children with and without ASD on imitation tasks. These findings can help educators choose appropriate tasks when preparing physical activity lessons.

**Augmented feedback**

In general, feedback refers to any type of information about a movement that has been performed. Feedback can enhance learning and performance of motor skills. Some feedback is inherent within a task, referred to as intrinsic feedback. This can include sensory-perceptual information that results from the performance of the movement through various sensory inputs, including vision, touch, proprioception, and hearing. Feedback can also be provided from external sources, such as from a teacher or peer. This feedback, known as extrinsic or augmented feedback, includes information in addition to intrinsic feedback from an outside source. The use of feedback is critical when learning and performing motor skills, however there may be challenges created by different impairments that teachers should take into consideration when planning lessons or activities.

Evidence-based practice research for children with intellectual disability recommends that instructors provide feedback in the form of movement outcome errors when learning a motor task. Teachers or peers can provide information on the accuracy of a throw (distance from target) or the length of a jump to augment the intrinsic information received by the mover. Tangible results provide meaningful information and aid in motor performance. A recent study compared this traditional technique to a reduced error protocol during a throwing task (Capio, Poolton, Sit, Eguia, & Masters, 2013). The researchers reasoned that the cognitive demands required to process complex information provided through feedback might impede acquisition of a skill. Researchers assigned one group of children to an error reduced (ER) group, while they placed a student comparison group in an error strewn group (ES). The ER group practiced throwing at a large target, while those in ES threw at a small target. The ER large target group made fewer errors, which is related to an instructional technique commonly known as errorless learning (Alberto & Troutman, 2006). The large target for the ER group was systematically made smaller, eventually matching the target of the ES group. The participants were asked to aim at the $+$ in the square. Success was counted as hitting anywhere in the square target. The feedback provided immediately after the task was implicit to the task, and provided whether participants hit the target or not. At the conclusion of this task sequence, the children in the ER group performed better than the ES group. Although traditional extrinsic feedback relies heavily on cognitive processes to correct for movement errors and improve skill performance, this may be difficult for children with ID. Decreasing cognitive demands, by reducing the amount of information provided, and setting up the environment to promote success proved effective for this group of children. The researchers reasoned that reduced reliance on cognitive processes was beneficial during motor performance. When working with children with ID, it is important to understand how feedback is processed and the cognitive demands these processes may require to ensure that the information received is beneficial. Intrinsic feedback benefits motor learning when the environment is carefully constructed.

Students with ASD may benefit from visual information more than other forms. Sensory integration problems are common among people with ASD and may make it difficult to use intrinsic information received during motor skill performance. Visual feedback has proven important for children with ASD. A recent study by Yang and colleagues confirmed that children with ASD have motor coordination problems and rely on visual feedback to adjust movements and successfully complete motor tasks (Yang, Lee, & Lee, 2014). When visual feedback was eliminated during a reaching task, motor coordination and movement time were affected.
When teaching children with ASD it is important to choose tasks and environments that provide visual feedback. Additionally, it is helpful to cue the individual to important aspects of the feedback provided.

Providing feedback to children with visual impairments can pose a challenge for educators. Visual feedback implicit to a task is not readily accessible to learners with low or no vision. Furthermore, conventional information regarding body position and movement provided by the instructor may not be very meaningful to these students. A recent study evaluated spatial skills, including body awareness, laterality, directionality, and perspective taking (Koustriava & Papadopoulos, 2012). When giving feedback to students with visual impairments about a movement, researchers commonly give information that involves use of these skills. For instance they might tell a child that the ball landed two feet left of the target, or that they did not step with their right foot. The researchers found that spatial skills in children with low and no vision were not developed in many children. They concluded that this lack of knowledge was not due to the visual impairment but to incomplete development. Therefore, based on this research, educators should assess a child’s spatial skills and adjust feedback accordingly. If a child is not sure where certain body parts are, how they move, or cannot differentiate between left and right, then this must be taken into consideration when providing feedback. For example, when teaching a child who cannot identify his left and right foot to step with the contralateral foot while throwing, a teacher can place visual cues on the floor for the student to step on with the correct foot. Three textured poly-spots, two placed side-by-side for the child to stand on and one in front of the foot that should step forward, will help the child know when he steps on the spot if he has used the correct foot.

**Amount and distribution of practice**

When considering the amount of practice to be scheduled for a learner, one can follow the general principle that more time for motor practice is better to improve performance and learning as long as fatigue is avoided. For example, young children better adapt their motor performance to a split belt treadmill where one leg moves faster than the other while walking, if they are provided with more previous experience or practice (Patrick et al., 2014). In addition to the amount of practice, educators might consider how to distribute this practice and whether the educator and learner should co-design the practice schedule.

It is widely accepted that for children without disability, practice should be distributed as compared to a massed schedule of practice that involves continuous practice with shorter and fewer breaks (Lee & Genovese, 1988; Shea, Lai, Black, & Park, 2000). A distributed schedule of practice allows more time for information processing and motor consolidation, minimizes fatigue, and may assist in motivation. Therefore, the preferred form of practice will include breaks for rest, observation of demonstration, self-evaluation, and error detection. However, an exception can be found in the literature, where children with ASD did not benefit from a distributed schedule of practice as compared to a massed schedule (Wek & Husak, 1989). Potentially, children with ASD’s limited capacity to acquire and use task-intrinsic (information generated by the body) as well as task-related information (information generated by an external source like the practitioner or peers) may account for this result.

Another established account regarding practice schedule is that for children without disability self-controlled practice is better than a schedule imposed by the practitioner (Wulf, Raupach, & Pfeiffer, 2005). For instance, Post, Fairbrother, and Barros (2011) reported that a self-controlled amount of practice facilitated motor learning since those individuals who chose their practice
schedules were more accurate during a transfer task. Interestingly, this same group of individuals also recalled the number of trials completed more effectively, suggesting that self-controlled practice has implications beyond task-specific factors. The added knowledge about the performance in itself via self-controlled practice, in addition to the cognitive processes (memory, for example) involved in motor learning, is a combination that recently has been acknowledged by motor learning scholars as important in the integration of motor learning concepts into PE (Rukavina & Jeansson, 2009). Rukavina and Jeansson (2009) propose that when students have an understanding of the learning process it can enhance motivation and their ability to select appropriate strategies for each unique learning situation. It is very plausible that similar effects might be detected in children with disabilities as long as self-controlled aspects of the practice are well matched with the individual’s capacities.

Although self-controlled practice may be beneficial to skill learning, reducing the overall amount of practice has been observed to be advantageous under self-controlled conditions (Post et al., 2011). If this is the case, then teachers have a challenge when designing a PE lesson or intervention session. The task must both ensure sufficient practice and permit the learner to benefit from a self-controlled practice schedule. Therefore, educators need to consider the delicate balance between the learner’s capacities and task demands to decide the self-controlled practice level optimal for each unique learner and situation.

Additionally, individual differences will influence the learner’s use of self-controlled practice. For example, children who requested feedback during the execution of successful practice learned a throwing task better when compared to those children who received the same amount of feedback but not necessarily timed with the success of their practice (Chiviacowsky, Wulf, de Medeiros, Kaefer, & Tani, 2008). Wulf (2007) hypothesized that certain individual characteristics, such as levels of motivation and information processing capacity, may interact with self-controlled practice. In other words, Wulf suggests that self-controlled practice enhances the learner’s motivation that, in turn, can generate deeper information processing, improving motor learning (Wulf, 2007).

Although the benefits of self-controlled practice also seem applicable to children with disabilities, further research is necessary and needs to examine the extent to which benefits of self-controlled practice can be generalized to children with disabilities. Thus far, such benefits have been found in patients with Parkinson disease (Chiviacowsky, Wulf, Lewthwaite, & Campos, 2012) and in a young adult with Down syndrome (Chiviacowsky, Wulf, Machado, & Rydberg, 2012). In these two studies, adults with different disabilities benefited from self-controlled feedback when learning a motor task (balancing for patients with Parkinson and a linear positioning task in the Down syndrome study) compared to a group of adults with the same disability that received the same amount and frequency of feedback but on a predetermined schedule. Again, being able to determine when feedback is needed may engage more cognitive processing and motivate the performer further compared to a pre-established schedule. It seems that self-controlled feedback enhances learning in individuals with disabilities.

**Variability and specificity of practice**

Whether the frequency of practice follows one or another schedule, practitioners will have to make decisions about the content to be included within the practice sessions and whether this content should be more or less variable (Porretta, 1990; Zipp & Gentile, 2010). In general, two forms of content practice have been defined: blocked, also called constant, and random, also called variable. There are advantages and disadvantages to each. Constant practice refers to repetitive practice of the same task. It has been shown to be more effective for improving...
specific task performance. When a motor skill is well learned, it typically demonstrates a high level of stability. On the contrary, random practice is defined by practice that involves varying the task demands over practice trials, purposefully destabilizing the skill performance. This type of variable practice has been hypothesized to improve adaptability and therefore transfer of learned skills to other skills of similar characteristics (Matsouka, Trigonis, Simakis, Chavenetidis, & Kioumourjoglou, 2010).

Different levels of practice conditions (from constant to random) may lead to different levels of stabilization, and the level of stabilization, in turn, will influence the child’s adaptation capability. Previous research demonstrated that better adaptation is achieved with a schedule of constant followed by random practice (Barros & Corrêa, 2006; Corrêa, Benda, Meira Junior, & Tani, 2003). Constant practice facilitates the formation of a movement pattern, and the subsequent random practice prepares the child to more easily adapt to new contextual demands (Corrêa et al., 2003; Lai, Shea, Wulf, & Wright, 2000). Furthermore, additional constant practice prior to random practice may not facilitate adaptive motor responses in the face of a new demand because excess of constant practice tends to make the motor skill more rigid (Corrêa et al., 2010).

Whether the benefits of a constant followed by a random schedule of practice are applicable to children is not clear, but recent research replicating the findings of research with adults to children suggested that random practice facilitates motor learning (Granda Vera & Montilla, 2003; Ste–Marie, Clark, Findlay, & Latimer, 2004). Limited research would suggest that the nature and degree of benefits may depend on the task complexity and the child’s age (Jarus & Gutman, 2001; Zipp & Gentile, 2010). Nevertheless, a small study conducted with children with Down syndrome demonstrated better performance on a transfer task of throwing to a more distant target under a random practice schedule (Baker, 2002). Also, children with dystonia, who have increased variability in their movements, are able to compensate their movement pattern appropriately in response to further increased variability (Chu, Sternad, & Sanger, 2013). Finally, in a study conducted with children with intellectual disabilities, variability of practice in a random schedule resulted in better performance in a throwing transfer task as compared to a constant schedule of practice (Matsouka et al., 2010). Together, these findings may suggest that children with disability may benefit from variable schedule of practice. Practicing skills within a constant context may involve repetition initially, but variability should be added to improve adaptability, enhancing transfer of the learned skills to different contexts.

Future research is necessary in the field of motor behavior in children with disabilities since many unanswered questions remain related to practice session design and content. However, the motor behavior principles presented in this chapter can be a great aid when practitioners are confronted with designing physical activity sessions for students with physical disabilities. Further, as the field of web-based technology and electronic devices continue to improve, these technologies could be incorporated as potential facilitators to enhance physical activity in individuals with disabilities, enhancing implementation of motivational routines and affording individualized progressive programs (Di Tore & Raiola, 2012; Wuang, Chiang, Su, & Wang, 2011).

**Summary of key findings**

- When viewed from a biopsychosocial perspective, disability is not limited to the person but encompasses constraints within the body and interactions with the environment (WHO, 2013). Dynamical systems theory provides a framework for understanding the interaction of the person, task, and environment.
• Individual constraints experienced by learners with disabilities can be accommodated through changing the demands of the task and environment.
• Gentile’s taxonomy of motor skills is a helpful model to systematically modify the closed to open characteristics of the task and environment to increase the demands on learners with disabilities.
• Attention problems are common among children with disabilities and can impact learning and performance.
• Instructors can focus on movement outcomes using an external focus to obtain best results (Chiviacowsky et al., 2013).
• Goal setting, problem solving, and choice can increase self-determined behavior for individuals with disability and can have a positive impact on their motivation to engage in physical activity (Wehmeyer & Abery, 2013).
• Children with ASD are better able to imitate actions that they perceive as meaningful and actions that require the use of objects, for instance, throwing a ball. These findings have direct implications when demonstrating actions.
• When teaching children with disabilities, instructors should ensure that feedback matches the person’s abilities.
• Children with visual impairments have been found to have poorly developed body awareness, laterality, and directionality.
• Because children with ID struggle with high cognitive demands of feedback, feedback should be limited.
• Because self-controlled practice has proven helpful for motor learning for individuals without disabilities, this concept should be examined for people with disabilities.
• Constant practice facilitates the formation of a movement pattern for individuals with disabilities, while subsequent random (variable) practice prepares the child with disabilities to more easily adapt to new contextual demands.

Reflective section with a study case

Six-year-old Suzie loves to listen to music, carry her favorite doll, and swim. Suzie has ASD and attends first grade in her neighborhood school. Suzie’s teacher has prepared a lesson designed to teach skills needed to play soccer. The focus of the lesson is on kicking a receivable pass. The teacher begins the lesson by explaining why kicking and passing a ball is important and demonstrates how to kick with the instep of the foot to direct the pass to a player who moves to receive it. Following the demonstration the teacher directs the class to divide into two groups and practice passing the ball to one another from a short distance. After passing back and forth for some time the class is directed to a goal kicking activity. This lesson is well received by the majority of the students and they are engaged in the activities. Suzie, however, does not seem to pay attention to the instructions, and then does not understand the task at hand. She is frustrated, wanders away, and does not participate. The teacher wonders how he might modify the instruction and activity to assist Suzie so she may participate successfully.

1. Using Newell’s model, identify individual constraints that Suzie may face. List the environmental and task characteristics of the lesson.
2. Gentile’s taxonomy of motor skills is helpful when planning multilevel activities. Using the taxonomy, plan three activities for Suzie that progress in skill level and could be set up as stations during the passing activity so she is optimally challenged.
3. Children with ASD experience difficulties in attention and motivation. Explain how the task and environment can be set up for Suzie, including delivery of demonstration and feedback, to optimize participation, motor learning, and skill performance.

4. When teaching a motor skill to students with disability, program practice and variability need to be taken into consideration. Describe ways in which Suzie’s teacher can provide the best conditions to practice this skill to facilitate transfer to a game situation.

References


R. Angulo-Barroso & T. Todd


Advances in disability research


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