PHYSICAL ACTIVITY AND STUDENT LEARNING

TARA STEVENS
Discussions of physical activity in schools often focus on health-related outcomes, but there is also evidence for its integral role in academic achievement, cognition, and psychological adjustment. Written by a scientist-practitioner, *Physical Activity and Student Learning* explores the effects of physical activity within the broader context of educational psychology research and theory and brings the topic to a wider audience. With chapters on positive school behavior, executive function, and interventions, this concise volume is designed for any educational psychology or general education course that includes physical activity in the curriculum. This book establishes physical activity as an important part of all learning—not just physical education and recess—and will be indispensable for student researchers and both pre- and in-service teachers alike.

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Physical Activity and Student Learning
Tara Stevens
Physical Activity and Student Learning
For reminding me that writing a book about physical activity is a sedentary activity, I dedicate this work to my daughter and running partner, Eliot.
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>One: Physical Activity through the School Years</td>
<td>6</td>
</tr>
<tr>
<td>Two: Executive Function and Academic Achievement</td>
<td>38</td>
</tr>
<tr>
<td>Three: Mental Health and Positive Learning Behavior</td>
<td>69</td>
</tr>
<tr>
<td>Four: Actively Moving Ahead with Interventions</td>
<td>105</td>
</tr>
<tr>
<td>Conclusions</td>
<td>139</td>
</tr>
<tr>
<td>Glossary</td>
<td>143</td>
</tr>
<tr>
<td>Index</td>
<td>148</td>
</tr>
</tbody>
</table>
Introduction

Children today use cell phones to maintain almost constant access to friends and family, internet connections to play video games with players across the world, and an array of movies and music to entertain them on their daily ride to school. Unlike earlier generations, children no longer need to physically move to see friends, find playmates, or get to school. Although some might think this lifestyle is reserved for those from higher socioeconomic backgrounds, an estimated 75% of children between the ages of 12 and 17 have a cell phone and 84% of children have internet access.¹ Less than 20% of children ride a bike or walk to school.² For children from low socioeconomic groups who do not have access to safe neighborhoods or organized sports in their communities, sitting in front of electronic devices offers not only a safe activity but one which also captures attention for hours. Thus, the average child watches more than four hours of television daily; however, most programming is no longer viewed on television screens but on computers and other electronic devices.¹ Statistics reveal children spend more time engaged with electronic media than they do with all other activities except for sleeping.³ Therefore, it is not surprising that almost 20% of children suffer from obesity.⁴
Introduction

While children’s health issues related to the decline in physical activity are often discussed in the popular media, many other outcomes are often overlooked. For example, sedentary behavior in children is associated with higher levels of anxiety and depression, as well as suicidal ideation.\(^5,6\) Additionally, decreases in physical activity are associated with declines in executive function, such as attention and inhibition, which are, in turn, related to lower academic achievement.\(^7,8\) Finally, children with better cardiovascular fitness, which is associated with higher levels of physical activity, tend to have higher attendance than those with poorer fitness, and physically active children have fewer behavioral problems.\(^9,10\) Interestingly, the general decline in children’s physical activity occurs at a time when depression and anxiety in youth are on the rise; concern for American children’s academic achievement, especially in STEM fields, relative to international performance remains an issue; and many children struggle with attention disorders that prevent them from benefiting from academic instruction.

As the research literature has expanded to show how the negative impact of low levels of physical activity extends beyond health problems to broader educational issues which relate to learning, the public school community has struggled to apply the findings. The dilemma of how to increase physical activity in school-aged children has centered on how to find more time for physical education and recess while maintaining children’s academic instructional time. Physical education and academics have typically been viewed as being on two ends of a continuum, with movement towards one end taking time from the other. This problem is further compounded by the variation typically
found in what degree physical education actually promotes physical activity. That is, physical education is not always physical. This may explain why physical education is sometimes found to relate to higher achievement but sometimes not. Due to such inconsistencies, as well as few to no findings relating physical education to declines in academic achievement, school administrators do not appear willing to invest more time in physical education. A closer look at how physical activity relates to positive educational outcomes, however, suggests that real increases in physical activity at school, rather than increases in time for physical activity, would benefit children’s executive function, well-being, and behavior. These benefits, in turn, promote higher academic achievement and, taken collectively, represent advantages to children’s learning.

Researchers and educators are only now beginning to understand the value of integrating physical activity across the school day and are thinking creatively to generate interventions that are not only effective but are also feasible. For example, some programs focus on activity before school starts each day by encouraging groups of children to walk to school through the provision of regular adult supervision. Other interventions incorporate regular breaks for physical activity in elementary classrooms. Periodic breaks can be used to not only allow children to move but to also simultaneously reinforce academic objectives related to mathematics, reading, language arts, science, social studies, and health and nutrition. Children might skip rope when learning to count up from the larger number in simple addition problems, walk the outline of a floor map of the original 13 colonies, or jog the earth’s orbit around the sun. Finally, some programs focus on improving student’s mental health
outcomes by introducing physical activity with counseling and related therapeutic approaches.

Many of these programs are still in their infancy, and public schools, which are required to use evidence-based approaches, must be assured of their efficacy before adoption. Unfortunately, many educators are still unaware of the educational benefits of physical activity and lack sources of information that will help them to know what types of interventions are based on research and which have been shown to improve student learning and related positive outcomes. The purpose of this book is to reframe physical activity’s role in learning to one that is essential rather than optional, as well as to show how psychological principles can shape physical activity interventions to be more effective. The first chapter will elaborate on what physical activity is, the important role of physical activity in children’s development, and how physical activity is supported differently across the school years. Chapters 2 and 3 will explain how physical activity supports cognitive function, academic achievement, and well-being. Finally, Chapter 4 will focus on how to approach intervention selection, including what educational and psychological qualities educators should consider. The final chapter will offer conclusions and future directions.

REFERENCES


2 Jones, S. E., & Sliwa, S. (2016). School factors associated with the percentage of students who walk or bike to school, School Health


One

Physical Activity through the School Years

How physically active should children be? After reviewing the research related to the benefits of physical activity, a panel of experts across specialties ranging from adiposity and cardiovascular health to academic achievement and mental health determined that school-age children required a minimum of 60 minutes of vigorous physical activity daily to achieve positive outcomes.\textsuperscript{1} They further advised that children should have access to different types of activities that are developmentally appropriate and enjoyable. This recommendation is supported by the Centers for Disease Control and Prevention, as well as by most other sport and health organizations, including the World Health Organization.\textsuperscript{2,3} Before determining how to incorporate the recommended 60 minutes of daily activity into the lives of children who typically spend more than seven hours sitting in desks each day at school, one must decide what physical activity is and how it varies as children develop. The focus of this chapter is the definition of physical activity, how physical activity changes as children develop, and how the context changes to influence children’s physical activity as children advance through the school years.
PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR IN CHILDREN

Physical activity is what most people think it is: the body in motion. To be more specific, physical activity can be defined as, “any bodily movement produced by skeletal muscles that requires energy expenditure.” Corbin, Pangrazi, and Frank add to this definition only slightly by specifying that skeletal muscles contract and that energy expenditure is substantially increased.

According to the World Health Organization, only 20% of the world’s adolescents achieve adequate levels of physical activity. Because children sit through the majority of the school day and most return home to engage in activities involving some form of screen time, they tend to spend the majority of the day sedentary. Sedentary behavior, such as watching television, playing video games, or interacting with peers on social media involves sitting and low energy expenditure. Children and adolescents could achieve the daily 60-minute physical activity recommendation but still spend most of their time sedentary. Much of the current research base focuses on how this phenomenon affects children’s health. Despite some inconclusive findings related to immediate negative health outcomes, most researchers agree that the long-term health effects of a sedentary lifestyle in childhood are evident. That is, children grow up with a greater risk for noncommunicative health diseases (i.e., cancer, cardiovascular disease, etc.) when they spend much of their time engaged in sedentary activities.

Understanding the long-term influence of sedentary behavior on children’s learning is an even more complicated endeavor. At first, researchers focused on the amount of
time children spent watching television. However, time spent engaged in television viewing started to decline as children’s access to computers increased. In the first decade of the present century, the price of computers dropped, and internet access became widely available through smartphones and tablets. By some estimates, 75% of preadolescents and adolescents have their own smartphone.\textsuperscript{6} Researchers did not immediately keep up with this trend. For example, some national studies, such as the Early Childhood Longitudinal Study—Kindergarten or ECLS-K, meant to provide databases of developmental variables that allow educational researchers to investigate young children’s educational progress and related issues ask parents about their children’s television, video game, and computer use but not their smartphone or tablet use.\textsuperscript{7} Of further concern, is that this information is garnered from parent estimates of how much time daily and weekly children spend in such tasks. The resulting estimates are likely biased by parents who might not actually know what their children are doing, especially when children have computers and televisions in their rooms. The cumulative effect of these concerns is that researchers have likely underestimated the amount of time children spend sitting and inactive and that the long-term effects on learning are relatively unknown.

**MEASUREMENT CHALLENGES**

Measuring physical activity also creates considerable challenges. In contrast to parents’ underreporting of children’s screen time and sedentary behavior, is their overreporting of physical activity. Problems exist with parents’ recall as well as measurement of activity levels that tend to vary
within children from day to day. For example, a child might play outside with friends for an entire afternoon on Sunday but spend an hour doing homework and then playing video games after school on Monday. Determining the child’s regular activity patterns would be difficult unless the parent reported consistently on the child’s behavior across days or even weeks. Researchers have tried to improve this method in a variety of ways, such as introducing computerized scoring and using beepers or texts to remind parents to record information. Finally, some researchers have tried to train children themselves to record their activity. Regardless, self-report methods only reliably identify active from inactive children. This is problematic, as researchers often want to know about the frequency, intensity, and duration of children’s physical activity.

If children should be active for at least 60 minutes daily, measuring the amount of time they spend engaged in activity or the duration is important. Likewise, determining whether this occurs daily or on occasion requires recording the actual frequency or occurrence of children’s physical activity. Finally, the idea that physical activity is differentiated from other activity by one’s substantial increase in energy expenditure suggests that its intensity should be assessed. Researchers have used a variety of measures to capture these dimensions of physical activity in children; however, the reliability and validity with which these methods have succeeded in measuring physical activity vary. For example, heart rate monitoring has been shown to correlate highly with direct observation of children’s activity when participating in a physical education class, but to correlate only moderately when children are engaging in typical classroom activities. Activity monitors have been
criticized for their inability to capture upper body movements and their expense. Pedometers offer similar challenges in capturing upper body movements but are affordable. Regardless, these measures suffer from the variable cutoffs employed by researchers. Should children walk the 10,000 steps generally accepted as the daily target for adults? What cut points should be used to determine complete intervals of activity and how many heartbeats per minute are necessary to indicate vigorous activity levels in children? Researchers have used heart rates ranging from 140 beats per minute to 160, although most have settled on 140.\textsuperscript{8} Such differences in the measurement of physical activity can lead to invalid estimates of engagement and misleading results.

**TRENDS IN SEDENTARY BEHAVIOR**

To complicate matters further, trends for sedentary behavior and physical activity differ based on age, gender, and context. For example, boys might spend more time playing video games than girls and children who live in poorer communities and neighborhoods likely spend more time engaged in sedentary tasks due to a lack of access to safe outdoor space. In a five-year longitudinal study of children from early to late adolescence, Nelson and colleagues documented a 50% increase, 10.4 hours per week to 15.2 hours per week, in leisure-time computer use for boys.\textsuperscript{9} In contrast, television viewing remained stable. The researchers also found that girls’ moderate to vigorous physical activity declined earlier than that of boys even though increases in computer use were noted for girls later than for boys. However, when comparing data collected in 1999 to that
collected in 2004, Nelson and colleagues found no evidence of a secular decline in physical activity for either gender. Overall, adolescents’ level of physical activity is not improving despite researchers, experts, and professional organizations raising the alarm and pleading for change.

Similar trends have been observed in preschool children, despite the image that many have of young children constantly on the move. In a review of 39 studies conducted between 1986 and 2007, Tucker found that just over half, or 54%, of young children between the ages of two and six reached the recommended 60 minutes of daily physical activity. Daycare and television were identified as the main obstacles to activity, and young girls were clearly less active than the young boys across the studies. However, such estimates can be difficult to interpret as young children’s engagement in physical activity tends to be intermittent rather than consistent. Young children are biomechanically less efficient and possess a lower tolerance for consistently vigorous activity. Observational studies have shown that few young children engage in intense activity for intervals longer than 15 seconds. With much of their activity emerging in short bursts, assessing their activity is difficult. Furthermore, researchers are forced to decide whether short bursts of activity that total 60 minutes are equivalent to activity sustained across 60 minutes. Thus, the activity patterns of children, especially young children, differ from that of school-age children as well as preadolescents and adolescents.

School-age children and adolescents have developed the biomechanics to engage in activity that requires physical coordination, such as kicking and hitting balls, quickly changing directions in a game of tag, and balancing on
a beam. Furthermore, with cognitive changes that allow for thinking beyond the present moment and understanding more abstract concepts such as fairness, older children can follow the rules of games and sports. Through sport and physical education, older children are typically given opportunities for physical activity on a regular basis which, if they engage, can ultimately improve their overall physical fitness. This state of well-being encompasses a variety of benefits, including, but not limited to, cardiovascular fitness, flexibility, and muscle strength and endurance that not only provide a physical basis for engagement in activities of daily life but also prevent disease.

**PARENT INVOLVEMENT**

Despite often possessing the ability to organize and manage their own physical activity and fitness, opportunities for play and sport are increasingly orchestrated by adults. Today, parents sign their children up for a variety of sports, such as soccer and gymnastics, at a very young age and schools decide the amount of physical education that will be made available to students, as well as its curriculum. School-age children benefit from deciding teams, making rules, and resolving rule disputes that relate to play and sport. When adults provide all the organization and regulation, opportunities for valuable social and cognitive development are lost.

Adults also influence young children’s physical activity in unique ways. Without well-developed **gross** (e.g., running, jumping, skipping, etc.) and **fine** (e.g., grasping, pinching, tracing, etc.) **motor skills**, toddlers and young children spend much of their physically active time refining these
skills through play or adult-directed activities that may be structured and rule-governed but require adult guidance for children’s success. When adults are not available for direct support or when children do not have an adequate safe place to play, adults often use the television or other electronic devices to entertain and keep children engaged. In other words, such devices are used as babysitters. Young children’s television and screen-focused activities have been vilified for their potential association with inattention, hyperactivity, and aggressive behavior. These relationships have been greatly debated in the research literature and have sometimes overshadowed the very important concern that young children learn by exploring and doing. Such exploration requires physical activity, and physical activity displaced by sedentary behavior prevents this exploration and related development.

**EARLY DEVELOPMENTAL PERSPECTIVES**

In many of the major theories of developmental psychology, physical activity has typically been relegated to **locomotion** or the ability of children to get where they need to go to explore their environments. For Jean Piaget, whose theory of cognitive development continues to be applied across classrooms even today, physical maturation was a part of his four-factor formula for development, but his interest in physical activity went no further than its support of cognitive development. When children coordinate their movements to reach objects and environments, they must develop new ways of thinking to incorporate what they find. As children act on their world, they move through stages that represent cognitive advances over prior immature
thought. For example, preoperational children, typically between the ages of two and seven, are unable to use operations or the internalized mental actions that form the structure of thinking. This means that they tend to think about one thing at a time and focus on what is in front of them. Young children find thinking about multiple concepts or ideas at once, reversing elements that relate to situations and events, and considering what might happen in the future as challenging.

For example, suppose preoperational children are shown two equivalent balls of clay and told that both are the same size. After the first ball of clay is rolled flat while the children watch, the children will indicate that the rolled clay is now larger. Young children have difficulty reversing what they see to recall that moments before both balls of clay looked exactly the same. Furthermore, they struggle to simultaneously think about the multiple dimensions (length, width, height) of the clay. These issues result in young children’s egocentrism and limited ability to take the perspective of others; therefore, young children’s peer relationships are affected as social cognition is immature. As young children explore and test their environment, their thinking changes and this immature thinking is replaced with a new way of thinking. Preoperational thought gives way to operational thought, which occurs when children are able to recognize that the flattened and balled clay are the same. Piaget did not go so far as to say that the physical action influences children’s emotions about their discoveries or their perspectives on what they see, hear, or feel as children physically interact with the environment. Changes in cognitive structure occur internally, or simply put, development occurs in children’s heads.
CURRENT DEVELOPMENTAL PERSPECTIVES

More recently, theorists have emphasized the interaction between children and their environments. In his social cognitive theory, Albert Bandura posited that bidirectional relationships occur between three elements: the person, the person’s behavior, and the person’s environment. Bandura referred to these interactions as **triadic reciprocal causation**, which provides the basis for change and development. For example, suppose a young child visits a new environment, a playground, with her parents. She observes other children swinging on a swing set, runs to the swings, and mimics their behavior. Her parents encourage her, and she looks to her peers to find that they push harder with their legs to swing higher. So, she does so as well and is met with additional parental praise. In this scenario, the child is influenced by the environment, but she also influences the environment by choosing the swings. She swings or engages in behavior, likely because of existing confidence she has in her physical abilities and her ability to cognitively reproduce what she has observed others doing. Her parents’ encouragement and praise come from the environment, both increasing her behavior or swinging and further improving her confidence in her ability to swing. In social cognitive theory, the social and cognitive are emphasized in this example. Experience with the social world and changes in the child’s thinking or cognition represent development. Physical maturation is only of interest because it allows children to reproduce the motor patterns they observe, which in this example is swinging.

Unfortunately, many view the physical achievements of infants and toddlers as milestones rather than as an integral
part of their cognitive and social development. This chronological, separate approach to physical maturation is often used to teach future educators about children’s development. Development textbooks designed for teachers in training are typically divided into physical, language, cognitive, and social and behavioral sections, which create an artificial dichotomy between domains. This understanding of development is evident in public schools where physical activity is separated from the classroom and viewed as having no place in learning. Physical education, which might occur daily depending on state regulations, is taught by a teacher who is most likely omitted from discussion of the academic curriculum or related matters. Physical education takes place away from the classroom, where the teacher to student ratio is likely to be two or maybe even three times what it is for an academic classroom and is taught by a teacher who may or may not be certified to teach in this area. In some schools, elementary teachers rotate the responsibility to teach physical education. The physical education curriculum, if one is followed, focuses on motor and skill development, following the rules of games and sports, and the value of physical fitness and is typically thought of as necessary to support children’s general physical health rather than achievement and learning. For many school administrators, physical education is only important because it allows children to appropriately expend energy outside of the classroom where excess energy is thought to cause disruption to the learning environment.

THE PROBLEMS WITH PHYSICAL EDUCATION

Although physical education might provide some children with the opportunity to engage in physical activity, physical
education classes do not always create an environment where prolonged, vigorous activity is actually possible. Not all schools, especially elementary campuses, have gyms; therefore, inclement weather relegates children to a cafeteria or multipurpose room where movement is limited. Even when space is available, researchers have documented that children spend only a percentage of the physical education class engaged in vigorous activity. For example, it was observed that, on average, sixth grade students were engaged in moderate to vigorous physical activity during only 19 minutes of a 55-minute physical education class.14

Secondary level students’ time in physical education can be replaced by competitive sports or athletics. Although most sports require physical fitness, engagement in some sports, such as golf, does not always reach vigorous levels of physical activity. In some schools, marching band can count as physical education. Even though marching can meet the definition of physical activity, the likelihood that students continuously move throughout each practice to reach a full 60 minutes of physical activity is low. Of further concern, is the seasonal nature of both sports and marching band. Some coaches require off-season physical training or even participation in other sports that require athletes to maintain their physical fitness. For example, to participate in basketball, coaches might require athletes to run cross-country. However, other coaches do not have such requirements. Finally, once high school students meet their physical education requirement, either through coursework or athletics, they do not have to continue. Therefore, participation in physical education and athletics at both the primary and secondary levels does not necessarily mean that students are achieving the recommended 60 minutes of daily physical activity.
Most adolescents, especially those who have reached puberty, have achieved the physical maturation of adults. Thus, when considered from a chronological view of development, decreases in physical education time are not of concern, as most adolescents’ biomechanical development is complete. Additionally, adolescents are expected to possess physical self-regulation so that they can sit without fidgeting throughout the day and are expected to take advantage of time in organized physical activity through athletics and physical education. These factors, as well as high academic demands at the secondary level, have resulted in the omission of recess for high school students as well as most middle-level students. The daily routine allows free time through a schedule that requires regularly changing classrooms and sometimes open lunch; however, little to no time is regularly scheduled for secondary students to engage in open, physical play during a recess.

**WHAT HAPPENED TO RECESS?**

Recess, which is formally defined as breaks that most often occur outside during the school day, has continued to be a staple of elementary schools across the world. Despite its universality, most schools have not developed curriculum, or even policies, beyond the requirement that children follow the school’s rules for appropriate behavior. However, behavioral requirements designed to deter bullying and fighting are difficult to enforce when the quality and quantity of playground supervision varies. Some schools require classroom teachers to monitor recess, whereas others use paraprofessionals or staff. Duties might rotate, which further contributes to inconsistencies in the provided supervision.
Finally, recess monitoring can be challenging regardless of the adult’s training and background. Recess often occurs on a playground that covers a lot of space with little shade. Teachers and staff typically keep to the shade, which sometimes puts a considerable distance between them and the large body of children they are monitoring.

Perhaps because of the variability of recess and associated supervision across schools and the poorly defined nature of what should occur during recess, opponents of recess emerged in the late 1980s and early 1990s. Pellegrini and Smith summarized the opponents’ objections, which included not only concerns for fighting and bullying but also time outside of instruction. This group reasoned that instruction was adversely affected by both omission and disruption. When excited children return to the classroom from being physically active during recess, opponents reasoned that children would be difficult to calm and unable to attend to learning tasks. Pellegrini and Smith described the position of the proponents of recess as just the opposite to that of the opponents. Proponents reasoned that children need to release their energy during recess to be ready and open to learning after returning to class. At the time, little research on recess was available to resolve the argument. Instead, high-stakes testing, at least in the United States, emerged to strongly influence schools to limit breaks and increase time spent in instructional settings.

High-stakes testing, or standardized testing, for which results are attached to a high-stakes outcome, such as graduation or advancing to the next grade, has been emphasized by legislation. In 2001, No Child Left Behind (NCLB) required states to set high standards for children’s educational
achievement, emphasized measurement and accountability, and demanded evidence-based practices. Thus, states adopted achievement standards and then implemented standardized testing to monitor children’s progress. Schools not making progress were held accountable and risked punishments related to decreased funding as well as interventions. In some states, continued teacher employment and salaries were tied to test scores. With such high stakes for both children and educators, many schools decreased or completely removed recess time from the school day in favor of either increased time in academic instruction, remediation, or both. Therefore, the amount of time devoted to recess since the 1990s has steadily declined. One study of a nationally representative sample of school districts conducted by the Center on Education Policy documented that 20% of surveyed districts reduced their recess time by 50 minutes a week, on average, in favor of time for English and mathematics.

THE VALUE OF IMMATURE THINKING AND RECESS

Around the same time that high-stakes testing was burgeoning, the American public became increasingly aware of the obesity crisis in American schoolchildren. With recess declining and schoolchildren’s weight increasing, researchers were also taking notice. In the spirit of NCLB, which required the use of evidenced-based practices in public schools, researchers worked to show that recess could not only improve children’s health but could do so without detriment to children’s learning. In their analysis of the importance of recess to children’s cognitive performance and school adjustment, Pellegrini and Bohn moved beyond a chronological view of children’s
development and focused on the cognitive immaturity hypothesis. In contrast to Jean Piaget’s perspective that young children’s immature thinking was something that children overcame through the interaction of maturation and the environment, the cognitive immaturity hypothesis emphasizes the value of immature thinking. Egocentrism and limited perspective-taking typically result in young children’s overestimation of their abilities, and this overestimation of successes and abilities can be motivating at a time when children need it most. Anyone who has had the experience of listening to young musicians developing their talent can attest that overestimation must be at work to encourage children’s perseverance. Whether it is playing music, bicycle riding, reading aloud, or solving mathematical problems, focus on oneself rather than what others think is an advantage.

For Pellegrini and Bohn, the immaturity of children’s thinking is not an indication of inferior thought processes but instead an indication of good fit to children’s environments. This is evident during unstructured recess time, which capitalizes on young children’s immature thinking and egocentrism. Without social constraints related to concern about what others think, children are free to explore a variety of roles which allow them to experience different perspectives, use language in flexible ways, practice emotional self-regulation strategies, and explore social cues and signals. Taken collectively, Pellegrini and Bohn proposed that these benefits promote children’s school adjustment.

On the other hand, Pellegrini and Bohn recognized that young children’s attention to task is limited in comparison to that of older children and adults. This negatively influences their ability to efficiently process large amounts of
academic information at one time. Young children do not have a lot of experience with the world or possess existing knowledge about academic content. Older children often have the benefit of foundational knowledge and experience with academic tasks, as they have received multiple years of prior instruction. When learning new information, older children can make connections to what they already know, which means that they can follow along and attention is likely to be maintained. Young children might struggle with making sense of new information if they have little to which it can be related. They are therefore more likely to experience cognitive interference, especially when learning tasks are highly focused. This makes breaks, such as recess that affords opportunities for physical activity, especially important to cognitive performance.

PHYSICAL ACTIVITY DURING RECESS

Pellegrini has spent years studying the role of recess in education. Through the mid-1990s, he and colleagues conducted a series of field experiments in which they manipulated recess time, as well as controlled the types of activities that occurred before and after. They consistently found that children’s attention was better after recess than it was before. In one experiment, Pellegrini and colleagues purposefully held recess indoors to evaluate the effects of a sedentary recess or one that simply offered a break from focused, cognitive activity. The researchers continued to find a positive effect on attention and concluded that physical activity’s role in this effect was minimal. In other words, the idea that the benefits of recess are related to children’s expenditure of energy or “blowing off steam” was not
supported. However, levels of physical activity were not measured in outdoor recess, and the authors assumed that children were physically active when given the opportunity to play outside.

At least three national organizations, the Center for Disease Control and Prevention (CDC), the National Association for Sport and Physical Education, and the National Association of Early Childhood Specialists in State Departments of Education, have used language in their recommendations to indicate that recess should include opportunity for physical activity. Although these inclusions reflects an intent to address issues related to children’s obesity and sedentary behavior, the recommendations also suggests that recess does not always afford opportunities for physical activity. First, considerable disparity exists with regard to which schools offer recess, at what grade levels, and for what amount of time. For example, rural schools have been shown to provide more recess time on average than urban schools. Schools with 75% or more of their student population receiving free or reduced lunch tend to have the least amount of time devoted to recess. Younger children are often provided with more time in recess than older children. Second, the physical environment does not always encourage physically active play. Although the investigation of the quality of playgrounds and facilities has yielded inconclusive results, some evidence is present to suggest that access to unfixed equipment, such as jump ropes, hula hoops, bouncy balls, and sports balls is positively associated with increases in children’s physical activity during recess. Finally, children often do not capitalize on the opportunity to be physical active, and engagement in physical activity varies by gender and age.
Several studies have revealed that children engage in moderate to vigorous physical activity during recess for only about 20% to 30% of the time.\textsuperscript{23,24} In a comparison of levels of physical activity between after-school, physical education, and recess contexts, researchers found that adolescents were the most active after school. Adolescents were the least physically active during recess. They further found differences for age levels, with older participants being more active during physical education but younger participants more active during recess. Finally, they found that boys were more active than girls across all situations. These findings make it difficult to say that a break from focused instruction is all that is important to children’s improvement in cognitive performance after recess. Physical activity may also play a role, if only it was a part of recess.

**EFFORTS TO INCREASE PHYSICAL ACTIVITY DURING RECESS**

Multiple researchers have devised interventions to improve children’s physical activity during recess, but most efforts have been attempts to improve overall health rather than children’s learning. Some have focused on changing the physical environment by improving playgrounds and providing unfixed equipment; however, the effects associated with such interventions have been inconclusive.\textsuperscript{25} Others have applied behavioral interventions with somewhat greater success. For example, Miller and colleagues (2018) created a game involving pedometers and step counts.\textsuperscript{26} Two teams of five- to eight-year-olds competed to see which team would achieve the highest number of steps during recess. Despite publicly posting each team’s results and an initial
slight increase in steps, children’s steps leveled off and ultimately showed only a minimal increase. However, when the children were allowed to also self-monitor their own steps, the researchers observed an increase of about 12 steps per minute, from an average of 74.6 steps per minute to an average of 86.3 steps per minute. Unfortunately, a review of individual students’ step increases revealed that not all the students’ step counts increased. Of further concern was that only four of the children achieved the goal of 100 steps per minute. Because 100 steps per minute was considered the threshold for moderate to vigorous physical activity, the researchers added goal setting and then goal setting with rewards in a second experiment. Although setting a goal to reach a specific number of steps during recess did little to increase the children’s average step counts, the addition of a reward was effective. Children were successful in increasing their activity to earn raffle tickets that would offer them a chance to win leisure items from a prize box at the end of the week. A review of individual children’s step increases revealed that 11 of the 18 children reached or exceeded the 100-step per minute threshold.

Zerger and colleagues (2017) also studied a team approach; however, they paired children based on pedometer score rankings. After recording the steps of 16 children between the ages of nine and 12 engaged in play during a regularly scheduled 29-minute recess, the researchers rank ordered the children by activity level and paired less-active children with more-active children. The teams of two were then told they would be competing to see which team would achieve the highest step count. The children were allowed to look at their own pedometers as well as the pedometers of their teammates. Although no
rewards were provided for the teams with the highest step counts, the results were presented to the children using a bar graph, and the step counts for all teams were visible. The results revealed that the children, on average, increased their step count by almost a third. Similar to findings of Miller and colleagues’ that individual results for all children did not indicate increases, a review of individual step counts revealed increases for just half of the children.\(^\text{26}\) However, 12 of the children did achieve step counts consistent with moderate to vigorous physical activity.

These studies reflect the challenges of conducting research in physical activity. Measuring physical activity, especially in young children, is difficult. The use of pedometers only accounts for steps and not upper body motion. Children’s activity is often intermittent, with bursts of energy rather than consistent activity as the norm. This means that calculating children’s average step count might not truly represent the amount of energy expended. Although problems with measurement might explain some of the deflated levels of assessed activity during recess, some children are simply not reaching adequate amounts of physical activity during periods of free play. For example, girls engage in physical activity at a lower rate than boys. Some have suggested this is due to sharing space with boys whose physical play might be viewed as intimidating by girls.\(^\text{16}\) Finally, multiple behavioral strategies seem to be needed to influence children’s activity levels, and despite evidence that some positive increases will result, not all children will benefit. If the idea of recess is to provide opportunities to explore, role play, and move, then increasingly structured recess that is organized and monitored by adults seems counterintuitive.
Furthermore, focusing on recess as the only opportunity for children’s physical activity at school makes little sense. Children, especially young children, will not likely achieve the recommended 60 minutes of daily physical activity while consistently engaged in one activity, such as physical education or recess. Instead, children will most likely accumulate the 60 minutes across the day. However, no one seems to be able to find time for physical activity. Many researchers have worked to justify the continued existence of physical education and recess by reporting that they do not harm children’s academic achievement. Instead, school administrators and parents want more assurance and demand clear benefit from physical education and recess. This is simply difficult to determine when it is the physical activity that provides the benefits from physical education and recess, and this physical activity is poorly measured, does not occur at a vigorous level, differs across gender and age levels, and/or occurs for only a small portion of the allotted time.

THE ISOLATION OF PHYSICAL ACTIVITY TO PHYSICAL EDUCATION AND RECESS

By relegating movement to physical education and recess, educators have created an artificial dichotomy between physical activity and children’s development and education. This is not surprising when physical development is often discussed in the context of maturation and accomplishment of milestones or is reduced to something that is merely needed to support children’s exploration of the world. This perspective suggests that physical activity develops independent of other processes. However, thanks to evolution, the human body needs physical activity to develop healthy
Figuring out where to go and how to get there requires coordination of skills across a number of psychological domains and time scales: coping with the sheer biomechanics of moving the limbs in a gravitational field, contending with different ground surfaces and their effects on balance control, gathering perceptual information about the ground ahead and about infants’ own propensities, searching out alternative means to traverse a surface or reach a location, and so on. 

Physical activity is an integral part of infants’ and children’s development, and increasingly, developmental theorists are focusing on this. Eleanor Gibson is credited with putting the body back into the study of development and moving development outside of one’s head. According to Gibson, environments contain structure, which means that the cognitive development of this structure is found through stimulation. As children move and interact with the environment, they learn about its distinctive features and learn to perceive what is already there. The idea that structure exists in the environment and physical action is required for its discovery sharply contrasts with the perspective that structure is created by children’s thinking. Children are active perceivers who must learn what different
environments afford, and these affordances offer children prospects for action.

For example, a young child who encounters a puddle for the first time might learn that the shallow indentation filled with water affords many different things: a challenge to walking, a wetness that makes her feet cold, splashing, enjoyment, and/or her mother’s negative emotional response. A soccer ball can be kicked, thrown, stepped on, or used in a game that requires children to consider a variety of physical factors, including how hard the ball must be kicked to reach a teammate or the goal, spatial distances between teammates, the amount of time it will take to reach the goal depending on speed, etc. Thus, children get to know the world through physical activity.

**DYNAMIC SYSTEMS THEORY**

In dynamic systems theory development also depends upon these interactions between individuals and their environment. Because the environment is constantly changing, and children’s thinking and emotion can vary, development is far from a linear process. Thelen likens development to a moving stream flowing from high in a mountain. Even though the stream is pulled by gravity, its movement depends on the geological features that guide it through the landscape. These features create places where the stream flows faster than others, eddies and whirlpools, and even frothy waves. In terms of children’s development, Thelen emphasized that physical, cognitive, social, and emotional/behavioral domains do not emerge independently from each other and should not be considered separately. They are like a river, with all domains interacting to move children
forward while working together to navigate obstacles and challenges that emerge at different times and places within and across children’s environments.

Humans perceive and move continually during every waking minute, and much of this has an emotional valence. Yet, in many purely cognitive accounts, the roles of perception, emotion, and especially movement are considered secondary to mental activities. But according to the principles of dynamics, mental activities not only are founded in emotion, perception, and action but also are part of the causal web of behavior throughout life.30

Just as the name suggests, dynamic systems theory emphasizes that multiple systems are working at once to influence individuals’ behavior. Therefore, Perone and Simmering described dynamic systems theory as “a set of concepts that describe behavior as the emergent product of a self-organizing, multicomponent system evolving over time.”31 Three concepts, multicausality, self-organization, and nesting of timescales, provide the foundation for developmental change. Nested, developmental processes can be working in the moment or gradually developing over many years.14 For example, an understanding of algebra requires cognitive processes that begin from early counting and recognizing a one-to-one correspondence between numbers and sets to a later balancing of two sides of an equation. This development takes many years. However, increases in neurohormones in the brain in response to moderate to vigorous physical activity might occur in seconds or minutes to
support children’s attention. Even so, these two systems are related or nested, as changes in brain chemistry that support attention can facilitate the benefits children receive from mathematics instruction. Although these systems self-organize into “attractor states” that can be expected to act in stable ways, they are also open to change in response to forces that come from within individuals and from without.14 This means that children change, develop, and learn in nonlinear ways.

In the mathematics example above, multiple systems converge to allow a child to solve an algebra problem. Physical activity promotes higher levels of executive function so that the child can attend to the task, inhibit or stop herself from thinking about things other than algebra, and regulate emotions, such as frustration, when they emerge. Solving the algebra problem also requires memory recall of numerous mathematical concepts, the use of perceptual-motor coordination to physically write out the problem, and social cognition should the child need to request assistance from a peer or the teacher. Unlike other development theories, dynamic systems theorists believe that these systems work collectively to yield behavior, and no one process is more important than any other. This multicausality requires researchers to look at multiple systems and forces to understand behavior; however, much of developmental and educational research focuses on only one process at a time and at only one point in time.

If physical activity is an integral part of a multicomponent system, then why consider it separate from the classroom? Understanding the interaction of complex systems to promote development and learning is challenging. Perhaps this and the demands often placed on educators to find quick
solutions to increase achievement scores have pushed educators to rely on simpler theories and perspectives to inform their classroom practices. Therefore, opportunities for physical activity have been either omitted from the school day or significantly reduced. Educators not only fail to see the value of physical activity beyond the need to improve children’s physical health and weight but also struggle to view physical activity as something different than exercise.

**PHYSICAL ACTIVITY DIFFERS FROM EXERCISE**

Exercise refers to the planning of repetitive physical activity with the goal of improving and/or maintaining physical fitness. Exercising to gain physical fitness conjures a variety of images, many of which involve a gym filled with specialized equipment. Exercise at the gym can result in physical activity, but physical activity can occur elsewhere. Often playing sports involves physical activity, although playing a game of baseball or volleyball does not require exercise or even physical fitness. The relationship between physical activity and sport is further complicated by the seasonal nature of sport participation. Of course, being physically fit and exercising to improve one’s fitness and readiness for a sport is typically necessary if one wishes to excel. Perhaps less obvious is the time spent engaged in physical activity when moving at school and work, getting around, completing household tasks and chores, and even relaxing. For example, dancing meets the definition requirements for physical activity as does walking to school and vacuuming the living room. Children might be considered physically active when building models of bridges in a science class, painting backdrops for theater class, or reading historical markers while walking...
a local trail. When educators are reminded that children need to increase their physical activity, many initially think of exercise. Some might consider the role of sport, but few will consider simple tasks like walking to school or frequently getting up and down to complete an assignment in the classroom. The definition of physical activity emphasizes movement that expends energy, which is relatively easy for most individuals to accomplish. Therefore, achieving the 60-minute-a-day requirement should not be so difficult if educators think about physical activity as moderate to vigorous movement necessary for learning and development.

Although the concept of schooling might conjure images of neatly aligned rows of children sitting quietly, modern classrooms come in all designs. Open-concept classrooms where elementary children can easily move from center- or learning-focused play areas to kidney-shaped tables designed for direct instruction are common. Middle-level students might work in groups at tables, and adolescents may be given opportunities to take unscheduled breaks in common areas. Therefore, opportunities for physical activity are available throughout the day if only educators understood how each environment affords them.

**CONCLUSIONS**

The first chapter defined physical activity as “any bodily movement produced by skeletal muscles that requires energy expenditure” and discussed how children engage in physical activity as they mature. The way children interact with physical education and recess was highlighted to explain that opportunities for activity do not always result in physical activity. Several theories were used to frame
physical development and its role in children’s thinking and social interaction. Early approaches were criticized for isolating physical development and activity, and dynamic systems theory was adopted as a framework for understanding how physical activity works with other developmental domains, such as cognition, to facilitate change and growth. Educators are challenged to think about physical activity’s role in learning differently so that they may be more likely to integrate it throughout instruction rather than relegating it to specific times and places, such as recess and physical education. Before discussing this integration, educators must first understand the evidence that physical activity does positively affect learning. This information is presented in Chapter 2.

REFERENCES


Physical Activity through the School Years


Chapter One covered complicated concepts ranging from different theories of human development to the varying methods for defining and measuring physical activity across the domains of physical education and recess. Multiple challenges were discussed, including the concern that opportunities for physical education and recess do not always lead to children’s physical activity. In this chapter, the association between physical activity and learning will be discussed. Because learning is considered the acquisition of knowledge, learning tends to encompass many variables. Thus, the research in this domain includes related but different outcomes. Researchers may use the same terminology, such as achievement or performance, but use entirely different measures to assess these outcomes. In their 2014 review of the past 45 years of research investigating physical activity and academic performance, Castelli and colleagues noted that researchers in the field had used imprecise measurement for most of the variables of study. Although Castelli and colleagues settled on the term, academic performance, for their review, they recognized that this term could encompass “academic behaviors, attitudes, attendance, time on task, homework completion, attention/concentration, memory, creativity, fluid intelligence, verbal ability, grades, and academic achievement on standardized test scores”1
(p. 135). This chapter will also work with these aspects of academic performance as a collective; however, two main areas, executive function and achievement, will be the focus.

Because no less than 100 studies have been conducted over the past 50 years to investigate the relationship between physical activity and learning, a comprehensive view of the field is available through discussion of the many reviews conducted by experts across the fields of development, kinesiology, and educational psychology. However, not all reviewers included the same studies, as they differed in their purpose and perspective on what studies represented quality research. Some reviewers focused only on studies of executive function or on academic achievement whereas others reviewed studies of executive function alongside studies of academic achievement. Fewer reviewers included only studies of brain structure using magnetic resonance imaging (MRIs). Although these outcome variables are related to learning, they are measured in a variety of different ways, which can account for differences in results and interpretation. Thus, problems associated with measurement will be discussed.

The first section of Chapter Two provides a very general overview of the role of cognition in the classroom to not only offer some description of the variables of interest but to also explain how they relate to classroom instruction. This discussion is also meant to demonstrate the interconnectedness of executive function and achievement variables and the systems that they represent. In dynamic systems theory multiple systems work simultaneously to facilitate development. Multiple developmental perspectives, and therefore multiple variables related to learning, are incorporated into this chapter. Although the inclusion of the many
learning variables can be confusing, especially as the same terminology might be used to refer to different constructs, this approach is important as such variables work collectively to support children’s development.

The second section is devoted to physical activity’s role in improving executive function. Executive function is treated separately from discussion of the achievement variables because of its important role in cognition and academic outcomes. The final focus of the chapter is not only physical activity’s influence on academic achievement variables but also the differences in research designs which can help in understanding variations found across the results of studies.

**HOW COGNITION RELATES TO INSTRUCTION**

Dynamic systems theory allows for multiple systems to be working at once and can, therefore, incorporate different theories and systems of development. When thinking about learning, education has typically looked to both behavioral and cognitive explanations. Whereas behavioral methods, such as programmed instruction, were popular in the 1950s and 60s, cognitive perspectives currently inform instructional design. Although theories of cognition or information processing often break down the development of knowledge to internal processes, they do recognize the importance of the environment. Children act on the environment to develop schemes about academic concepts and to construct knowledge. For example, through exploration of objects, children learn about larger and smaller, taller and shorter, heavier and lighter, etc. When presented with a cake that is subsequently cut into pieces, children use this information to determine the largest piece. An older sibling
might point out that his younger brother’s piece is twice that of his own. Parents and educators might count balloons, stars, steps, or crackers and point out shapes ranging from stop signs in the shape of octagons to yield signs in the shape of triangles. These experiences create connections between cognitive concepts and the real world so that the information is encoded in a meaningful way. With more and more connections made to the same underlying content, an increasing number of pathways for recall are made available. This represents learning.

Although classroom experiences include similar opportunities for authentic learning, educators also incorporate drill and practice. This is sometimes criticized as “drill and kill”; however, there is a place for building automaticity for specific skills. This is especially relevant when learning basic mathematics facts or developing vocabulary for reading. Automaticity occurs when knowledge is learned so well that it is recalled “automatically” with little effort. Because individuals can only process a limited amount of information at one time, typically seven plus or minus two pieces of information, or even less if the information is novel, automaticity is important.³,⁴ When information is automatic, individuals do not have to think about it, which allows them to devote precious cognitive space (for lack of a better term) to process other content. For example, a child who has automaticity in her addition and subtraction facts can devote working memory to the process of solving a two-digit multiplication problem rather than processing basic facts. A child who has automaticity for the order of operations can devote more working memory to deciding the best way to simplify an algebraic expression. A child who has a good vocabulary can read fluently without
frequently stopping to look up words or ask his teacher for assistance. Because he is reading fluently, he can devote working memory space to process imagery and main ideas.

THE IMPORTANCE OF PHYSICALLY ACTIVE PLAY

This discussion, albeit limited, reflects common theoretical perspectives on children’s learning and cognitive development. Students engage in practice to develop automaticity, participate in classroom discussion to construct knowledge, and engage in project-based learning to relate new knowledge to authentic and real-world issues. Thus, many educators and parents would advise that the majority of the school day be spent engaged in these types of classroom activities. Although this might seem logical and in the best interest of learning, this approach fails to consider that multiple systems are at play in learning, of which cognitive forces are just one element. This focus on only the cognitive system is especially evident in early childhood classrooms where time for play, even in play centers devoted to children’s exploration of a variety of different developmental skills (e.g., number and letter recognition, counting, phonological awareness, social skills, fine and gross motor, etc.), has been declining since the implementation of high-stakes testing. Although high-stakes standardized tests are typically not administered before the second grade, educators and parents want children to be ready. Therefore, classroom practices, such as group instruction and independent seatwork, which have typically been reserved for older students, have been increasingly employed to teach young children. This has created misalignment between instruction and children’s developmental levels, and young children are spending even more time sitting at
desks instead of engaging in physical activity. The negative consequences are not just related to potential health concerns, such as obesity which is associated with a sedentary lifestyle, but also to learning and achievement.

Early childhood center time and certain project-based learning activities in elementary and secondary classrooms could bring students out of the classroom and moving; however, educators and parents might not understand the value. Many educators and most parents may not see that physical activity plays a role in promoting mathematics understanding, reading fluency, or other areas of academic achievement. However, evidence of a “physical activity-cognition coupling” exists. From early infancy through adolescence, physical activity interacts with development not only over time but in each moment. Pellegrini and Smith summarized the manner in which physically active play influences development at different stages. Infants kick and rock in rhythmical stereotypic behaviors that likely promote control over motor functions, preschoolers run and chase in exercise play that builds their strength and stamina, and school-aged children playfully wrestle in rough-and-tumble play that aids in establishing social dominance and reading emotional cues.

Physical activity also directly influences cognition. Young children struggle with keeping information in their working memory and tend to be distracted more easily than older children and adolescents. This may be a result of differences in cognitive structure or simply that young children do not possess a variety of experiences or an expansive knowledge base to which they can relate new information. “As a result, their working memories are often cluttered with irrelevant information, leaving less mental capacity for task-relevant information or the execution of cognitive strategies.”
Therefore, young children may struggle with attention and distractibility as well as shifting from one task to the next. Overall, their ability to self-regulate themselves is limited, and they may need frequent redirection to tasks and activities. According to Pellegrini and Smith, physical activity, especially through play, is adaptive, as a sudden change in activity level can clear cluttered thinking and support attention and concentration. Furthermore, play affords many opportunities for success and feelings of efficacy, which can prime children for the learning environment. They can return to academic tasks with confidence and a belief in their ability to succeed.

EXECUTIVE FUNCTION

As students develop new cognitive concepts, apply these concepts to different situations and contexts, and develop automaticity, these processes are being facilitated by children’s attention, concentration, and other executive functions that regulate thinking. Despite extensive focus on cognition in instruction, the role of higher-order cognitive variables, such as executive function, is less frequently considered. Like the name implies, executive function might be viewed as the functions that help to execute thinking and cognition. These functions include planning and organizing, shifting between tasks and knowledge, manipulating information held in working memory, inhibiting inappropriate responses, and using context to evaluate the appropriateness of responses. Some researchers organize these functions into the three dimensions of updating of working memory, inhibition, and shifting; however, the dimensions remain related rather than distinct. Regardless, inhibition and working memory tend to
be the most frequently studied in relationship to education and learning. Perhaps the best way to understand the role of executive function is to consider situations in which it fails to work effectively, as in the case of Attention Deficit Hyperactivity Disorder or ADHD.

According to a leading expert on ADHD, Russell Barkley, the academic difficulties typically seen in children with ADHD are likely related to problems with executive function. Although problems with working memory are often considered, Barkley has largely studied limitations in children’s inhibition. Thus, the most important indicators of ADHD may be neurocognitive in nature rather than behavioral. Children who have trouble with inhibition might find it difficult to refrain from moving away from their desks when they are expected to be seated or they may find it difficult to stop themselves from blurting out answers when their teachers expect them to raise their hands. The problem behaviors are what teachers first notice; however, the underlying cause is likely executive function.

Although engagement in problem behaviors can adversely affect children’s academic performance, especially if children are removed from the classroom due to what are viewed as disciplinary concerns, poor inhibition and working memory are also closely connected to learning. While reading, children need to inhibit thinking about other topics, such as what they plan to do after school or sharing what they have just read with the student sitting next to them. When taking a timed test, they need to limit their recall to related content and stop themselves from thinking about extraneous ideas and while solving a mathematics problem they need to remember procedures as they are working through the individual steps. Therefore, it is not surprising that executive
function is positively associated with children’s academic achievement, especially mathematics achievement.\textsuperscript{12–15}

**MEASURING EXECUTIVE FUNCTION**

Studying executive function might at first seem difficult because it is hard to know what processes are working behind the scenes as children are learning and engaging in academic work. However, certain tasks tend to be quite effective at assessing executive function. Working memory can be evaluated by asking children to simply restate numbers that are read to them. The evaluator typically begins with two or three digits and then asks the child to repeat the values. At each success, the evaluator adds a digit, which places an increasing demand on the child’s working memory. To further create cognitive load and assess children’s working memory, the evaluator will ask the child to read the digit span backward once the child has reached his or her capacity for recalling the expanded digit lists read forward. For example, if the digits seven, four, six, and nine are read out by the evaluator, then the child would respond nine, six, four, and seven. Because most individuals can hold about seven pieces of simple information in their working memory at one time, they find it difficult to recall all the numbers when digits are added beyond seven, especially when told to state the numbers backward. That is, they are unable to keep the information in their working memory. A common real-world application of this task would be remembering a new phone number. When trying to remember a new phone number, which is conveniently about seven digits long, individuals will typically repeat the number until they can write it down. If they are
interrupted, the new number, which has not been committed to long term memory, will be forgotten, as the interruption added new information beyond the capacity of working memory.

A popular test of inhibition centers on a “go/no go” task. A go/no go task for middle and high school students is most often conducted on a computer or other electronic device and involves presentation of letters. Students might be told to tap the screen if the letter A appears but to not touch the screen if an X appears. The letters are flashed across the screen rapidly to assess the students’ ability to inhibit their touch response in the case of the appearance of an X. This task has been adapted for younger children to include images rather than letters. For example, young children might be told to tap on the screen when a cartoon image of a fish quickly swims across but to avoid touching the screen when a shark swims across. Children who continue to touch the screen when told not to do so, likely have trouble inhibiting their responses. Researchers often use these tasks to measure executive function before and after physical activity to assess associated changes.

**THE DEVELOPMENT OF EXECUTIVE FUNCTION**

The connection between executive function and learning is relevant for all children, regardless of the presence of ADHD. Researchers have studied the “the 5 to 7 shift” and understand this period is important for attention development. For example, seven-year-old children are significantly better at attending to relevant information while ignoring irrelevant information than five-year-old children. Young children’s neural networks are thought to develop through a “pruning”
process that involves an interaction between genetics and environmental influences with pathways that are used being strengthened and those not used withering away. The acquisition of language is a good example. Infants begin to lose the ability to discriminate certain sounds when they do not have exposure to those sounds. With the withering of certain pathways related to language, acquiring another language later in life tends to be difficult. Other evidence of such pruning occurs in the case of reading, which requires early phonological awareness for success. Young children with greater exposure to the sounds of speech or the basic sounds that comprise words tend to learn to read faster than children without this exposure. Children who have learning disabilities and who have not had the benefit of early practice to facilitate phonological awareness may find reading an increasingly impossible task as time passes without intervention.

In some domains, such as language and attention, the pruning phenomenon takes a clear developmental course. Just as the “5 to 7 shift” is important to attention, around the age of two years, children experience what can best be described as an explosion of language due to the amazing speed with which words and language are acquired. Additionally, around one year, infants make incredible gains in locomotion. As mentioned in Chapter 1, the cognitive and physical integration needed to accomplish the task of walking is often underestimated. Infants must adapt to changes in surface, depth, and physical obstacles all while coordinating physical systems that were used quite differently when crawling. Certainly, synaptic pruning does not mean that children lose the ability to crawl. However, children think about the world quite differently subsequent to locomotion. Thus, developmental psychologists understand that
certain time periods are critical for specific aspects of development.

Although language and locomotion appear to occur swiftly and early, the development of executive function takes a longer course. According to Best, Miller, and Jones, executive function does not mature until adolescence or even young adulthood. Physical activity facilitates this process not only through children’s movement but also through the increased production of neurotrophins, such as brain-derived neurotrophic factor (BDNF) that supports synaptic plasticity. Best referred to this as an “action-cognition connection” (p. 332).

THE ROLE OF NEUROHORMONES AND CHANGES IN BAIN STRUCTURE

The study of BDNF is promising but is currently based on animal research as it involves a chemical change in the brain that cannot currently be assessed in humans. BDNF is not the only focus of brain-based researchers. Researchers have also hypothesized how physical activity improves executive function through the mediating role of cardiovascular fitness and neurohormonal changes. The cardiovascular hypothesis simply states that it is fitness that mediates or explains the relationship between physical activity and executive function. Simply put, the brain receives a greater flow of blood and oxygen. This hypothesis is supported by findings that show children with higher levels of physical fitness tend to have better executive function in comparison to children with lower levels of physical fitness.

Other researchers have focused on neurohormones, such as norepinephrine and endorphins, which are increased
when individuals engage in physical activity that reaches a certain level of intensity or duration. Many are familiar with the term “runner’s high,” which refers to the euphoric feeling that individuals feel following long bouts of physical activity. Although this response can occur with other forms of activity, it is often associated with activities that are rhythmical in nature, and hence, tends to occur when running. Although recent research suggests that endogenous cannabinoids are likely the cause, the same logic is at play; neurohormones improve mood while decreasing stress. This state improves learning in numerous ways. For example, children may be more likely to respond appropriately to teacher directives, less likely to experience test anxiety, and less likely to respond negatively to challenging peer-to-peer exchanges.

Changes in brain function could also be associated with changes in actual brain structure, and researchers have found evidence that the brains of physically activity children differ from those of children who are not. Various imaging techniques, such as functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI), have been increasingly used to examine the underlying neural network that supports children’s executive function. For example, children randomly assigned to a physical activity after-school intervention were found to have increased white matter integrity in comparison to children participating in an after-school program that did not focus on physical activity. However, in their review, Donnelly and colleagues found only five studies, of which two were randomized controlled trials, investigating the relationship between physical activity and brain structure. Therefore, they referred to this area of study as promising but preliminary.
COMPARING DIFFERENT TYPES OF PHYSICAL ACTIVITY

Despite growing interest in brain studies, others have approached the study of physical activity’s role in executive function from yet a different perspective. In the cognitive stimulation explanation, the qualitative nature of the physical activity is considered. When children are playing soccer, they must constantly attend to where the ball is located in relationship to other players on the field. Children must judge the force required to kick the ball to their teammate based on distance and motion. These cognitive demands occur while children are moving; therefore, they receive both cardiovascular and cognitive benefits. Researchers have found that cognitively engaging physical activity is more strongly associated with positive increases in children’s executive function.\(^6\),\(^27\)

These findings are encouraging researchers to consider the qualitative aspects of physical activity instead of just the frequency, intensity, and duration. Such distinctions are important for educators and parents to consider as well. Physical activity that requires children to quickly change their focus from one aspect to another can help with shifting. This can be easy to do in games that require shifting from an offensive stance to one that is defensive, such as shooting a basketball through the hoop one moment but then trying to prevent others from shooting the ball the next. Playing basketball and other team sports can also require children to practice inhibition, as children have to wait and hold the ball until either a teammate is open to receive the ball or they are open to shoot a basket. Finally, children who organize such games themselves must rely on their working memory to keep track of points as well as who might be playing on their team.
In addition to comparing cognitively engaging physical activity with physical activity that is only aerobic, researchers have compared acute and chronic activity, even though differentiating between cognitively engaging and simply aerobic activity can sometimes be difficult to do. **Acute physical activity** occurs only once, whereas **chronic physical activity** is repetitive. The latter is positively associated with physical fitness and cardiovascular health; however, both have been linked to higher levels of executive function. This means that even single instances of physical activity can increase individuals’ scores on tests of executive function in children and adolescents.\(^{28,29}\) This finding is promising, as educators who can find time, even inconsistently, to engage their students in physical activity can positively influence their students’ executive function.

**REVIEWS OF PHYSICAL ACTIVITY AND EXECUTIVE FUNCTION RESEARCH**

In their comprehensive review, which formed the basis of the position stand for the American College of Sports Medicine, Donnelly and colleagues found support for the association between physical activity and executive function.\(^{26}\) They reviewed studies relating to cognition, learning, and brain structure and function, however, rather than focusing on just executive function. Additionally, unlike other reviews, Donnelly and colleagues included results from studies of brain structure and function, including MRIs and fMRIs. Although this approach helps to understand how these systems work together to lead to academic achievement, educators can find it difficult to apply such research to daily classroom practice.
In his review of experimental studies investigating the impact of physical activity on executive function, Best offered some important insights that are relevant to educators’ consideration of how to effectively incorporate physical activity to improve children’s executive function at school.6 Best pointed out that the neural circuitry which provides the basis for executive function is immature for most schoolchildren; for some children this is the case even well into their adolescence. He further argued that executive function is “multi-componential” with each component following a different developmental pathway. This means that considerable variation might exist in the way in which physical activity, as well as the type of physical activity, influences each component. Just as cognition changes, the nature of physical activity changes, and the relationship between the two is likely adaptive. Unfortunately, researchers have not yet collected longitudinal data to adequately investigate these claims.

**PHYSICAL ACTIVITY AND ACADEMIC ACHIEVEMENT**

Children’s learning results from a confluence of systems that are operating simultaneously. This nesting of timescales in dynamic systems theory explains that executive function is only one element that influences children’s learning and that no single element is more important than any other. Physical activity may be related to better executive function and executive function related to higher achievement; however, physical activity’s role in learning is considerably more complex. On a more practical level, in the context of NCLB, educators need evidence-based research to change educational and instructional practices. Because NCLB and state
requirements emphasize the importance of results on standardized tests to determine which educational practices work, increases in physical activity in the school environment must be related to consistent increases in those test scores. Despite over 50 years of investigation, the most frequent conclusion reached by investigators is that increases in physical activity (e.g., increased physical education and recess time, implementation of interventions that introduce physical activity into the classroom) in the school environment do not harm students’ academic achievement. A null finding, even when the field accepts that physical activity increases children’s positive health outcomes, has not been enough to convince school administrators to let go of instructional methods that rely on seated, sedentary student behavior.

With hundreds of studies conducted to investigate the impact of physical activity on academic achievement, one would think that a consensus would have been achieved concerning the importance of physical activity in educational settings. To make sense of this vast body of research that spans over 50 years, researchers have conducted reviews, meta-analyses, and reviews of reviews. Reviews have been organized around different themes and inclusionary criteria to better understand why results have varied. Additionally, meta-analyses have been used by some to calculate effect sizes across multiple studies. Meta-analysis is a technique that involves carefully selecting studies that investigate physical activity’s effect on achievement, compiling statistics that represent the effect, and then calculating the total effect size across all the sampled studies. Unlike qualitative reviews, meta-analysis results in an overall estimate of the size of the effect in an area of study.
Castelli and colleagues selected only experimental studies, organized studies in their review by time period, and calculated an effect size or an estimate of the overall effect of the studies in each group combined when it was possible.\textsuperscript{1} They noted that early researchers between 1967 and 1999 failed to control for a number of background variables that could account for the positive effects of physical activity. For example, a positive association found between sport participation and academic achievement could be the result of children’s socioeconomic status that makes them more likely to be involved in sports. Socioeconomic status includes not only the financial resources families have but also the education level of parents. High socioeconomic status, not the sport participation itself, could account for children’s academic achievement. Thus, researchers often measure this variable to statistically control for its effects. Once it is factored out of the equation, then researchers can tell how much of the variance in academic achievement is attributable to sport participation. Castelli and colleagues further criticized the methods researchers used during this period and noted that they often failed to attend to the intensity of the physical activity in studies and failed to use validated measures of academic achievement. Despite these limitations, Castelli and colleagues reported that no adverse effects of physical activity were found. “The common conclusion among the research was that there are no known negative effects associated with taking time away from academics to participate in recess, physical education, or other physical activity breaks”\textsuperscript{1} (p. 132).

In their review of the period from 2000 to 2009, Castelli and colleagues observed that researchers focused more on young children than on adolescents, with some researchers
taking advantage of large, national databases to investigate the influence of physical activity on achievement over time. Multiple programs that integrated physical activity into either the school day or after school were also developed and evaluated. Results indicated that physical activity could not only be successfully integrated into the day but that this could also be accomplished without harming students’ academic performance. Thus, during this period, practical recommendations for educators emerged.

Finally, Castelli and colleagues reviewed studies conducted between 2010 and 2012, which they noted increased in number exponentially. They further observed that the effect size or strength of the relationship between physical activity and academic performance also significantly increased in comparison to studies conducted earlier. The methodology of studies from this period included large-sample designs as well as measures of academic performance that were better defined and adequately assessed. Thus, the reviewers pointed out that “only positive and neutral studies have been published to date, despite the greater sensitivity in the cognitive measures and large-scale samples being recruited”¹ (p. 135).

Howie and Pate also reviewed studies investigating the relationship between physical activity and academic achievement using a historical perspective.³⁰ Similar to Castelli and colleagues, Howie and Pate observed an increase in methodological quality in studies conducted after 2010. However, Howie and Pate noted many inconsistencies across the reviewed studies, despite acknowledging the consistent presence of positive effects. This inconsistency could be a result of differences in inclusion criteria used by each group of reviewers. Castelli and colleagues reviewed only 20
experimental studies, whereas Howie and Pate reviewed 125 studies that included a variety of methodologies. However, the authors attributed variation to differences in the outcomes measured and the tendency for physical activity to be more strongly associated with some factors than others. For example, physical activity tends to be most strongly correlated with increases in working memory and inhibition, which also tend to be the executive functions most frequently studied. Howie and Pate further cautioned that a positive reporting bias was emerging in the research literature, as researchers seemed to overemphasize positive over null results.

**THE CONSIDERATION OF RESEARCH DESIGNS**

An understanding of how physical activity research is conducted is important. For example, researchers might conduct an experiment or they might conduct a quasi-experimental study. When conducting experiments, researchers randomly select and assign children to either a control group or a group that receives the treatment (i.e., physical activity). Both groups are then given the same measure of academic achievement. By randomly assigning children, any differences that naturally occur between children will be randomly distributed between the groups and thought to have no systematic influence over the outcome (i.e., children’s final scores on an achievement test). Thus, one group should not include only physically fit children or only children with high achievement scores and any differences in the groups should only be attributable to the treatment.

Conducting experimental studies in public schools is often difficult because children from similar neighborhoods
attend the same school. When researchers can work with different school districts, children are still already assigned to classrooms and such assignments can be based on student behavioral, academic, and social needs. Even if schools randomly placed students in classrooms, students in the same classrooms would share the same teachers. Teachers differ on many variables, including quality, communication, and values. For example, some teachers might regularly encourage their students to move about during breaks whereas others might require more seatwork. Although one might think that laboratory studies should be considered with such challenges, real-world or authentic research is needed to truly understand how physical activity makes a difference to academic achievement in the school context.

In quasi-experimental designs, children are not randomly assigned to groups and are instead selected based on their membership in an existing group. In this design, children are already a part of a group and then the treatment is implemented. For example, a school principal might be open to adding physical activity breaks to the classrooms on her elementary campus, but a second elementary principal might refuse the intervention on her campus. Thus, the researcher works with the existing groups. In another quasi-experimental study, the academic achievement scores of children who already engage in high levels of physical activity, perhaps they play organized sports or attend a school with regularly scheduled physical education classes, might be compared to the scores of children who report low levels of physical activity.

Similar to quasi-experimental designs, correlational designs simply look for associations between children’s existing physical activity levels and academic achievement. In this
case, the researchers do not manipulate physical activity and instead rely on the report of the children’s parents or teachers. Finally, explaining the difference between cross-sectional and longitudinal studies is important. In cross-sectional designs, children from different age-groups or grade levels are studied at one time, whereas in longitudinal designs, the same children are studied across time. Sometimes effects take time to reach a detectable level, which might be the case of executive function’s influence on achievement. Children might be able to inhibit inappropriate responses in their academic work, as well as behaviorally following physical activity; however, the positive impact of these changes in executive function might not immediately appear in their academic achievement.

Only in experimental studies can the effect of physical activity on subsequent academic achievement be determined. In quasi-experimental and correlational designs, other variables could account for differences in subsequent academic achievement. Children who are existing members of groups might already share characteristics. Children who attend the same campus might be of similar socioeconomic status, children might have been assigned to a classroom because of their academic needs, and children who share a teacher might receive other support for their physical activity that extends beyond the researchers’ study. Although researchers can work to statistically account for these factors, they are often unable to identify and measure all confounds.

In their review of literature, Castelli and her colleagues found only 20 studies between 1967 and 2013 that were considered experimental or included both a control and treatment condition. Of these 20, only four were randomized controlled trials or experimental studies that included random selection and assignment. For example, one study provided
the physical activity intervention to an existing group of children and another study randomly assigned classrooms, rather than individual students, to the physical activity intervention. Similarly, Howie and Pate located 17 experimental designs in research conducted prior to 2007.\textsuperscript{30} However, they reported that less than half, or only 47\%, of the studies actually involved randomly selecting and assigning children to treatment and control conditions. They identified 14 studies with experimental designs after 2007 with seven using randomized designs.

**FACTORS CONTRIBUTING TO DIFFERENTIAL FINDINGS**

The lack of randomized controlled trials has prompted reviewers to call for higher methodological quality in the study of physical activity and achievement.\textsuperscript{1,30,31} Although the use of randomized designs is an improvement, reviewers have identified other concerns that likely result in differences across findings. The first is the issue of dose-response. **Dose-response effects** refers to differences in outcomes that occur relative to the frequency, intensity, and duration of physical activity. Another way of looking at this issue is that researchers define physical activity differently. Some simply use physical education or recess as physical activity interventions without consideration that these activities do not always engender physical activity, and if they do, not to the same degree for every student. Thus, researchers using physical education and recess might establish frequency and duration in the physical activity of their young participants, but they fail to reach a reasonable level of intensity.

Even though it seems that research using developed interventions designed to ensure participants engage in
appropriately intense physical activity would avoid problems with dose-response, results still depend on the fidelity of the treatment implementation, which is a second concern that can influence research results. Treatment fidelity refers to whether the researcher, teacher, or experimenter is, in fact, implementing the treatment as intended. A teacher asked to use a physical activity intervention in her classroom might not always stop the class for physical breaks or require that all students participate. In such cases, benefits might not be observable, or they might be documented for only one group (e.g., boys but not girls). This is especially problematic as differences between groups’ response to intervention may very well be expected.

For example, in a study of a national database which included physical education information across elementary school, positive effects were found for girls but not for boys.\(^3^2\) However, in a study of middle and high school students’ participation in team sports, positive effects on academic outcomes were found for boys but not girls.\(^3^3\) If researchers fail to evaluate groups within their samples separately, then the null findings for one group could diminish the positive results found in another. This is yet another concern that can result in null effects in experimental studies. Discrepant findings, in addition to some studies finding no significant effect of physical activity on academic outcomes, have led some researchers to take a cautionary stance, as in the case of the position stand for the American College of Sports Medicine written by Donnelly and his colleagues in 2016.\(^2^6\) Donnelly and colleagues called for functional magnetic resonance imaging (fMRI) and electroencephalogram (EEG) studies to evaluate biological models, as well as more longitudinal randomized
controlled trials, in order to establish cause and effect between physical activity and academic achievement. However, such approaches will only yield meaningful results if researchers are able to measure academic achievement in a way that means something to public schools.

**THE MEASUREMENT OF ACHIEVEMENT IN PHYSICAL ACTIVITY STUDIES**

Chapter 1 introduced the challenges of measuring physical activity. Although the definition of physical activity, which identifies movement of the large skeletal muscles that increases energy expenditure, is accepted by most researchers, not all agree on the level of energy expenditure needed to result in positive outcomes. Perhaps even more challenging is finding practical measurement tools to capture physical activity. Accurately and reliably capturing children’s step counts, upper body movement, and heart rates can be difficult, especially when young children might accidentally reset devices out of curiosity or even remove them due to discomfort. Thus, estimates of children’s activity might not be reliable (i.e., consistent across measurements) or valid (i.e., truly measuring physical activity).

The challenge of measuring achievement variables tends not to be related to the validity or reliability of scores, as in physical activity, but in understanding what is actually being assessed and labeling it appropriately. For example, in an effort to understand physical activity’s influence on mathematics achievement, a researcher might administer the mathematics calculation subtest from the Woodcock Johnson Tests of Achievement IV (WJIV), which is a nationally normed, standardized test often used to assess children’s academic performance. The researcher would likely refer to
the children’s scores as estimates of mathematics achievement. However, multiple subtests comprise the WJIV achievement scores for each domain. In the case of mathematics, both fluency and applied problems are considered in addition to calculation, and the researcher might miss important elements of mathematics achievement that could be influenced by the physical activity if they are not assessed. Consider mathematics fluency, which refers to the speed to which children can solve basic mathematics facts and applied problems, which require children to keep multiple pieces of information about a problem in mind as they work to solve it. Children’s executive function, especially working memory and inhibition, will be especially important in helping them to succeed in these types of tasks. Therefore, researchers must select appropriate achievement variables and use the correct terminology when investigating the importance of physical activity to learning.

Other academic outcomes are not as clearly matched to executive function. For example, children’s mathematics achievement derived from classroom performance typically extends beyond a single test or type of task. Students’ grades reflect assignments, exams, and even classroom participation. Grades are further influenced by students’ efforts in correcting assignments and interacting with peers on group projects. Tests can be limited in their assessment of children’s knowledge when the content does not address the content covered in children’s coursework; however, grades can be influenced by extraneous variables ranging from students’ motivation to teachers’ grading inflation. When physical activity is found to be associated with academic achievement that extends beyond testing, researchers can find it difficult to understand what the underlying
mechanism is for this association. Even so, disentangling effects might be impossible, as multiple systems are constantly working together to facilitate children’s learning. Therefore, the goal may be to study physical activity in context rather than in isolation.

CONCLUSIONS
Consistently, reviewers have reached similar conclusions: the majority of research supports that a positive association exists between physical activity and academic achievement, but despite this acknowledgment, disagreement continues concerning whether this relationship is causal. That is, do increases in physical activity actually cause increases in academic achievement? Furthermore, reviewers have found variability across research results, with a few studies showing no effect. Because of the inconsistency in findings, especially in studies conducted prior to 2000, some reviewers caution taking a strong stance on increasing physical activity time in public schools. Regardless, most researchers in the field agree that positive or neutral results at the very least indicate that physical activity in schools offers little to no risk in harming academic achievement, and all acknowledge that physical activity is needed for positive health outcomes and combatting childhood obesity.

The evidence that relates physical activity to higher-order cognitive function indicates that schools should be rethinking how physical activity is incorporated into the school day. However, multiple questions still exist about its implementation. Although a guideline of 60 minutes of physical activity a day is provided by the CDC and other agencies, advice concerning the intensity children need to reach and
for how long to achieve the best cognitive benefits is needed. Additionally, just as variability exists in the qualitative nature of physical activity and how different types of activity influence learning, most researchers agree that an interaction occurs between developmental level and type of physical activity. This means that young children might benefit from certain types of physical activity, whereas adolescents might benefit from another. Longitudinal research is needed to address these concerns, which will take time. In the meantime, additional evidence is available to suggest that physical activity influences learning through other routes, such as children’s well-being and mental health outcomes. These routes are the focus of Chapter 3.

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Executive Function


Executive Function


Children’s academic performance does not occur in a vacuum. Children must arrive at school ready to learn and, once there, possess a certain level of well-being and positive mental health which allow them to benefit from instruction. Unfortunately, many children suffer from various forms of trauma or adverse childhood experiences (or ACEs) that have been shown to be associated not only with negative academic outcomes but also negative health outcomes in adulthood.⁠¹⁴ ACEs include living in a household where substances are abused; being physically, emotionally, or sexually abused; and experiencing parental divorce, domestic violence, and/or parental incarceration.⁠¹⁵ These experiences occur before children reach the age of 18 years and result in physical and/or emotional harm. At the very least, ACEs are experienced as threatening and result in children’s stress reaching toxic levels. Schools are growing increasingly aware of the importance of addressing children’s social, emotional, and behavioral needs, especially those experiencing ACEs. Researchers have developed guidelines for trauma-informed schools, and more staff are being trained in how to identify and support children in crisis.⁠¹⁶ These efforts are now supported through legislation or the Elementary and Secondary
Education Act, which is now termed the Every Student Succeeds Act or ESSA (PL 114–195).⁴ Despite evidence connecting physical activity to reduction in stress hormones and increases in neurotransmitters that improve mental health, most educators have failed to consider how physical activity can play an important role in supporting children experiencing ACEs. The purpose of Chapter Three is to discuss the role of physical activity in improving mental health outcomes and how such improvements not only support children’s well-being but also promote learning. However, the chapter first identifies several challenges to conducting research related to mental health outcomes that help with understanding results and recommendations.

**THE PREVALENCE OF ACES AND THE CONNECTION TO MENTAL HEALTH PROBLEMS**

In their review of research spanning the years of 1990 to 2015, Perfect and colleagues indicated that most children, or two out of three, will be exposed to at least one ACE before reaching the age of 17.⁵ In their study of a nationally representative database of school-aged children, Porche, Costello, and Rosen-Reynoso found that over half of the children had experienced ACEs related to family issues, with the average number of ACEs experienced for this group being 2.1.⁶ Schools are tasked with providing a free appropriate public education (FAPE) for all children, and this includes children diagnosed with disabilities, such as emotional disturbance, autism spectrum disorder, learning disabilities, and ADHD. Some children with ACEs, especially without intervention, might become eligible for special
services, as ACEs are associated with higher mental health diagnoses, learning problems, and impaired neurological development.\(^7\)

According to the *Condition of Education* report published in 2018, 13\% of children between the ages of three and 21 received special education services during the 2015–2016 school year.\(^8\) Of those students, 5\% received services to address an emotional disturbance, which is the federal category that relates to depression, anxiety, and other behavioral problems that interfere with children’s ability to learn and benefit from instruction. Children who have experienced multiple ACEs might also qualify for special education services under other categories, as ACEs are associated with ADHD, as well as for the severity of the disorder. Additionally, ACEs have an adverse impact on children’s development and can influence children’s behavior and mental health.\(^9\)

**THE CONNECTION BETWEEN EMOTION, BEHAVIOR, AND LEARNING**

With more than two-thirds of children experiencing trauma and 13\% receiving special services to address a disability, schools need access to effective interventions to support the education of students with diverse educational needs. Interestingly, the discussion of trauma-informed schools does not include the positive influence that physical activity has on reducing stress hormones or improving mental health. Despite a growing body of research that supports physical activity’s role in improving these outcomes, school administrators, educators, and parents seem to remain unaware of physical activity’s benefits. Furthermore, dynamic systems
theory, which emphasizes interactions between systems, would support that improving mental health also improves children’s learning.

For example, an adolescent suffering from depressive symptoms might sleep poorly, wake up late for school, skip first period class, and sleep through the remainder of the day. Perhaps during fifth period, the student is sent to the school office for sleeping in class and engages in a heated argument with the principal (likely due to the irritability that is often associated with depression in children). The student is placed in in-school suspension where he must work independently in a cubicle alongside other students in cubicles who recently engaged in similar offenses. Although a teacher is available for academic support, the teacher’s primary duty is to supervise a room of students who are struggling behaviorally and likely academically at school. Instruction and, therefore, learning is limited in such environments.

This example demonstrates the interconnectedness between emotion, behavior, and learning. Certainly, discussion of the student’s attention and concentration as well as executive function that are typically adversely affected by depression would also be relevant. Thus, the consideration of learning should also include discussion of mental health. Suppose engagement in physical activity would have allowed the example student to sleep, increased the student’s levels of serotonin to reduce his irritability, or reduced the student’s cortisol levels to reduce stress so that the verbal altercation could be avoided.

Internalizing behavior, such as feelings of depression or anxiety, and externalizing behavior, including disobeying rules, arguing, and physical aggression, have been consistently
associated with academic achievement. These relationships have been documented across gender and developmental level. Additionally, emotion and behavior continue to influence achievement even when socioeconomic status, intelligence, and parenting quality have been statistically accounted for or controlled.

COMMUNITY VERSUS CLINICAL SAMPLES

All children may display emotion and behavior difficulties from time to time at school. As these problems increase, academic problems tend to increase. On the extreme end of this association, children may require professional intervention. Some researchers focus only on children with extreme problems, whereas others investigate the association between emotion, behavior, and learning in more representative samples of children. Community samples include children and adolescents who have not visited a mental health professional and who have not received formal diagnosis and treatment. In contrast, clinical samples include children and adolescents with formal diagnoses and who are possibly receiving treatment, such as medication, counseling, or a combination of the two. This differentiation is important because children in clinical samples may simply possess more behavioral symptoms of depression and anxiety than peers from community samples, which means that they have more room for improvement in response to interventions. Children from community samples likely experience some depressive and anxious behavior; however, if they possess only a few symptoms, then it becomes difficult to document any change in a positive direction. When children are asked about their depressive symptoms but report only a
few depressive behaviors, they can only improve by one or two behaviors on some measures. This is not enough to see a statistically significant difference.

**CATEGORICAL VERSUS CONTINUOUS VIEWS OF MENTAL DISORDERS**

Researchers’ selection of participants, either community or clinic based, might also reflect the researchers’ understanding of mental health and related disorders. Although clinicians and researchers recognize that affective disorders and ADHD are defined by criteria listed in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5), this does not mean that they view such disorders as being categorical.\(^{11}\) That is, everyone experiences depressive and anxious symptoms as well as inattention, but not everyone experiences these symptoms to a degree that makes them function in a qualitatively different manner.

If viewed categorically, symptoms do not become important until they reach a specific threshold, which is typically that defined by the DSM-5. If viewed continuously, symptoms are important regardless whether their number reaches a specified threshold. Furthermore, symptoms can be viewed based on their severity rather than amount. Consider that children with ADHD may have lower levels of BDNF and atypical brain development.\(^{12}\) Individuals with depression tend to have lower levels of the neurotransmitter, serotonin, which is associated with sleep and perception of pain. If these differences only occur in individuals with diagnosable disorders or in clinic samples and such differences interact with physical activity, then the impact of physical activity on mental health will vary depending on sample type.
OTHER CONSIDERATIONS WHEN STUDYING MENTAL HEALTH ISSUES

Medication and other therapies further complicate comparisons. For example, in their meta-analysis of studies focused on physical activity’s effects on children with ADHD, Cornelius, Fedewa, and Ahn found that children who were not receiving medication therapy to address ADHD symptoms benefited more than those taking medication to treat the disorder. Because medication has been shown to address many symptoms of ADHD and medication is currently the preferred treatment for the disorder, medicated children and adolescents may demonstrate less severe symptoms. As in the case of children from community-based samples, these children may not have much room for improvement. That is, their symptom severity is already low. This is called a floor effect. Consider an extreme example of a child who reports no symptoms of ADHD. The child’s score simply cannot go any lower on the measure used by the researcher. Thus, the researcher cannot see any change even though change might be present. Although medication to treat childhood depression is not as prevalent as that used to address symptoms of ADHD, the same phenomenon may occur in studies investigating the effect of physical activity on depression.

Researchers can account for medication use by employing experimental designs that separate out children taking medications from those who are not. Researchers can then compare the effect of physical activity on the different groups. However, a considerable amount of research continues to be correlational or the investigation of the relationship between physical activity and mental health.
outcomes. When two variables are related, such as an increase in physical activity associated with a decrease in depressive behavior, the findings do not mean that increases in physical activity cause depressive behavior to decrease. The possibility exists that children who are depressed may lack the motivation and energy to engage in physical activity. The relationship could also be bidirectional, which means that increased physical activity decreases depression, but increased depression also decreases engagement in physical activity. Thus, more credence is typically given to results from randomized controlled trials and longitudinal studies that allow researchers to show that the outcome can be controlled by the presence or absence of physical activity.

**PHYSIOLOGICAL BASIS OF PHYSICAL ACTIVITY’S INFLUENCE ON MENTAL HEALTH**

Mental health can be defined many ways but typically refers to the quality of individuals’ social, emotional, and psychological well-being. As mentioned at the start of this chapter, mental health can be influenced by traumatic events, such as ACEs. However, biological factors are also important to consider. In the case of depression, researchers have found differences in brain structure as well as function. For example, the hippocampus region, which regulates emotion, tends to shrink in depressed individuals and affective salience networks that can adversely affect how individuals experience pleasurable feelings can be altered.\(^\text{15}\) Additionally, cortisol levels are typically higher to indicate higher levels of stress in depressed individuals and serotonin levels, which regulate appetite and pain perception, are lower.\(^\text{16}\)
DEPRESSION AND ANXIETY IN CHILDREN

When enough symptoms are present for a long period, children may be diagnosed with a major depressive disorder (MDD). Dysphoric or depressed mood and loss of interest in activities that were once enjoyable are the main symptoms; however, diagnosis also requires individuals to experience “vegetative” symptoms, such as sleep disturbance and changes in eating habits. Problems with concentration are, therefore, also likely. Finally, MDD is associated with feelings of hopelessness that can lead to suicidal ideation and behavior and, ultimately, death. Thus, MDD is a serious disorder, and intervention efforts are needed.

Children with depressive behavior are also likely to have problems with anxiety, as anxiety disorders are often diagnosed along with MDD. An estimated one-third of adolescents will have enough anxiety symptoms to qualify for diagnosis before they reach the age of 18. Understanding how physical activity affects anxiety, especially when it reaches levels that warrant diagnosis, is difficult, as research in this area is much more limited in comparison to the study of depression. Furthermore, seven different anxiety disorders can be diagnosed in childhood, including a generalized type that occurs when a child experiences excessive anxiety and worry across different events as well as more specific types that are associated with specific phobias, agoraphobia, anxiety in social situations, selective mutism or failure to speak in certain situations, overwhelming feelings of panic, and separation.

The influence of physical activity may differ depending on the type of anxiety children are experiencing. Of additional concern is how children with certain types of
anxiety might be able to participate in various physical activities. For example, team sports often require social interaction, physical education classes and recess typically involve large groups of children, and often large, open spaces are the setting for sports, physical education, and recess. Such situations are often challenging for children who experience anxiety interacting with peers and being in crowds and open spaces.

Anxiety disorders have been associated with differences in brain structure and function. The amygdala has been most widely studied in individuals with anxiety, as this area of the brain is associated with survival instincts and emotion. However, as in depression, the hippocampus is involved as is the neurohormone, cortisol. When cortisol is increased in response to stress and remains at high levels, anxiety disorders can develop.

**PHYSICAL ACTIVITY, CORTISOL, AND SEROTONIN**

Children and adolescents who engage in more physical activity have been shown to have lower levels of cortisol and higher levels of serotonin.\(^{16}\) A randomized controlled trial of adolescent girls with depressive symptoms that required one group to jog at a mild intensity for 50 minutes, five times a week and a second group to engage in their regular activities over the course of eight weeks resulted in lower levels of cortisol for the physically active group.\(^{19}\) Additionally, only the girls in the jogging group reported significantly lower levels of depressive behavior.

Not all studies have focused on brain and hormonal differences in physically active and sedentary groups, and just as in the case of academic performance, there are noticeably
fewer randomized controlled trials in comparison to cross-sectional or correlation designs. This means that what is mostly known about physical activity and mental health is that the two are related. The relationship between physical activity and depression was explored throughout the 1990s. Although the samples studied were typically large and even nationally representative in some cases, the focus was predominately on adults or older adolescents.

**PHYSICAL ACTIVITY AND DEPRESSIVE BEHAVIOR**

Steptoe and Butler found negative associations between sports participation and scores on a measure of psychological symptoms in a sample of over 5,000 16-year-olds in the United Kingdom.\(^{20}\) They further noted that adolescents who engaged in “non-vigorous” activities tended to have higher scores on the same measure. With additional colleagues, Steptoe continued his study of physical activity in leisure time using a sample of over 16,000 undergraduate students across 21 countries and again found a negative relationship between physical activity, exercise in this case, and reported depressive symptoms.\(^{21}\) That is, higher reports of exercise were associated with lower levels of depression.

The authors statistically controlled for age and sex but did not account for differences in socioeconomic status. This means that age and sex could not explain this association; however, without considering socioeconomic status, the results could mean that those who exercise might also have other financial and educational resources that offer protection from depression. For example, those from higher socioeconomic backgrounds have more education, which would likely expose them to knowledge about nutrition and
other aspects of self-care, such as meditating or getting enough sleep. Individuals from higher socioeconomic back-
grounds typically have higher incomes, which might, for
example, allow undergraduates to avoid the stress of paying
 tuition or the need to work a part-time job. Both factors
could lead to higher levels of depression. Therefore, without
accounting for the influence of socioeconomic background,
physical activity’s causal effect on levels of depression
cannot be determined.

PHYSICAL ACTIVITY AS AN INTERVENTION
At the turn of the century, researchers’ attention shifted to
interventions, and more randomized controlled trials that
involved randomly assigning participants across treatment and
comparison or control groups were conducted. This random-
ization ensured that any preexisting differences between indi-
viduals were randomly distributed across groups so that they
could not influence the outcome. For example, all groups
would be equally likely to include individuals from high or
low socioeconomic backgrounds so that participants’ level of
income and education could not account for any differences
found between groups at the end of the study. Perhaps one
of the most important randomized controlled trials of this
period, although conducted with adults 50 years of age
and older, found that physical activity was just as effective as
antidepressants in reducing symptoms of depression.22 Across
16 weeks, 156 men and women either engaged in aerobic
exercise, took an antidepressant, or did both. Although the
participants taking medication improved the fastest, by the
end of the study, no differences were found between the parti-
cipants who exercised and those who took medication.
Blumenthal worked with colleagues to improve upon his original study by splitting the physical activity condition into two sections: one that involved supervised exercise and a second that involved home-based exercise.\textsuperscript{23} The remaining conditions included antidepressant therapy and placebo pill. Participants totaling 202 men and women were randomly assigned to one of the four groups and assisted by a treatment team that was not privy to which group the participants were assigned. As in the results of the original study, Blumenthal and colleagues found that physical activity, regardless of whether achieved via supervised or home-based exercise, provided a reduction in depressive symptoms that is comparable to that found for antidepressants.

**PHYSICAL ACTIVITY AND ANXIETY**

Very few randomized controlled trials have been used to study the effect of physical activity on anxiety. An additional challenge is that with seven diagnoses in this category, variations in responses across diagnosis are likely. This means that generalizing or applying the results of a study involving participants with one type of anxiety to individuals with another type of anxiety may be inappropriate. Even so, in his review of physical activity and anxiety, Ströhle identified multiple meta-analyses investigating the effects of exercise on anxiety.\textsuperscript{24} Although limited by the number of studies and adequate investigation across the different types of anxiety disorders, Ströhle concluded that some evidence was present to support that exercise reduces symptoms associated with panic disorder, generalized anxiety disorder, and social phobia. He further noted evidence that exercise may improve the effects of other therapies, such as cognitive behavior
therapy, commonly used to treat depression and anxiety. Finally, he identified studies that indicated that aerobic physical activity, such as walking or running, might be more beneficial than nonaerobic, such as lifting weights or engaging in resistance training, although both are effective at reducing anxiety.

THE FOCUS ON DEPRESSION AND ANXIETY IN CHILDREN

Although these findings suggest that physical activity is a promising intervention to improve individuals’ mental health, the majority of the studies were conducted with adult samples. Fortunately, interest in how physical activity influences schoolchildren’s mental health has increased in recent years, which has allowed for the publication of multiple reviews. In one of the earlier reviews, Larun and colleagues accessed only 11 studies of children and adolescents investigating physical activity’s effect on mental health outcomes, including anxiety and depression.25 The studies included trials comparing typical children and adolescents engaged in either vigorous activity or no intervention. The authors found that physical activity did improve anxiety based on six reviewed studies; however, the effect was not statistically significant. This means that although anxiety improved, it did not improve so much that the authors could be confident that it differed from the level of anxiety reported for the comparison groups who received no intervention. The authors did find a significant improvement in children’s depression after participation in physical activity interventions across five studies. As a result, the authors concluded that there were simply too few studies to determine the effect of physical activity on mental health but noted that a small effect may be present.
Five years later, Ahn and Fedewa conducted a meta-analysis using 73 studies published on the topic between 1974 and 2009. Although, unlike Larun and colleagues, the authors included correlational studies, they took whether or not the studies were randomized controlled trials into consideration in their analysis. They found that when randomized controlled trials were used, the size of the effect of physical activity on mental health outcomes was significant but small. When the same statistic was calculated for studies using correlational designs, the effect was somewhat larger. They also found that aerobic activity, when mixed with resistance training, was the most effective. These findings suggest that physical activity affects mental health outcomes in children in much the same way it does in adults.

APPLICATION OF FINDINGS TO PUBLIC SCHOOLS

Several of Ahn and Fedewa’s results are especially important for school settings. Their analysis indicated that studies in which the interventions were directed by teachers and physical education specialists, as well as interventions led by researchers, yielded the strongest positive effect on the mental health of participants. This finding is important, as children and adolescents typically spend seven or more hours a day at school. Thus, the school setting should be a focus for intervention implementation. Even so, several challenges must be considered.

Although researchers are often competent and invested in interventions offered at schools, they fail to stay after the completion of the study. On the other hand, teachers might want to continue interventions passed on to them from researchers and special grant programs offered periodically.
at their schools; however, they often are not provided the extra time, training, or incentive to continue. With the demands of high-stakes testing and accountability, such interventions are often discontinued when studies end. Teachers enlisted and trained to provide interventions for studies might be assigned to such roles by school administrators and not completely invested. Finding that teachers provide just as effective interventions as the researchers themselves suggests that it is possible to work with teachers to provide physical activity interventions; however, longitudinal studies are needed to know the degree to which teachers continue to implement interventions with fidelity.

In 2013, Brown and colleagues reviewed nine randomized controlled trials that were mostly conducted in schools and came to a conclusion similar to that of Ahn and Fedewa.27 They found only a small, but significant, effect for physical activity’s influence on children and adolescents’ depression, with physical activity interventions associated with lower levels of depression. Brown and colleagues noted considerable variability in the results across the studies they reviewed, which was possibly related to their inclusion of both preventative and treatment trials. Thus, the baseline levels of depression across the studies varied widely, which means that some participants had more room for improvement.

DIFFERENT DEGREES OF BENEFIT BASED ON STUDENT CHARACTERISTICS

In their reviews, both Ahn and Fedewa as well as Brown and colleagues found evidence to suggest that this may be the case.26,27 Participants with certain characteristics tended to benefit more from physical activity interventions. For
example, Brown and colleagues reviewed two studies that evaluated the effect of physical activity on mental health problems in only overweight youth, and noted larger treatment effect sizes than observed in other studies to indicate that these children experienced more benefit. Although Ahn and Fedewa were also interested in whether overweight children benefited more from physical activity interventions, their analysis of studies did not indicate any difference in effect size between children identified as overweight or obese and those of typical weight. This finding held true across both correlational and randomized controlled trials. Ahn and Fedewa were expecting to find a difference, especially as children identified as overweight and obese tend to struggle socially and emotionally and at school, which would likely indicate greater mental health problems that would leave room to respond to intervention. Even so, they noted that the finding should encourage clinicians to recognize that children who are overweight can still benefit from physical activity. This is important for educators to realize as well.

Educators would also be interested in Ahn and Fedewa’s findings that randomized controlled trials involving children described as “cognitive impaired” or “emotionally disturbed” yielded stronger effect sizes. Children and adolescent participants in these studies experienced better mental health outcomes in response to physical activity in comparison to studies of typical children and adolescents. “In fact, the RCT studies used for analysis demonstrated an effect size that was five times as large for children with cognitive impairments and almost twice as large for students with emotional disturbance”\(^{26}\) (p. 395). Because these children were more likely to have mental health problems and perhaps diagnoses, they may have had more symptoms to be improved. That is,
they stood to gain more than children with fewer mental health issues.

**ADHD AND COMORBIDITY**

The school environment offers a context that can be challenging for children who have difficulty learning and whose emotional problems lead to behavior that is not appropriate for the classroom. Unfortunately, investigations of the role of physical activity in improving outcomes for children receiving special education services to address an emotional disturbance are scarce to nonexistent. In contrast, considerable research has been conducted on physical activity interventions and their impact on the behavior and cognitive function of children with ADHD. Although not considered a mood, anxiety, or social disorder, ADHD commonly occurs with these disorders. Clinicians and researchers refer to this as **comorbidity**, and individuals with ADHD are at high risk for comorbidity.

Approximately 20–30% of individuals with ADHD also have depression and approximately 25% of individuals with ADHD also have anxiety.\(^{17}\) In a sample of children diagnosed with autism spectrum disorder, 59% were also diagnosed with ADHD.\(^{28}\) Although prevalence rates of ADHD’s comorbidity across disorders varies, most agree that ADHD, in children, most commonly co-occurs with conduct disorder, oppositional defiant disorder, and anxiety and mood disorders. About 52% of children with ADHD will have an additional diagnosis and around 26% will have two. With estimates as high as 10% of children having a diagnosis of ADHD, most teachers will have at least one child with ADHD in their classroom, and that one child will likely have more problems than ADHD that are affecting learning.\(^{29}\)
SPECIAL SERVICES FOR CHILDREN WITH ADHD

If children’s behavior is adversely affecting learning on an ongoing basis, children may be eligible for special education services to receive accommodations, modifications, and supports. Although a federally defined special education category for ADHD does not exist, children with ADHD can be eligible for special education services to address an “Other Health Impairment” or OHI. This is possible as ADHD is a health impairment that adversely affects children’s alertness.

Children with ADHD who do not qualify for special education services are still afforded protection from discrimination under antidiscrimination law, Section 504, and similar services can be put into place to ensure their ADHD does not prevent them from school participation. Such legislation ensures that schools work hard to include children with ADHD, which means that educators are often seeking interventions and strategies that do not restrict these children from the general education classroom. Because physical activity is cost effective and can easily be implemented in schools, the investigation of physical activity’s effect on symptoms related to ADHD is gaining popularity in comparison to investigations conducted for other groups of children. Additionally, ADHD is associated with hyperactivity, which matches well to an intervention focused on movement and energy expenditure. That is, educators and parents intuitively sense that children with ADHD need to burn up excess energy or “blow off steam.”

PHYSICAL ACTIVITY AND ADHD

No fewer than three reviews of physical activity’s effect on ADHD-related problems and symptoms were recently...
published in 2017 and 2018. Although all the reviewers expressed concern over the limited number of studies conducted, they agreed that physical activity has a positive effect on outcomes related to ADHD. Two groups of reviewers attempted to identify at what levels the frequency, intensity, and length of time spent engaged in physical activity were needed to observe the best effect. A third group focused on differences between acute and chronic forms of exercise. Cornelius and her colleagues found no differences in physical activity’s effects on ADHD with relation to how frequently children in the studies engaged in activity, how intensely they engaged in the activity, and how long the physical activity sessions were.\textsuperscript{13} Cornelius acknowledged that schools would find it difficult to integrate physical activity interventions into the school day without this information. Similarly, Suarez-Manzano and her colleagues did not find that intensity and length of time of physical activity consistently offered an explanation for effect sizes.\textsuperscript{30} Even so, they did specify that 20 to 30 minutes of acute physical activity at 40% to 75% intensity was needed to achieve a positive effect on executive functioning and processing speed, but noted that the effects varied by age. Finally, they reported that the outcomes could be further improved when physical activity becomes regular or chronic practice.

An additional difference between the Cornelius and Suarez-Manzano findings was that the former found that physical activity only significantly affected the emotion and mood of children with ADHD and not cognitive outcomes. In contrast, Suarez-Manzano reported that physical activity positively and significantly affected both. Finding significant effects depends on which studies were included in the reviews. Reviewers make decisions about inclusion based on
the quality and design of studies, what variables were included in the studies, age levels, and type of activity, to name a few. Cornelius and colleagues reviewed 20 studies, whereas Suarez-Manzano and her colleagues included 16. Despite the two groups of reviewers including several of the same studies, their inclusion criteria differed so that they each investigated a different set of research studies.

Suarez-Manzano and colleagues focused on cognition, which was somewhat different from the approach taken by Cornelius and colleagues who were also interested in emotional and behavioral outcomes. The latter group was writing for school psychologists who typically work directly with children experiencing emotional and behavioral disorders in schools as well as the children’s teachers. Thus, their focus was to investigate physical activity as a possible intervention for the types of referral questions typically directed to school psychologists. Their findings are promising, especially as medication prescribed to address ADHD symptoms often does not also address the emotional difficulties experienced by children with ADHD. Furthermore, children with ADHD are at risk of developing other emotional and behavioral disorders that do not respond to traditional medication therapy for ADHD.

The third group of reviewers, Ng and colleagues, reviewed 30 studies investigating the relationship between physical activity and ADHD outcomes.\(^3\) Notably, the authors did not conduct a meta-analysis and only qualitatively completed findings. This means that they did not actually use analyses to calculate the size of effects across studies and/or investigate whether the strength of the effects was beyond what would likely be found for any type of intervention. Ng and colleagues found overall positive
benefits for children’s cognitive, behavioral, and physical outcomes in children with ADHD in relationship to their engagement in physical activity. They noted that physical activity did not result in any negative outcomes but that the number of studies available was limited. Finally, they advised that physical activity is most effective when it reaches at least moderate intensity.

THE TRANSLATION OF RESEARCH TO EDUCATIONAL SETTINGS

Although questions remain concerning how to apply research findings to educational settings or how to address the gap that exists in translation, the idea of physical activity as an intervention to improve children’s mental health and behavior is promising and growing in momentum. As some researchers are working to determine the frequency, intensity, and duration of physical activity that is needed across gender, age levels, and problem type to create prescriptions to be adopted by schools, others are raising additional important questions about the translational gap. Specifically, do mental health problems lessen individuals’ engagement in physical activity? Randomized clinical trials show that physical activity can improve symptoms, but the possibility also exists that reduced physical activity is a consequence of mental health problems. Experimentally speaking, physical activity could be both an independent and a dependent variable. However, investigations of the impact of mental health problems on physical activity are correlational or quasi-experimental in nature, because it is not ethically possible to cause someone to experience a mental disorder to determine if the disorder causes a decline in physical activity.
As elaborated on in Chapter 1, not all children are physically active during recess and not all children are physically engaged during physical education classes. Therefore, when considering how to apply the findings that show physical activity positively affects mental health outcomes, educators should recognize that simply increasing time for both recess and physical activity will not be enough. Children and adolescents who are experiencing mental health disorders may not take advantage of these opportunities to become more active due to the barriers that their symptoms present. Therefore, a preventative approach makes sense, and fortunately, evidence exists to suggest physical activity plays an important role in supporting the development of positive characteristics in children and adolescents.

**POSITIVE APPROACH**

Increasingly, psychology is moving from medical models explaining mental health issues to those that are more positive in focus. Instead of first looking to diagnoses to explain what is wrong with children when they are behaving poorly at school, a positive approach encourages educators to consider how to improve children’s social skills and emotional regulation to promote positive school behavior. Positive psychology emphasizes children’s strengths over diagnoses. Therefore, to increase children’s fit to school environments, educators and parents can support children in developing healthy qualities, such as **self-concept** and motivation. In turn, schools can alter environments to promote the inclusion of all children. If physical activity has a positive effect on self-concept and **self-esteem**, then schools should add more opportunities for movement.
PHYSICAL ACTIVITY AND SELF-CONCEPT

Self-concept refers to individuals’ perceptions of their personal qualities, including strengths and weaknesses, which is multifaceted and hierarchical. Although young children possess a self-concept, the construct is most often studied in middle school students as many opportunities for social comparison across multiple domains emerge during early adolescence. This social comparison paired with children’s cognitive development sets the stage for self-awareness in the school context. Just as the school context offers a variety of subjects and social opportunities, self-concept is multifaceted and hierarchical. Children might have a positive, overarching view of themselves but also recognize areas of weakness or difficulty. Additionally, a child might develop a positive self-concept for reading but a negative self-concept for science. Self-concept also extends to physical appearance and physical activity.

Researchers interested in physical activity have often explored children’s physical self-concept. This construct has been defined generally but also more specifically, with focuses on physical appearance, perceived physical competence, and perceived fitness. Even so, all relate to how children and adolescents view their physical qualities. Physical self-concept is important because researchers have found, not surprisingly, that children and adolescents with higher levels of physical self-concept are more likely to engage in physical activity. When childhood obesity and sedentary behavior present major health crises, understanding what promotes more engagement in physical activity is important. Therefore, some believe that improving physical self-concept will increase physical activity.
However, other researchers tend to view the relationship differently and suggest that increases in physical activity are associated with increases in physical self-concept. Enough research has been generated to warrant a systematic review and meta-analysis, conducted by Babic and colleagues in 2014. Unfortunately, after their analysis of 64 studies, they were unable to resolve the debate and found studies and evidence to suggest moderate effects in both directions. That is, physical activity could be either the independent variable or the dependent variable. The reviewers noted that “it is not clear if participation in physical activity leads to improvements in physical self-concept or those with high levels of physical self-concept are attracted to physical activity” (p. 1596). They conceded that it might be both. That is, the association may simply be bidirectional.

**SELF-CONCEPT AND SELF-ESTEEM**

Positive physical self-concept can lead to positive self-appraisal of individuals’ self-worth or self-esteem. Although the two are related, self-esteem might be considered a valuation of self, whereas self-concept is more of a belief about who one is. Thus, self-esteem tends to be based on outcomes and how one feels about them. For example, suppose a sixth-grade student has a low self-concept for reading. In contrast, the student perceives herself to be highly competent in mathematics, and therefore, has a high mathematics self-concept. She does not feel badly about her reading but simply accepts this as part of who she is. In fact, her self-esteem might be high because she highly values her mathematics skills and plans to be an engineer one day.
Because self-esteem is a feeling associated with personal evaluation, its juxtaposition to depression is apparent. Furthermore, low self-esteem has been associated with numerous mental health problems and behavioral concerns, including anxiety, suicidal ideation and behavior, eating disorders, and conduct problems. A positive and preventative approach suggests focusing on how to improve the self-esteem of children and adolescents rather than waiting to address these problems. Physical activity is related to increases in children’s self-esteem, which gives it another advantage as a school intervention.

**PHYSICAL ACTIVITY, SELF-CONCEPT, AND SELF-ESTEEM**

Although the research base investigating relationships between physical activity, self-esteem, and self-concept is growing, findings have been mixed. However, analysis of the overall effect of physical activity on self-esteem in children and adolescents in published, randomized controlled trials has been described as small and positive by Ahn and Fedewa and moderate and positive by Ekeland and colleagues. Differences in these results relate to the number and quality of trials each group of reviewers included in their analysis. Ekeland and colleagues analyzed 23 randomized controlled trials, but some studies included participants close to the age of 20. The authors noted that many of the studies’ samples sizes were small and of low quality. Ahn and colleagues, who also included studies investigating physical activity’s effect on self-concept, analyzed a total of 73 studies and compared results depending on whether the studies were randomized controlled trials or correlational in design. Because the reviewers were interested in studying other mental health
outcomes, the number of studies including self-esteem and self-concept were much smaller, especially for self-concept.

More recently, Liu and colleagues conducted a review and analysis of 25 randomized controlled trials and 13 non-randomized trials that investigated the effects of physical activity interventions on the self-concept and self-esteem of children and adolescents. Analysis of studies that did not involve randomly assigning participants to treatment and comparison groups, yielded no statistically significant results. Thus, these studies indicated that physical activity did not have an impact on self-concept or self-esteem. However, analysis of experimental studies which randomly assigned participants to treatment and comparison groups revealed significant effects for physical activity’s impact on self-concept and self-esteem. When participants are randomly assigned to groups, any preexisting differences are randomly distributed between the groups. This ensures that other confounding factors will not affect the results. Therefore, findings from randomized controlled trials tend to be more robust.

Liu and colleagues further found that effects sizes did not differ depending on the intensity of the physical activity intervention measured by the minutes in the treatment sessions, the frequency of the intervention as determined by how many times per week it occurred, or length of the intervention in weeks. Interestingly, they did find that physical activity interventions implemented in schools or gymnasium-based settings yielded higher effect sizes in comparison to those conducted in clinics, detention facilities (as in studies conducted with juvenile offenders), or family settings.

Although the results across these reviews and meta-analyses all indicate a positive association between physical activity
and self variables, including self-esteem and self-concept, differences were observed in the strength of associations and some mixed findings were present. For example, Ahn and colleagues also reviewed studies that were not randomized controlled trials and found the strongest effect size for this group of studies when Liu and colleagues found no significant effect for studies that did not use randomization. Even though more research is needed to understand how physical activity impacts self-concept and self-esteem, these findings are important as they show that physical activity may not only offer a “prescription” to mental health problems but also offer some level of prevention.

**PHYSICAL ACTIVITY AS A SCHOOL INTERVENTION TO IMPROVE MENTAL HEALTH AND LEARNING**

Taken collectively, the study of physical activity’s effect on mental health lends credence to physical activity as an appropriate school intervention. Studies indicate that physical activity interventions can be implemented by teachers, and interventions conducted in school settings might be more effective. Research findings further suggest that physical activity’s influence on mental health is multifaceted, and although it might be more effective for those who display more symptoms, interventions work for both typical and atypical groups of children and adolescents. Furthermore, physical activity may offer some protection from mental health problems by increasing self-concept and self-esteem.

Research supports that self-concept is related to academic achievement and self-esteem is not only associated with lower levels of depression, anxiety, and behavior problems, but also associated with higher achievement. Physical
activity appears to be connected to multiple variables related to learning, including self-concept and self-esteem, depression and anxiety, symptoms of ADHD, cognition, executive function, and academic achievement. The overlap in associations and evidence from randomized controlled trials of physical activity’s effects suggests that physical activity plays an important role across multiple processes that support learning in children and adolescents. This role is not always consistent across groups, situations, or time, and perhaps this dissuades researchers from making stronger conclusions and diminishes the number of parents demanding more physical activity in schools.

UNDERSTANDING PHYSICAL ACTIVITY’S ROLE THROUGH A DYNAMIC SYSTEMS THEORY PERSPECTIVE

However, when viewing the physical activity research base through the lens of dynamic systems theory, the perspective changes. In this framework, single cause explanations are not expected. Therefore, physical activity would not necessarily be expected to have extremely large effects on learning outcomes. Using traditional, randomized controlled trials limits the ability to view how physical activity interacts with other processes as other processes are typically isolated. Additionally, physical activity can be a treatment or an outcome. That is, physical activity can promote higher self-esteem and lower depression, but it is likely that these variables, in turn, influence the degree to which children and adolescents engage in physical activity. Children and adolescents might be assigned to physical activity interventions, provided with extended recess, or enrolled in high quality physical education class, but this does not mean that they will fully
participate. Finally, the frequent discussion of variables, such as intensity, frequency, and duration or focus on dose-response, implies that researchers expect outcomes to relate to physical activity in a linear manner. As physical activity increases, benefits should increase; therefore, an emphasis is placed on finding that point of intensity, frequency, and duration that is associated with the most benefit. What if there is no such point or this point differs across individuals? What if it takes time for children to develop enough fitness to benefit from the 30 minutes allotted for physical education? What if children who increase their fitness through a physical activity intervention no longer benefit from the assigned duration and require more time to achieve the same results?

For example, an adolescent cross-country runner might train in the fall for a two mile race by running three and four mile training runs as well as engaging in speed training (e.g., running fast for specified time periods) over the months of August, September, and October. However, in the spring, she might forgo the track season and stop training because she is planning to take college entrance exams and enrolling in preparatory classes. After all, she does not enjoy track meets that last a long time. Without engagement in other types of physical activity, by May, the cross-country runner will likely find it difficult to run three or four miles at once. This example raises several points. First, children and adolescents might enjoy some types of physical activity but not others. In this case, both cross-country and track involve running, but the surfaces, training, and season differ enough to offer different appeal. Second, fitness levels vary, and, therefore, the amount and type of physical activity that is needed for individuals to benefit will not only vary across
children and adolescents but also within individuals. Finally, educational demands change as children and adolescents change. These pressures, which differ depending on culture and gender, can influence decisions about physical activity.

Applying dynamic systems theory “requires rethinking the very nature of human thought, behavior, and development relative to our theoretical predecessors” (p. 73). Physical activity not only changes children’s brain chemistry and, ultimately, brain structure but also challenges individuals to make judgments about their body in space and time (e.g., throwing a ball with enough force to reach a peer while running down a field), perceive the world differently (e.g., maintaining one’s balance when standing on one’s hands), and perceive peers in new ways (e.g., working with unfamiliar peers to form a basketball team). Physical activity impacts the lives of children and adolescents in many ways and is constantly influencing development as development influences it. Therefore, isolating and understanding its role in learning may be impossible.

**CONCLUSIONS**

Rebar and Taylor suggested that physical activity may prove to be an important tool in improving mental health outcomes across the world. They referred to a strong research base to support this claim. However, the literature investigating physical activity’s role in children’s mental health is still growing. Evidence suggests that physically active children have lower levels of depression and anxiety while also benefiting from higher self-concept and self-esteem. This relationship has formed the basis of physical activity interventions that lead to significant improvements
in mental health outcomes in children who have participated in the intervention in comparison to those maintaining their regular levels of activity. Interventions implemented in schools and by educators tend to have the strongest effects. As in the case of achievement, the strength of the effect of physical activity on mental health outcomes is not quite clear, with most researchers agreeing on a small overall effect. However, effects for children from special groups, such as those experiencing ADHD or cognitive disabilities, seem to be strong.

Even so, intervention implementation does not guarantee children’s interest, motivation, and engagement, and the expectation should be that effects will vary depending on these factors as well as developmental level and gender. Rebar and Taylor pointed out that translating research on physical activity’s association with positive mental health into practice is further compounded by the bidirectionality of this relationship. Although individuals who engage in physical activity will likely experience increases in positive mental health outcomes, individuals with poorer mental health will struggle to engage in physical activity. Chapter Four explores interventions and the qualities of interventions that may be most likely to promote physical activity in children and adolescents.

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Many researchers investigating physical activity’s role in academic outcomes have recognized the need for schools to have an evidence base for interventions before implementation. Indeed, legislation has demanded that educators investigate and demonstrate the effectiveness of interventions prior to implementation. The What Works Clearinghouse (WWC) was established for this purpose. The WWC is hosted by the Institute of Education Sciences whose mission is to ground educational practices in research and scientific sources of evidence.¹ The WWC reviews research on educational interventions but only includes studies that reach a rigorous level of quality, such as in the case of randomized controlled trials.

The emphasis the WWC places on randomized controlled trials and other rigorous methodological designs may not be practical, as carrying out such designs in public schools is quite difficult. Furthermore, experimental designs are meant to isolate variables to better understand the effect of the intervention or treatment. Although this goal is valuable for researchers, translating the results into the complex school environment is challenging. Regardless, many educators are not familiar with the WWC or multiple other online databases designed to organize and report on research relating to educational interventions, and fail to use such tools as
a resource. As Slavin lamented, “Education lacks a tradition of looking to evidence for program decisions, and without clear support from government, marketing will always trump evidence”\(^2\) (p. 126). Robert Slavin has written extensively on educational reform and what it will take to make changes in education. He argued that schools require specific directives concerning what is scientifically based research. Because publishing companies of educational interventions and programs can easily adopt the words “evidence-based” or “research-based” to describe their products, school administrators and educators must be able to evaluate the data for themselves to select appropriate programs. Unfortunately, most rely on the marketing materials. The purpose of the first section of Chapter 4 is to discuss what resources are available and what practical issues must be considered to make better decisions about selecting and implementing physical activity programs for schools. The second section’s purpose is to outline what intervention qualities offer promise when considering children’s motivation and interest as well as physical and social development.

**HOW MUCH RESEARCH IS NECESSARY**

Few to no interventions related to improving academic achievement in schools have been scrutinized to the same degree as physical activity. Consider a popular reading program whose publisher refers to it as a “research-proven” program. The program is used across the nation in an effort to improve reading comprehension through regular reading and evaluation. Interestingly, as of June 2016, the WWC only identified two studies that met their research quality standard for the investigation of the program as an
intervention for reading comprehension. Their review of the two studies indicated mixed results. The WWC identified only one study that has evaluated the program’s intervention for reading fluency, and the results indicated no discernible effect. Still, school administrators and educators find that the program works with their reading programs and curriculum and consistently use it in their schools.

How is it that physical activity has not been adopted as a school intervention when it has been studied through multiple randomized controlled trials, the gold standard of research designs, and found to have consistent positive effects on children’s mental and physical health and executive function? Additionally, predominately positive effects have been found for academic achievement, and most have agreed that increases in time devoted to physical activity are not associated with declines in achievement. Physical activity positively affects mental health, well-being, and behavior which also support children’s ability to benefit from instruction and learn.

**TEACHER FIDELITY OF INTERVENTION IMPLEMENTATION**

Of course, researchers believe the answer lies with more research, and once specific advisement on dose-response is achieved, school administrators and educators will heed the call for increased physical activity at school. Unfortunately, research investigating how interventions are implemented in public schools suggests a different outcome. Researchers have found that teacher fidelity of intervention implementation may not be common and many have failed at their attempt to address the problem. Supporting change in teacher practices can be challenging. For teachers, the classroom strategies and design they use may have become
habit, and habits, as for most individuals, tend to be very difficult for teachers to change. “The typical finding is that strong habits are repeated relatively independently of intentions and personal norms.” Teachers may be willing to incorporate new interventions, but they will likely find it difficult to make changes in the activity levels of their classrooms, simply because they do not automatically think about it. Therefore, teachers must be invested in the benefits of physical activity and see results in their daily experiences as well as have access to regular support and reminders to implement changes. Information on dose-response might be of interest to researchers; however, it matters more to researchers than to teachers.

**SOCIAL VALIDITY**

Although research findings can be convincing, the results of randomized controlled trials do not always impress school administrators and educators. They are interested in what works in their schools and classrooms, and results from experiments may say little about that. Researchers try to control for extraneous factors that could confound or confuse what is the cause of the results. They randomly assign children to groups so that any potentially systematic influences due to confounding variables are randomly distributed between the treatment and control conditions. This strategy ensures that these variables can be ruled out as causes of the results. Researchers also put checks in place to be sure that treatments have been implemented with fidelity. If the treatment condition requires adolescents to spend 45 minutes alternating between stationary cycling and weight lifting, then the adolescents will spend 45 minutes doing just this.
Days are not skipped or shortened, and substitutions are not made. Finally, researchers often have access to facilities and equipment and can schedule their studies during times of the year when the climate is temperate. If jump ropes are needed, then every child in the physical activity intervention condition has a jump rope. If adolescents are required to run as the intervention, access to a track or park is available to all the participants.

In contrast, teachers and school administrators may strive for intervention fidelity but will inevitably fall short. Children and adolescents cannot be randomly assigned to groups to ensure fair evaluation of the effect of the intervention. Students are assigned to school schedules based on their grade levels, academic needs, electives, and extracurricular activities. Sixth-grade students taking band in fifth period, the only time it may be offered to that grade level, are simply unable to participate in a physical activity intervention planned for that period. Some students receive specialized instruction during the day, others enrichment, and some both. Students are assigned to classes based on these scheduling issues as well as academic grouping, such as advanced placement. Thus, most schools elect to incorporate physical activity interventions into the school day through recess and physical education; however, extending time and providing supervision is still challenging.

Once time is identified, schools must provide quality instruction and supervision, as they cannot entrust students’ physical well-being to just anyone, and sometimes, teachers and school staff are absent, just as students are absent. The daily school schedule might be temporarily changed to accommodate a wide range of issues, such as pep rallies, standardized testing, early release for parent-teacher
conferences or holidays, and assemblies. Perhaps, more often, students are absent due to illness or so that they may participate in field trips and academic competitions. Furthermore, schools may not have appropriate or consistent access to facilities. The gym might be decorated for an upcoming dance or the school may be located in a cold climate where running outdoors is not possible due to ice but running indoors is not feasible in a small gym. Some schools might have enough equipment for all students to use or the equipment may be shared with other groups of students. Thus, the school context does not always allow for precise levels of intervention implementation.

Such differences between research and school settings often make research results appear unrelatable to school administrators and educators. Even when research is conducted within schools, researchers are changing the environment so that it does not represent what happens on a regular school day. In the very least, researchers’ presence introduces novelty, which will be more likely to capture children’s attention, encourage interest, and ultimately facilitate investment in the treatment. The same might not be true when interventions are adopted by schools and teachers. Teachers may also view proposed interventions as just the next trend and may fail to take them seriously. These issues relate to a concept referred to as social validity. Social validity involves the degree to which educators perceive an intervention to be acceptable and important. To determine an intervention’s social validity, researchers must ask teachers about their experience and satisfaction using the intervention. Unfortunately, this is rarely done outside of the field of applied behavior analysis (ABA).

ABA is a discipline that uses behavioral principles to promote positive, socially significant behavioral change.
Analysts, who often work to address behavioral problems in children with autism spectrum disorders, use single-subject designs to evaluate their intervention work. After developing an intervention for a child using an assessment that determines the underlying function or cause of a target or problem behavior, analysts investigate if that intervention is working by using experimental techniques. Techniques often involve starting and stopping the intervention, or reversing the intervention, to monitor whether the target behavior changes in the expected direction. In ABA, the goal is to bring the target behavior under the control of the presence or absence of the treatment. Several of the studies discussed in Chapter 2 were conducted using ABA techniques.

**USE OF DIFFERENT RESEARCH DESIGNS**

The goal of single-subject designs is to inform the practitioner or researcher of what works with an individual or maybe small groups, such as a classroom of children. The goal of group designs, such as the randomized controlled trials conducted with children randomly selected and assigned to either an intervention or control condition, is to be able to generalize findings to other children who did not participate in the study. Those who work with single-subject designs, often those working in the field of ABA, criticize group designs for their lack of social validity as well as reductionist approach. That is, in group designs, the scores on outcome variables, which might be achievement test scores, number of depressive symptoms, or degree of confidence children have in their mathematics abilities, are reduced to an average or single value that represents the entire group, and then the averages for the participants in different
conditions or groups are compared using statistical methods. As a reductionist method, a large group of participants’ scores are represented by a single value, but not every child in that group scored the average score. Some will have scores lower than the average and some higher. This means that a randomized controlled trial can indicate that, overall, children in the intervention group had significantly higher scores than children in the control condition; however, it is possible, if not likely, that some children in the intervention group could have performed worse than some children in the control condition.

In contrast, single-subject designs are criticized for their inability to relate to large groups of children. Understanding that an intervention works for one child may say little about what the intervention will do to change behavior across all children. Rob Horner, who has authored over 150 papers on behavioral analysis topics and worked to support the implementation of positive behavior interventions and supports across thousands of school districts, proposed that single-subject designs can also effectively inform practice. That is, the findings are not just limited to understanding the subject of the study. Horner and colleagues advised that with at least five quality single-subject studies conducted by at least three different researchers across three different locations with a total of a minimum of 20 participants, an intervention could be considered evidence based. Although this standard is not officially adopted across fields, the WWC referred to Horner’s guidance when setting the standards for what WWC will consider as evidence. Even so, requirements offer little assistance to school administrators and educators trying to make sense of the research base.
EVIDENCE-BASED VERSUS RESEARCH-BASED

Understanding “what works” for students in controlled trials and single-subject designs is an important piece of understanding how physical activity impacts learning; however, consideration of other types of research designs can be valuable. As Schoenfeld, and Cook and Cook have pointed out, even experimental designs can be flawed. Dependent variables, such as achievement or self-esteem, could be poorly measured, or the intervention could be implemented inconsistently. Cook and Cook emphasized that this is reflected in the terminology. Research-based practices are those that are simply supported by research, and research may not provide clear indication of what causes an effect, such as the case in correlational designs.

Finding associations between physical activity and learning outcomes in a large, nationally representative database is research; however, associations do not reveal cause and effect. In contrast, by using the term, evidence-based practice, educators can be more confident that the results indicate that an effect occurs because of the intervention studied. However, clearinghouses designed to share evidenced-based practices with teachers might go too far by not mentioning important elements of a study, such as positive results that do not quite reach statistical significance but show promise, or not recognizing studies at all because of their correlational or quasi-experimental design that did not use random selection and assignment of participants. Such designs, especially when conducted longitudinally, can offer important information about how variables are related.

For example, no experimental evidence exists to show that cigarettes cause lung cancer, as researchers could not
ethically require individuals randomly assigned to the treatment group to start smoking so that they could study the effect. Instead researchers relied on comparing individuals who already smoked with those who did not. The consistent association between the two, across studies and time, has proven to be enough. Science is a cumulative process, and correlational and quasi-experimental studies have a place, especially when studying students’ behavior in schools where children are often purposefully rather than randomly assigned to classrooms and interventions.

THE WWC EVIDENCE FOR PHYSICAL ACTIVITY’S EFFECT ON LEARNING OUTCOMES

A search of the evidence base for physical activity interventions in the WWC yielded only one Regional Educational Laboratory (REL) response. The Northwest REL, which represents five Northwestern states, fields questions to its “reference desk” to offer guidance to schools. In September 2017, the REL answered a question concerning the effectiveness of physical activity in elementary school classrooms. Specifically, the question asked, “What does the research say about the relationship between physical activity and elementary students’ behavior, self-regulation, and academic performance?” The REL provided a list of references and descriptions of methodology from studies located from public sources and published between 2015 and 2017. However, the REL noted that the list was not exhaustive and inclusion of studies did not necessarily indicate the studies met WWC criteria for review.

A second hit derived from the search was a review of a randomized controlled trial of a physical activity intervention’s effect on symptoms of ADHD. The review conducted in May
of 2015 yielded a rating of “does not meet WWC standards.” Despite being described as a randomized controlled trial, the authors adjusted group membership to create greater similarity in the body mass index (BMI) between groups, and, therefore, did not use true randomization. Additionally, the report indicated that imputation was used to create values for missing data. Because WWC does not consider imputation a valid technique and due to the lack of true randomization, the study was not reviewed. Although the WWC has the potential to be an important resource for educators, such high standards and failure to consider translation of experimental findings to school settings can make it impractical.

**PRACTICAL ANALYSES—COST BENEFIT**

School administrators and teachers face practical challenges related to intervention implementation while also trying to ensure that students are receiving the instructional time required by state regulations and expected by parents. They are looking for evidence or what works; however, what works does not necessarily mean what can be implemented successfully or financially. Even with positive WWC endorsement, school administrators may not move forward to implement physical activity interventions in their schools. Administrators also need to consider the cost benefit ratio of intervention implementation, and not just in relation to cost in terms of time spent out of direct instruction but in terms of money. In 2015, the Washington State Institute for Public Policy (WSIPP) conducted such an analysis and found that school-based programs designed to increase children’s levels of physical activity yielded a positive benefit to
cost ratio of $33:1. The WSIPP only considered physical activity programs that were not a part of physical education programs or recess activities, and the focus was only on elementary children attending kindergarten through eighth grade. The evidence cited focused on the reduced costs of health care associated with increased physical activity and decreased levels of obesity as well as increased earning power associated with children’s higher academic achievement. The institute reported a 66% chance that physical activity program benefits will exceed the costs.

The goal of the WSIPP is to identify evidence-based policies to offer advice for policy and lawmakers in their decisions to use taxpayers’ money effectively. Although the analyses conducted are meant to apply only to Washington state, reviews included the broad research base. This approach of synthesizing the research literature in relationship to financial cost and benefit, likely offers greater appeal to school administrators who must consider practical issues related to intervention implementation.

**CENTER FOR DISEASE CONTROL IMPLEMENTATION TOOLS**

The Center for Disease Control and Prevention (CDC) also takes a policy-focused approach in supporting school implementation of interventions to improve health. In addition to reviewing the research literature published between 1985 and 2008 and concluding that physical activity has a positive effect on academic achievement, cognition, and behavior conducive to learning, the CDC provided clear recommendations for increasing children’s physical activity. They have further devoted a website (www.cdc.gov/policy/hst/hi5/physicalactivity/index.html) to help influence policy changes
through the availability of several tools and models. For example, the Physical Education Curriculum Analysis Tool (PECAT) can be downloaded for free and allows schools to evaluate their physical education curriculum’s alignment to national standards depending on grade level. The goal is to help schools determine curricular changes as well as the need for development.

The CDC, in conjunction with SHAPE America, a society of health and physical education for educators, created the Comprehensive School Physical Activity Program or CSPAP approach. The CSPAP provides guidance on developing, implementing, and evaluating comprehensive physical activity programs. The CSPAP is notably a multicomponent program that goes beyond guiding physical education programs. The approach models how the recommended 60 minutes of physical activity can be implemented throughout the school and community environment. This requires staff training, physical activity opportunities before and after school, physical activity during the school day, and family and community engagement as well as high-quality physical education. Not only does the CSPAP offer a step-by-step guide for schools that includes a planning chart and budget and implementation plan templates, but also a framework that includes support and guidance.

**CURRENT STATE REQUIREMENTS**

Despite such advisement, tools, and models, most school districts continue to avoid implementation of specific physical activity programs beyond physical education or, at the very least, to expand and improve their existing physical education curriculum. Changes will likely need to occur at a
state-mandated level. To date, only one state, West Virginia, has adopted a statewide physical activity program, Let’s Move! Active Schools, for all its public schools. However, enrollment is at the elementary school level only. According to a 2017 report by the Council of State Governments, other states have physical activity requirements in place to either require recess or time for general activity during the school day.\textsuperscript{16} Five states, Connecticut, Indiana, Missouri, Rhode Island, and Virginia require recess. Eight states, Arkansas, Colorado, Iowa, Louisiana, North Carolina, South Carolina, Tennessee, and Texas have general requirements about physical activity. Most indicate that 30 minutes of physical activity is required for elementary school children daily; however, how to achieve this, what the activity looks like, or who is qualified to supervise it is not clear. The legislation does not go far enough to specify 60 minutes daily or to require quality curriculum, which is problematic as children are not always physically active during recess or physical education when the curriculum does not encourage it. Of further concern is the focus on only elementary school children. Legislation most often applies to only elementary school students, although a few states extend the requirements through middle school. No state includes high school students.

The evidence presented in Chapters 1, 2, and 3 which relates physical activity to higher order cognitive function, academic performance, and mental health indicates that schools should be rethinking how physical activity is incorporated into the school day. However, multiple questions still exist about its implementation. Although a guideline of 60 minutes of physical activity a day is provided by the CDC and other agencies, advice concerning the intensity children need
to reach and for how long to achieve the best cognitive benefits is absent. Additionally, just as variability exists in the qualitative nature of physical activity and how different types of activity influence learning, most researchers agree that an interaction occurs between developmental level and type of physical activity. This means that young children might benefit from certain types of physical activity whereas adolescents might benefit from another. Differences in benefit might also occur due to physical fitness levels, interest in types of activity, and the variability that exists across social situations.

The remaining sections consider these factors in the context of the school setting. The factors are arranged based on evidence; however, they are also organized in a hierarchical, practical manner. For example, motivation and interest are considered first because these factors are needed to engage children and adolescents, and educators simply cannot make students move if the students do not want to do so. The discussion of motivation and interest is followed by developmental and social considerations, which can guide more appropriate intervention development when understood by educators. Although frequency, duration, and intensity are addressed, the discussion centers on why they should not matter as much in the school environment. School administrators and educators must fit a lot into the school day, and information about how much time should be devoted to physical activity to be most likely to achieve benefit is important. Additionally, this time investment can be maximized by considering the intensity of children’s physical activity. However, such precision in physical activity interventions is not likely practical and perhaps not needed. Finally, the incorporation of cognitive stimulation into physical activity is addressed, as it may also add further educational
benefits. With each factor, the considerations narrow to continue to improve interventions’ effectiveness. Of course, as the factors narrow, achieving their successful implementation in schools becomes more challenging.

**MOTIVATION AND INTEREST**

The first three chapters argued for the positive effect of physical activity on learning outcomes, ranging from improving executive function to decreasing depression in children and adolescents. Although much of the research base discussed included investigations of interventions and what was needed to achieve results, the most obvious requirement was not sufficiently addressed. Before children and adolescents can benefit from physical activity interventions, they must be motivated and interested in engaging in physical activity. Researchers have found that despite access to recess and physical education, students often remain inactive for much of the time they are expected to be moving. Many children bring electronic devices to recess that maintain their attention and offer a significant barrier to involvement in physical activity.17

Motivation for physical activity and exercise has been studied extensively, with considerable focus on goal orientation and achievement motivation.18,19 **Achievement motivation theory** posits that individuals’ success in sport, exercise, and physical activity is related to the type of goals that people set for themselves. Goals can be divided first into whether individuals are seeking to master the activity or to perform. When mastery is the goal, individuals often set out to improve their skill, experience improvement, or enjoy being engaged in the activity. When performance is the goal, individuals work to
outperform others or demonstrate their success to gain the attention or approval of others.

Mastery and **performance goals** can further be divided by their valence or whether the goal is to approach or avoid. A mastery approach goal involves working to master the activity whereas performance approach involves seeking out high performance. The former might translate into a goal of “I will power through the hills at the end of Saturday’s 5K” but the latter might translate into a goal of “I will finish first in my age-group at Saturday’s 5K.” Finally, mastery and performance goals can be avoidant. Although mastery avoidant goals are somewhat difficult to formulate and tend to only weakly influence physical activity outcomes, most researchers still consider them important. In this case, the goal might be, “I will run a 5K that has no hills.” Performance avoidant goals tend to be more recognizable, and might sound something like, “I will train for the 5K so that I won’t finish last.” Performance avoidant goals tend to be associated with the lowest performance.

Interestingly, people can set both performance and **mastery goals** simultaneously, and determining what goals were set based off the outcomes observed may be difficult. A teenager who sets a mastery goal for running a two-mile cross-country race at a six-minute-per-mile pace might win the race and outperform her peers. However, the teenager’s motivation for running differs depending on the type of initial goal. In applying achievement goals to sport and exercise, Elliot and Conroy speculated that achievement goals have unique implications for sport and exercise.²⁰ For example, they reasoned that performance avoidant goals might motivate athletes to take risks to avoid loss, such as taking a risky shot in golf or going out hard at the start of a race. However, such behavior could also lead to injury and could undermine one’s enjoyment and
intrinsic interest in the sport. Therefore, achievement motivation theory offers a basis for selecting physical activity interventions that focus on children and adolescents experiencing mastery, progress, and success rather than competition and performance.

**SELF-DETERMINATION AND PHYSICAL ACTIVITY**

Although educators can help children and adolescents to set mastery goals related to their physical activity, they can also support self-determination, which is associated with a focus on mastery and enjoyment. Self-determination theory posits that well-being results when individuals experience autonomy, competence, and relatedness.\(^\text{21}\) The theory is centered on the degree to which individuals view their engagement in activities and tasks as under their own volition. Not surprisingly, children are more likely to engage in physical activity when they feel self-determined which can be fostered through support of their choice in physical education environments.\(^\text{22}\) If individuals are given choices when engaging in an activity, experience success that communicates their competence, and feel connected to others, then they will likely continue to engage in the activity.

Consider again the adolescent training for the cross-country race. Suppose the girl signed up for the sport and enjoys the freedom of determining her own running pace during training. This encourages feelings of autonomy and choice in running. She also notices that her times are getting faster as she trains, and her coach mentions that she has learned to keep a consistent, fast pace throughout the race distance. This information supports the girl’s feeling of competence in running. Finally, the girl is often encouraged by her teammates
Actively Moving Ahead with Interventions during practice, and she sits with most of her teammates at lunch where they joke about eating more pasta to fuel their training. These experiences communicate a sense of relatedness or belonging. Collectively, feelings of autonomy, competence, and relatedness results in the girl’s continuation in cross-country and her motivation to improve.

Standage and colleagues investigated the relationships between self-determination variables and how they were influenced by physical education environments that supported mastery goals to predict young adolescents’ intentions to engage in physical activity in their leisure time. Although they found some differences in the strengths of the associations, the authors found that children reported higher feelings of autonomy, competence, and relatedness when the children perceived that their physical education teachers created an environment that supported their effort, self-improvement, and choice. Children’s self-determined motivation, in turn, positively influenced their intentions to engage in physical activity outside of school.

Children who perceived their physical education climate to be performance-oriented or focused on doing better than other children, reported lower levels of intentions to engage in physical activity during leisure time. Although learning that children intend to engage in physical activity outside of school is valuable, intentions do not always lead to actual behavior. Even so, the work of Standage and his colleagues, as well as the broad research base relating to self-determined motivation, suggests that when selecting physical activity interventions for children, a focus on mastery rather than performance may be the key to ensuring high levels of not only participation, but also continued engagement in physical activity outside of school.
Autonomy-supportive environments for young children will look different than those designed for older children and adolescents. As discussed in Chapter 1, young children often engage in short bursts of physical activity, which is evident when tasking them with running around a track. Young children will typically take off at breakneck speed only to start walking after they realize it is difficult to catch their breath. Once they recover, they are off again. Older children learn to pace themselves, which is probably associated with their more developed cognitive skills which allow them to think more in the future tense and to plan accordingly. This type of thinking further facilitates older children’s ability to engage in rule-governed games and activities.

Older and younger children further differ in their social cognition or ability to think about social situations. Young children often focus on the present and on only one thing at a time. Thus, their ability to take the perspective of others is often limited in comparison to older children. This type of egocentrism also leads to an overestimation of abilities. Many young children will often expect to run the fastest, jump the highest, and throw the farthest. Challenging young children to do just that during recess and physical education may work well. However, the same intervention strategies might not work well for older children, especially preadolescents and adolescents in middle school who can be painfully aware of social differences and engage in considerable social comparison. At this age, social groups emerge and self-concept develops so that involvement in physical activity may be avoided due to stereotypes and self-perceptions.
For example, many researchers have identified differences in physical activity levels between boys and girls. Studies of gender differences during recess have shown boys to prefer large open spaces where they can play physical games and girls to prefer their own spaces that allow for social interaction. The assumption that all girls want to stay in small social groups during recess or that girls want to avoid physically demanding activities is inappropriate; however, these findings may offer insight into the pressures and challenges that children face when making decisions about whether to join physical activities during recess time. Furthermore, educators should not assume that girls are naturally inclined to focus on social interactions while boys focus on physical abilities. Such differences are also influenced by cultural standards and models.

**SOCIAL COGNITIVE THEORY**

Social cognitive theory emphasizes the bidirectional interaction between individuals, their behavior, and their environments. An example of this bidirectionality is apparent in the recess environment. Even though a school provides open spaces and equipment for physical activity, or a positive environment, adolescents may not change their behavior to become physically active. Instead, adolescents may use the space to sit and talk or use the distance to move away from others to attend to their phones.

Educators must consider how adolescents’ beliefs about themselves, or person variables, influence how adolescents interact with the environment and not just what environments offer. This bidirectionality also indicates that changing the way adolescents think about physical activity is
important. Beliefs about physical activity are often influenced by the models to which children are exposed. Is it surprising that many young boys want to engage in physically intense games, such as football or basketball, when television and online channels are devoted to these sports, professional male athletes are paid millions of dollars, and these athletes are often treated as heroes? In contrast, young girls are not exposed to as many female athletic models, and female athletes are typically not rewarded in the same manner and to the same degree as male athletes.

THE PROBLEM WITH PARENTS AS MODELS

Of course, children are regularly exposed to their parents who also have the potential to serve as healthy models of physical activity. Interestingly, researchers have not found statistically significant associations between parents’ activity levels and that of their children. In social cognitive theory, observation of similar models is important to the development of self-efficacy or individuals’ beliefs about their ability to successfully accomplish specific tasks. However, in the case of treating parents as models for their children’s physical activity, one must account for the fact that most parents are not physically active. Parents would then serve as models of inactivity, and finding no statistically significant association between parents’ activity levels and that of their children would be a positive result.

So, why might children not model their parents’ inactivity? First, children can learn from models what not to do just as they can learn what to do. If a child views a peer who pushes to the front of the line be redirected to the back of the line, the child may learn from observing the peer that
pushing to get ahead is not a good idea. Individuals decide who is a good model, and when individuals view others as similar to them but to have more social status, they tend to pay more attention. As children get older, their interest in adults as models, especially parents, tends to decline and they focus more on peers as models.

Second, other factors also play an important role in choosing what to model. For example, children’s self-efficacy, or belief in their ability to succeed in a specific task, will influence who they perceive as a viable model. Children develop self-efficacy for physical activity through mastering physical activity and receiving positive feedback for their successes. Feeling good or receiving positive physiological feedback while engaging in physical activity also promotes positive self-efficacy as does vicariously learning from others. However, mastering tasks and activities has the strongest effect on children’s feelings of efficacy. Children with a high degree of self-efficacy for physical activity will likely aspire to model the behavior of more accomplished athletes in comparison to children with low self-efficacy. Therefore, children may not often look to their parents to model physical activity.

PARENTS’ ROLE IN SUPPORTING PHYSICAL ACTIVITY

Unlike most children, parents often understand that sedentary behavior is not healthy. They may recognize not only the health but also the social benefits of participation in organized sports and opportunities for physical activity. Thus, many parents encourage and/or pay for their children’s involvement in physical activity. Parents can communicate their encouragement for physical activity in many ways, including driving
children to practice, attending and cheering at games, as well as simply talking to their children about their physical performance. This behavior, in addition to providing children the opportunity to experience success in their participation, includes praise and feedback that can help to develop higher levels of self-efficacy.

Lochbaum and colleagues found that parents’ report of their time spent sitting did not significantly predict parents’ report of their children’s time spent engaged in physical activity; however, parent time sitting significantly and negatively predicted parents’ preference for their children’s activity.26 Parents who sat less preferred that their children engage in more physical activity. Parents’ preference for the level of their children’s activity then predicted children’s time engaged in physical activity. These modeled relationships suggest that children’s engagement in physical activity might not come from what they see their parents do but from what their parents communicate through their preferences. Although Lochbaum and colleagues26 did not study children’s beliefs or what the parents did as a result of the physical activity preferences they had for their children, the authors’ results suggest that interventions that help to change parents’ perceptions and preferences about physical activity may be important.

**SELF-EFFICACY AS MODERATOR**

Although parents can help to change the environment so that children and adolescents have more opportunities and encouragement for physical activity, children must be able to take advantage of such changes. Self-efficacy has been viewed as a moderator of the relationship between interventions and
physical activity engagement. Moderation occurs when interventions’ impact on levels of physical activity depends upon the degree of self-efficacy possessed by children. Having a belief in one’s ability to successfully engage in activity or self-efficacy for physical activity is important, as self-efficacy is associated with choosing more difficult tasks and persistence in the face of challenges. When moderation is present, interventions can offer quality opportunities for increasing physical activity but not strongly impact levels of physical activity because children do not believe in their ability to successfully engage in the activity. That is, children’s self-efficacy is low. In contrast, when interventions are of lower quality but self-efficacy for physical activity is high, performance could still be positively affected.

Suppose a school implements an intervention that involves walking and running before and after school as well as during lunch to encourage children to log enough miles to complete a marathon. Some students might think that they will have no problem rounding the school track each day to accumulate the miles. They are confident in their physical ability and might even think back to the number of times they have run around the track during physical education to support their belief in success. Their peers might offer praise by commenting that they are sure to finish the marathon first, and these children may even look forward to walking and running because they feel good doing so. In contrast, other students might view the task as monumental in light of their prior experiences with physical activity. Perhaps they have always struggled rounding the track during physical education, especially when they were required to do so under a specified time. Their peers might laugh or negatively respond to their expressed interest or initial efforts, and the thought
of running or even walking around the track may elicit feelings of nausea or nervousness. The former group of students are displaying high self-efficacy for the marathon activity whereas the latter are experiencing low self-efficacy. Despite the intervention being the same for all students, the former will likely experience positive outcomes, but the outcome for the latter students will not likely reach a beneficial level. This is how self-efficacy works to moderate physical activity outcomes.

Unfortunately, the study of self-efficacy’s role in physical activity, especially in children and adolescents, is limited; however, some evidence exists that self-efficacy is important. Social cognitive theory was used to develop an intervention specifically targeting girls’ physical activity. The LEAP or Lifestyle Education for Activity program was designed to increase adolescent girls’ physical activity by changing the school and home environments. Changes were made to physical education to ensure that girls had opportunities to master activities and teachers received training to instruct about healthy lifestyle choices. LEAP implementation, which occurred over a period of two years with more than 1,000 girls, focused on not only opportunities for girls to engage in activity but also to build their efficacy for physical activity. Dishman and colleagues found evidence of increases in both in comparison to girls in schools who did not receive LEAP and noted that the girls’ levels of self-efficacy made a difference in how well the girls benefited from the instructional changes.

When selecting interventions to improve children’s physical activity, school administrators and educators should consider not only developmental levels but also differences in how physical activity is experienced and valued by their students as
they advance through school. For example, a program that publicly compares children’s step counts, even if reported as a team, after physical education might not be motivating for all children. Playing vigorous games or sports during physical education may appeal to some students but not others, especially if students vary in their skill levels, which they always do.

Additionally, if interventions do not include specific training to support children’s self-efficacy for physical activity, educators can provide encouragement to students as they engage in new physical activity initiatives, and information about interventions can be shared with parents with directions to encourage and talk with their children about increases in physical activity. The takeaway message from this section is that finding a good intervention is not enough. The intervention must be appropriate for the students, and even when developmentally appropriate, the students themselves must believe in their ability to engage successfully in the activities. Quality interventions that have been shown to have positive effects in other groups of children will not necessarily be a quality intervention for all students. However, through careful selection and supportive implementation, educators can increase the likelihood of success.

**BEYOND FREQUENCY, DURATION, AND INTENSITY**

The search for the ideal dose-response is ever-present throughout the literature base investigating physical activity’s impact on learning outcomes and has proven elusive. The search focuses on how much physical activity at one time and across time is necessary to experience benefits as well as how often and to what degree. Both low levels and high levels of intensity have been associated with positive outcomes and
positive outcomes have been documented across interventions of various durations. Finally, better learning outcomes are associated with greater frequency of physical activity, especially if physical activity occurs more than three times a week. Even so, the ideal amount has not been determined.

The study of frequency, duration, and intensity appears important for several reasons. First, if learning outcomes are dependent upon physical activity reaching a certain threshold, then schools need to know what those thresholds are. Second, if schools have only so much time to devote to physical activity, then a precise prescription of activity would be helpful to know the least amount of investment they can make and still experience benefits. Finally, schools include diverse student populations and must know if the thresholds for physical activity in frequency, duration, and intensity are the same for all students or if modification is required for children at different age levels and across groups.

Although adjusting interventions implemented on elementary campus and those on secondary campuses makes sense, using the level of precision suggested by researchers is probably not practical for most public schools. With diversity in children’s existing fitness and skill levels, finding just the right amount of frequency, duration, and intensity to fit every student in a public school is impossible. Instead, following the CDC recommendations of 60 minutes of physical activity daily seems an appropriate goal, as consistent exposure to opportunities for physical activity regardless of intensity or duration of each activity likely matters less than simply getting children active. Thus, schools should really be questioning how to fit much of that 60 minutes into the school day as well as how to keep children moving once they head home.
Although the first thought many school administrators have is to improve the physical education curriculum or to provide more opportunities for physical activity during recess, such changes will likely not be enough. However, if educators reconsider physical activity’s relationship to learning outcomes, as argued throughout the first three chapters, then they will be more open and creative about integrating physical activity into the classroom and school day. Physical activity, according to dynamic systems theory, is a central part of learning. Physical activity offers children opportunities to practice decision-making, challenges children to interact differently with peers, and presents practice to improve perception and motor skills while at the same time moving more oxygen to the brain, changing brain chemistry, and potentially altering brain structure. The associated outcomes positively affect children’s executive function and achievement as well as mental and physical health. Why should physical activity be kept separate from the learning environment, when activity is central to learning?

Multiple interventions have been designed to bring physical activity into the classroom. These range from regular breaks which allow students to move at their desks in response to teacher-led activities, to movements that accompany specific curricular topics. For example, elementary students might skip along a number line at school when learning to add and subtract. Several books, like Eric Jenson’s Teaching with the Brain in Mind, offer practical suggestions for educators looking to incorporate more movement into their classrooms. Students may toss a ball back and forth as they discuss content or act out vocabulary words in a physical game of charades. Although these activities may not allow all children
to reach vigorous levels of intensity, such activity may cumulatively offer learning benefits.

Increasingly, teacher forums are discussing the importance of physical activity in classrooms to not only positively impact the physical health of students but to also reduce behavior problems and promote achievement. This approach may be key, as school administrators will not likely change the school schedule to accommodate large blocks of time for physical activity. Furthermore, teachers who value physical activity’s role in learning will be more likely to seek out and implement interventions. Thus, changes in the level of physical activity in classrooms will most likely occur when teachers decide that more physical activity is needed.

CONCLUSIONS
The focus of Chapter 4 was the discussion of how to identify evidence-based and appropriate physical activity interventions for school settings. Although experimental research with random selection and assignment of participants is needed to create an adequate evidence base, the amount of evidence needed is not clear. In comparison to other popular educational interventions, physical activity has been extensively studied and randomized controlled trials have indicated positive effects, albeit the effects are often small. The fidelity of intervention implementation was explored as not only a possible reason for small effect sizes but also as a challenge for moving forward. Schools require interventions that are feasible and effective. Thus, other perspectives on selecting interventions, including policy and cost benefit analyses and the CDC self-evaluation approach, were reviewed and further revealed governmental encouragement, but not financial
or legislative support, for increasing physical activity in public schools.

The final sections of Chapter 4 centered on psychological qualities of effective interventions and the need to integrate physical activity throughout the school day. Interventions that provide children with choice and promote mastery goals will be more motivating than those that emphasize performance and control. Positive feedback and enjoyment will not only help children to feel a sense of competence that can lead to continued physical activity, but also help to build self-efficacy beliefs. Self-efficacy likely serves as a moderator of physical activity interventions and learning outcomes by encouraging children to actively participate and persist in activities when they are made available, and educators should work to make physical activity available throughout the day. Educators can pair physical activity with academic tasks, teach concepts through movement, and allow short, but frequent, breaks for physical activity.

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136 Actively Moving Ahead with Interventions


Conclusions

When asked to conjure an image of school, most will think of classrooms that include children sitting at desks. The same prompt centered on physical education will trigger thoughts of a gym, and recess will yield images of a playground. These images reflect the compartmentalization of physical activity at school. School rules penalize running in the hallways and discourage fidgeting in seats. Although I agree that allowing children to run down the hall is not a good idea, the need to have such a rule in the first place should give us pause. Children need to move and, ironically, it is physical activity that promotes learning how to regulate it. When children play physical games that involve starting and stopping, taking turns, or catching at times but throwing at others, they are learning to regulate their behavior.

Certainly, children cannot spend the school day playing such games; however, maybe they would have more opportunities to do so if school administrators, educators, and parents understood the importance. Physical activity is associated with positive changes in executive function, which allow children to regulate their thinking through attention, emotional control, organization and planning, inhibition of intrusive thoughts, and shifting from one idea or task to the next. Chapter Two discussed these connections as well as explored physical activity’s relationship to achievement.
Executive function positively influences achievement; therefore, physical activity could indirectly influence achievement through executive function. However, evidence suggests that physical activity is also directly related to achievement outcomes.

Mental health was the focus of Chapter Three, which reviewed research linking physical activity to lower levels of depression and anxiety. At the same time, physical activity promotes higher self-concept, especially physical self-concept, and self-esteem. These positive outcomes, in turn, promote children’s attendance and achievement. Positive results have been documented in typical children but also in children who are more likely to struggle at school with attention and behavior. Children with ADHD respond positively to physical activity interventions.

Multiple reviews, as well as reviews of reviews, overwhelmingly show positive effects in comparison to a limited number of negative findings. Null effects are also present to suggest that although physical activity may not promote positive learning outcomes it does not harm learning either. Therefore, the overall effect of physical activity on learning outcomes is typically reported as small. Although the research base includes randomized controlled trials, which are often considered the gold standard in intervention research, researchers have expressed the need for more experimental analysis of physical activity as an educational intervention.

Longitudinal studies are needed; however, a dynamic systems theoretical perspective suggests that physical activity’s integration into children’s development may make it difficult to ever isolate its effects. Unlike other theories of development that relegate physical activity to the locomotion needed
to assist children in their environmental exploration, dynamic systems theory recognizes that movement occurs “continually during every waking minute” to influence executive function, cognition, emotion, and behavior. Children’s engagement in physical activity changes as they develop; therefore, these relationships also change over time as well as influence outcomes differently at different time points. Physical activity may benefit young children’s attention but play a more important role in inhibition as they reach school age. Furthermore, early benefits to executive function might not be evident in achievement until children encounter more challenging cognitive tasks at school. Researchers should continue the investigation of physical activity’s role in learning outcomes; however, their approach should focus on longitudinal analysis and multifacted investigation rather than experimental designs that work to isolate the exact frequency, intensity, and duration needed for the best effect.

Finally, Chapter Four discussed the importance of feasible and socially valid physical activity interventions in the school setting and challenged educators to think of ways to integrate physical activity throughout the school day. The chapter further explored the need to consider children’s motivation and how to set goals to promote children’s enjoyment and long-term interest in being physically active. Discussion of how to support children’s efficacy development for physical activity was also addressed.

The purpose of this book was to not only introduce school administrators, educators, and parents to the evidence supporting the importance of physical activity in improving learning outcomes but to also encourage them to view physical activity through a new lens. Physical activity needs to be a part of the educational conversation, and its inclusion in a
series on insights in educational psychology is a meaningful start. Educators must develop a deep intuitive understanding or insight into how physical activity is central to children’s learning before they begin integrating more physical activity into their classrooms. Increasing children’s physical activity is not about increasing physical education or recess at the expense of learning. Increasing physical activity is about moving in classrooms, taking regular breaks for movement, and encouraging more physical activity in play so that children can learn.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Achievement motivation theory</strong></td>
<td>A hierarchical framework that proposes individuals set achievement goals based on underlying personal and environmental factors which can be described by 2 x 2 dimensions: mastery approach, performance approach, performance avoidance, and mastery avoidance.</td>
</tr>
<tr>
<td><strong>Acute physical activity</strong></td>
<td>Physical activity that occurs only once.</td>
</tr>
<tr>
<td><strong>Adverse childhood experiences</strong></td>
<td>Experiences that occur before children reach the age of 18 years and result in physical and/or emotional harm.</td>
</tr>
<tr>
<td><strong>Amygdala</strong></td>
<td>An area of the brain associated with survival instincts and emotion.</td>
</tr>
<tr>
<td><strong>Applied behavior analysis</strong></td>
<td>A discipline that uses principles of learning and behavior to positively change socially significant behavior.</td>
</tr>
<tr>
<td><strong>Authentic learning</strong></td>
<td>Learning that occurs in real-world settings or contexts.</td>
</tr>
<tr>
<td><strong>Automaticity</strong></td>
<td>Occurs when knowledge is learned so well that it is recalled “automatically” with little effort.</td>
</tr>
<tr>
<td><strong>Brain-derived neurotrophic factor (BDNF)</strong></td>
<td>A neurotrophin that increases with physical activity supports synaptic activity.</td>
</tr>
<tr>
<td><strong>Chronic physical activity</strong></td>
<td>Physical activity that is repetitive.</td>
</tr>
</tbody>
</table>
Cognitive immaturity hypothesis
The hypothesis that children’s development benefits from immature thinking, such as egocentrism and limited perspective taking.

Comorbidity
Occurs when one or more disorders accompany a primary mental health disorder.

Cortisol
A hormone released in response to stress.

Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
A handbook published by the American Psychiatric Association that guides health care professionals’ diagnosis.

Dose-response effects
Variations in levels of response based on dosage. In physical activity, the frequency, duration, and intensity needed to achieve the maximum benefit.

Dynamic systems theory
A theory of development that emphasizes multicausality, self-organization, and nesting of timescales, to provide the foundation for developmental change.

Egocentrism
The limited ability to take the perspective of others.

Emotional disturbance
Federal category of special education eligibility that centers on children’s emotional and behavioral problems that adversely affect their ability to learn.

Evidence-based practices
Educational interventions and practices that meet predetermined criteria related to the quality, quantity, and effect size of the research base.

Executive function
The functions that help to execute thinking and cognition, including planning and organizing, shifting between tasks and knowledge, manipulating information.
held in working memory, inhibiting inappropriate responses, and using context to evaluate the appropriateness of responses.

**Exercise**
The planning of repetitive physical activity with the goal of improving and/or maintaining physical fitness.

**Experiment**
A study of the effect of a treatment on an outcome using random selection and assignment of participants to treatment and control groups.

**Externalizing behavior**
Visible behavior, such as disobeying rules, arguing, and physical aggression.

**Fine motor skills**
Control of movement of the hands, wrist, and fingers as well as the feet and toes.

**Gross motor skills**
Control of movement related to the large muscles, including crawling, walking, and running.

**Heart rate monitoring**
Measurement of the heart in real time using a personal monitoring device.

**High-stakes testing**
Standardized testing for which results are attached to a high-stakes outcome, such as graduation or advancing to the next grade.

**Hippocampus**
A region of the brain considered the center of emotion, memory, and the autonomic nervous system.

**Internalizing behavior**
Behaviors that are not readily visible that are typically associated with depression, anxiety, and withdrawal.

**Learning**
The acquisition of knowledge.

**Locomotion**
The ability of children to get where they need to go.
Major depressive disorder  A serious mood disorder that lasts longer than two weeks and typically affects individuals’ mood, interest in fun activities, levels of concentration, and sleeping and eating habits.

Mastery goal  A goal centered on learning a new skill, experiencing improvement, or enjoying being engaged in the activity.

Moderation  Occurs when the direct effects of one variable on another depend on levels of moderator.

Meta-analyses  A technique that involves carefully selecting studies that investigate the effect of interest, compiling statistics that represent the effect, and then calculating the total effect size across all the sampled studies.

Neurohormones  Hormones released by neuroendocrine cells, such as norepinephrine and endorphins.

Pedometer  A small device that counts an individual’s steps through detection of the motion of the wearer’s hands or hips.

Performance goal  A goal centered on outperforming others or demonstrating success to gain the attention or approval of others.

Physical activity  Any bodily movement produced by skeletal muscles that requires energy expenditure.

Physical education  Planned instruction involving sport, games, and physical activity typically occurring at school.

Preoperational children  Children, typically between the ages of two and seven, who are unable to use operations or the internalized mental
actions that form the structure of thinking.

**Quasi-experimental study**  
Investigation of an independent variable’s influence on a dependent variable without random selection and assignment of participants to groups.

**Recess**  
Breaks that most often occur outside during the school day.

**Section 504**  
Federal legislation that prohibits discrimination against individuals with disabilities.

**Sedentary behavior**  
Behavior requiring little energy expenditure, such as watching television or working at a desk.

**Self-concept**  
Individuals’ perceptions of their personal qualities, including strengths and weaknesses, which is multifaceted and hierarchical.

**Self-determination theory**  
A theory centered on the degree to which individuals view their engagement in activities and tasks as under their own volition.

**Self-esteem**  
A value, typically based on prior performance, which results in either positive or negative feelings about oneself.

**Serotonin**  
A neurotransmitter associated with sleep and perception of pain.

**Social validity**  
The degree to which educators perceive an intervention to be acceptable and important.

**Triadic reciprocal causation**  
The bidirectional interactions between individuals, their behavior, and the social environment that facilitates developmental change.
academic achievement 1–4, 6, 27, 38–40, 43, 46, 52–9, 62–4, 73, 96–7, 106–7, 116
academic performance 38–9, 45, 56, 62, 69, 78, 114, 118
achievement motivation: defined 143, 120, 122
acute physical activity: defined 143, 52, 88
ADHD 45, 47, 70–1, 74–5, 86–90, 97, 100, 114, 140; see also Attention Deficit Hyperactivity Disorder
adverse childhood experiences (ACEs): defined 143, 69–71, 76
affordances 29
amygdala: defined 143, 78
applied behavior analysis (ABA): defined 143, 110–11, 113
attendance 2, 38, 140
attention 1–2, 21–2, 31, 38, 44, 47–8, 72, 110, 120–1, 127, 139, 140–1
authentic learning: defined 143, 41
automaticity: defined 143, 41–2, 44

Bandura, A. 15
behavioral problems 96, 134
biomechanical 11, 18
biomechanics 11, 28
brain derived neurotrophic factor (BDNF): defined 143, 49, 74
brain structure 39, 50, 52, 76, 78, 99, 133
cardiovascular: and benefits 51; and disease 7; and fitness 2, 12, 49; and health 52; and hypothesis 49; and systems 28
center for Disease Control and Prevention (CDC) 23, 64, 116–18, 132, 134
chronic physical activity: defined 143, 52
cognition 1, 15, 28, 34, 39–40, 43–4, 49, 52–3, 89, 97, 116, 141; see also social cognition
cognitive function 4, 64, 86, 118
cognitive immaturity hypothesis: defined 144, 21
cognitive load 46
cognitive performance 20, 22, 24
comorbidity: defined 144, 86
correlation: and design 58–9, 83, 94, 113; and investigations 90; and research 75; and studies 83, 85, 114
cortisol: defined 144, 72, 76, 78
counseling 4, 73
curriculum 1, 12, 16, 18, 107, 117–18, 133
Index

depression 2, 71–80, 82, 84, 86, 94, 96–7, 99, 120, 140

development: and atypical 74; and attention 47; and biomechanical 18; and children’s 4, 13–16, 18, 21, 27–31, 33, 39–40, 43, 49, 71, 91, 99, 140; and cognitive 12–13, 28, 42, 92; and infants’ 28; and motor 16; and physical 27, 34, 106; and social 12, 16, 106; and theories 31, 38, 40, 140

Diagnostic and Statistical Manual of Mental Disorders (DSM-5) 74
dose-response: defined 144, 60–1, 107–8, 131
duration 9, 50–1, 60, 90, 98, 119, 131–2, 141
dynamic systems theory: defined 144, 29–31, 34, 39–40, 53, 71, 97, 99, 133, 140–1
egocentrism: defined 144, 14, 21, 124
electronic devices 1, 13, 47, 120
emotional disturbance: defined 144, 70–1, 85–6
energy expenditure 7, 9, 33, 62, 87
evidence-based: defined 144, 4, 20, 53, 106, 113, 116, 134
executive function: defined 144, 1–3, 31, 38–40, 44–7, 49–53, 57, 59, 63, 72, 88, 97, 107, 120, 133, 139, 140–1
exercise: defined 145, 32–3, 43, 79–81, 88, 120–1
experimental: and design 60, 75, 105, 113, 141; and research 134; and studies 53, 55, 57, 59, 61, 95
externalizing behavior: defined 145, 72

fidelity: of intervention implementation 84, 107, 109, 134; of teachers 107; of treatment implementation 61, 108
fine motor skills: defined 145, 12, 42
frequency 9, 51, 60, 88, 90, 95, 98, 119, 131–2, 141
functional magnetic resonance imaging 50, 61
gender 10, 11, 23, 27, 73, 90, 99–100, 125
Gibson, E. 28
gross motor skills: defined 145, 12, 42
group designs 111

heart rate monitoring: defined 145, 9
high-stakes testing: defined 145, 19–20, 42, 84; see also standardized testing
hippocampus: defined 145, 76, 78

immature thinking 13, 14, 20, 21, 53
inattention 13, 74
inhibition 2, 28, 44–5, 47, 51, 57, 63, 139, 141
intensity 9, 50–1, 55, 60, 64, 78, 88, 90, 95, 98, 118–19, 131–2, 134, 141
internalizing behavior: defined 145, 72

interventions 3, 4, 20, 24, 48, 50, 54, 58, 60–1, 70–1, 73, 77, 80, 82–90, 94–100, 105–116, 119–20, 122–3, 128–135, 140–1

locomotion: defined 145, 13, 28, 48–9, 140

longitudinal 8, 10, 53, 59, 61, 65, 76, 84, 113, 140

magnetic resonance imaging 39; see also functional magnetic resonance imaging

major depressive disorder: defined 146, 77

mastery goals: defined 146, 120–3, 135

measurement 8, 10, 20, 26, 38–9, 62

mental health 3, 6, 65, 69–76, 79, 82–3, 85–6, 90–1, 94, 96, 99–100, 107, 118, 140

meta-analyses: defined 146, 54, 75, 81, 83, 89, 93, 95

milestones 15, 27

moderate to vigorous physical activity 10, 17, 24–6, 30, 33

moderation: defined 146, 129

moderator 128, 130, 135

movement 2, 7, 10, 13, 17, 27, 29–30, 33, 49, 62, 87, 91, 133, 135, 141–2

neurohormones: defined 146, 30, 49–50, 78

neurotransmitter 70, 74

No Child Left Behind (NCLB) 19–20, 53

obesity 1, 20, 23, 43, 64, 92, 116

organized sports 1, 58, 127

pedometer: defined 146, 10, 24–6

performance goals: defined 146, 121

physical education: defined 146, 2–3, 9, 12, 16–8, 23–4, 27, 33–4, 38, 54–5, 58, 60–1, 78, 83, 91, 97–8, 109, 116–18, 120, 122–4, 129–31, 133, 139, 142

physical fitness 12, 16–17, 32, 49, 52, 119

physical maturation 13, 15–16, 18

Piaget, J. 13–14, 21

play 12–13, 18, 23, 25–6, 42–4, 142

positive psychology 91

preoperational children: defined 146, 14

quasi-experimental: defined 147; and design 58, 59, 113; and investigation 90; and study 57, 58, 114

randomized: and clinical trials 90; and controlled trials 50, 59–62, 76, 78–81, 83–5, 94–7, 105, 107–8, 111–12, 114–15, 134, 140; and designs 60

recess: defined 147, 2, 18–27, 33–4, 38, 54–5, 60, 78, 91, 97, 109, 116, 118, 120, 124–5, 133, 139, 142

reliability 9, 62

research-based 106, 113

school adjustment 20–1

sedentary behavior: defined 147, 2, 7, 8, 10, 13, 23, 54, 92, 127

self-concept: defined 147, 91–7, 99, 124, 140

self-determination theory: defined 147, 122–3
Index

self-efficacy 126–31, 135
self-esteem: defined 147, 91, 93, 94, 95, 96, 97, 113, 140
self-regulation 18, 21, 114
serotonin: defined 147, 72, 74, 76, 78
shifting 44, 51, 139
single subject designs 111–13
social cognition 14, 31, 124
social cognitive theory 15, 125–6, 130
social validity: defined 147, 108, 110–11; see also validity
socio-economic status 55, 59, 73, 79
special education 71, 86–7
sport 1, 12, 16–17, 23, 32–3, 51–2, 55, 58, 61, 78–9, 120–2, 126–7, 131
standardized testing 19, 20, 42, 54, 62, 109; see also high-stakes testing
step counts 24–6, 62, 131
suicidal ideation 2, 77, 94
television viewing 8, 10
Thelen, E. 29
validity 9, 62, 108, 110, 111; see also social validity
video games 1, 7, 9–10
vigorous physical activity 6, 10, 17, 24–6, 30
well-being 4, 12, 65, 69–70, 76, 107, 109, 122
WWC 105–7, 112, 114–15
working memory 41–7, 51, 57, 63
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