

The Brain Body Connection: Advocating Physical Activity in Our Schools

BY ELIZABETH FRANXMAN & JAESOOK L. GILBERT, PH.D.

Ben is in the fourth grade. When he practices his weekly spelling words or runs through his multiplication tables, he has to pace around the kitchen to do it. For example, he tells himself as he buzzes from the door to the stove and back again, “Four times four is sixteen. Four times five is twenty...” There are many other children who are just like Ben. Ben represents many children for whom movement facilitates their learning. Physical movement actually supports brain development. Gross motor play enhances children’s emotional well-being (Howard & McInnes, 2012). Exercise helps facilitate cognitive function (something that Ben was experiencing), and regular engagement in physical activity provides an all-around boost to motor performance (Krombholz, 2012; Tomporowski, Davis, Miller & Naglieri, 2008). For Ben and many other children just like him, exercise is not just something that is nice to have more of, but for whom exercise is *needed* in order for him to function properly. The authors in this paper will discuss how brain and body are powerfully connected and provide strategies for intentional integration of physical activities within the school day.

Physical Activity and Learning

The universal sequence of physical development in children enables specific, localized body movements and actions. This ability to move and manipulate tools provide children a means for problem-solving and exploration of their world, resulting in learning. Thus, young children learn when they are actively engaged and physically manipulating hands-on materials. For theorists such as Jean Piaget, Maria Montessori, and Howard Gardner, actions children take to problem solve and adapt their solutions is critical to children’s learning (Donaldson, 1978; Gardner, 1993; Montessori, 1966) and physical movement is a necessity for children to take action. As illustrated by Jean Piaget’s (1952) title for the first stage of cognitive

development, the sensorimotor stage, children under two years use their five senses and movement to process their world. During Piaget’s preoperational stage, preschool and early elementary school age children still need to physically manipulate concrete objects through fine and gross motor skills (small and large muscle, respectively) to make sense of new concepts and language. Gardner (2011) also noted the importance of movement in his categories of multiple intelligences. According to the Institute for Learning Styles Research (<http://www.learningstyles.org>), the kinesthetic learning style is one of the seven perceptual learning styles. A kinesthetic learner is most effective in gaining new information when he/she can move around and physically touch or manipulate objects because the process of moving helps the learner focus on the instruction. Maria Montessori (1967a) recognized the integral nature of movement for young children’s learning when she stated, “only by action can the child learn” (p. 172) and identified movement as one of her sensitive periods for early childhood age children (1967b). Since academic learning emphasizes visual and auditory learning (i.e., children are expected to watch and listen to their teachers during instruction time), children who are tactile or kinesthetic learners tend to not perform as well in school (Reiff, 1992).

Physical activity or exercise positively impacts children’s intellectual learning and executive function (Ayhan, Aki, Aral, & Kayihan, 2007; Tomporowski, Davis, Miler, & Naglieri, 2008; Wassenberg et al., 2005). Children gained in early literacy skills when they were provided with a total of 30 minutes of moderate level of physical activity (Kirk, Vizcarra, Looney, & Kirk, 2014). In conclusion, physical activity programs in schools can foster improvement in children’s cognitive learning and academic success (Sibley & Etnier, 2003; Taras, 2005; Trudeau & Shepard, 2008).

Opportunities to engage in physical activity may heighten children’s social and emotional development as children can learn about the space around them, how much space they occupy in relationship to others near them, and how to negotiate social rules within the space with others, along with language acquisition associated with movement, time, direction, and orientation (Ben-Ari, 2002; Jensen, 2005; Shoal, 2006, 2010; Tversky, 2008). When children take turns, follow rules and interact with another child or a group of children during physical play such as rough-and-tumble or soccer, they become more socially aware and develop a sense of belonging (emotionally and literally as a member of that soccer or baseball team). Children feel a sense of pride in their physical accomplishments as they begin to master various movements such as running or throwing. Children’s discovery of how to become better at jumping or throwing reinforces their physical skills and increases their self-esteem as well as their desire to share these experiences (verbally and physically) with others (Leppo & Davis, 2005). Physical activity, especially aerobic exercise such as running, also benefits children’s biological health. Vigorous exercise gets oxygen into children’s brains (Wittberg, Northrup, & Cottrell, 2012), helps with emotional stability (Basch, 2011), and controls weight gain which reduces potential negative medical conditions associated with childhood obesity (Institute of Medicine, 2011; Jago et al., 2005; Klesges & Klesges, 1995).

Finally, the studies by Krombholz (2012) and Reilly et al. (2011) indicate regular engagement in physical activities enhances motor performance (body coordination, physical fitness, and dexterity). Children’s motor skill ability helps “in establishing a child’s reputation among peers and in the development of self-esteem and therefore increasing confidence” (Krombholz, 2012, p. 929). Therefore, physical play facilitates children’s executive functioning, it enhances

literacy learning, it improves children’s emotional well-being, and it enhances motor performance.

Physical Activity and Children’s Motor Development

Gagen and Getchell (2006) describe the progression of motor development for young children as reflexive (womb to six months), rudimentary like rolling over, sitting, creeping and standing (six months to age 2), to fundamental phase (age 2 to 7 or 8) where children practice their locomotor (e.g., running) and stability movements (e.g., twist, bend and hang upside down) along with improving their ability to control objects (e.g., strike, kick and throw). Graham, Holt-Hale and Parker (2001) delineated movement possibilities during Gagen and Getchell’s (2006) fundamental phase, which the authors slightly modified as a checklist

to facilitate teachers thinking about physical activity opportunities for their children during this phase in Table 1: “Movement Possibilities For Children To Explore” below. Each movement below present a different way to execute a large muscle physical movement within the Gagen and Getchell’s (2006) fundamental phase (ages 2-7), and the checklist helps prompt for teachers to have their students engage in different movements (i.e., traveling, jumping, balancing, kicking, throwing, catching, volleying, dribbling, and striking). For example, a teacher can have their students stop every 15-20 minutes and catch a rolling ball at the first break, catch a ball from a skilled teacher (i.e., teacher) at the next break; catch a ball in a drop-catch sequence at the next break; then catch a ball by tossing to self at the last break.

These movements from above are what young children should be working on

mastering and, typically, children would acquire them through the normal course of play. In the past, children spent ten hours a day engaged in active play, mostly outside, thus these skills developed naturally. Now, however, teachers must plan to intentionally incorporate physical activity into children’s school days and daily lives. A teacher can use the checklist (**Table 1**) to keep track of opportunity for physical skills for their students by asking “What did we do yesterday? What kind of movement have we not done yet? What kind of movements have we not worked on in a while?”

Addressing Barriers to Physical Activity Integration

The first author interviewed six teachers representing preschool to third grade in the fall of 2014 and found that the biggest challenge they faced when trying to incor-

Table 1: “Movement Possibilities For Children To Explore”

PRECONTROL PROFICIENCY LEVEL (BEGINNER) CHECKLIST	
<p>Traveling</p> <ul style="list-style-type: none"> <input type="checkbox"/> in general space <input type="checkbox"/> with different locomotor movements <input type="checkbox"/> in different ways <input type="checkbox"/> with imagery <input type="checkbox"/> in rope pathways 	<p>Catching</p> <ul style="list-style-type: none"> <input type="checkbox"/> a rolling ball <input type="checkbox"/> from a skilled thrower <input type="checkbox"/> in a drop-catch sequence <input type="checkbox"/> by tossing to self
<p>Jumping</p> <ul style="list-style-type: none"> <input type="checkbox"/> and landing using different patterns <input type="checkbox"/> for distance <input type="checkbox"/> for height <input type="checkbox"/> over a swinging rope 	<p>Volleying</p> <ul style="list-style-type: none"> <input type="checkbox"/> by striking balloons in the air <input type="checkbox"/> by striking a balloon forward <input type="checkbox"/> by striking with different body parts <input type="checkbox"/> by striking lightweight objects
<p>Balancing</p> <ul style="list-style-type: none"> <input type="checkbox"/> on different bases of support <input type="checkbox"/> on a wide base of support <input type="checkbox"/> in different body shapes <input type="checkbox"/> by traveling on low gymnastic equipment <input type="checkbox"/> by traveling and stopping in balanced positions <input type="checkbox"/> on boards 	<p>Dribbling</p> <ul style="list-style-type: none"> <input type="checkbox"/> by bouncing a ball down and catching it <input type="checkbox"/> by bouncing a ball down repeatedly (dribbling) <input type="checkbox"/> continuously <input type="checkbox"/> and walking
<p>Kicking</p> <ul style="list-style-type: none"> <input type="checkbox"/> a stationary ball from a fixed position <input type="checkbox"/> a ball at large targets <input type="checkbox"/> after approaching a stationary ball <input type="checkbox"/> the ball by tapping (as in soccer) 	<p>Striking (rackets and paddles)</p> <ul style="list-style-type: none"> <input type="checkbox"/> balloons (lightweight paddle) <input type="checkbox"/> a suspended ball
<p>Throwing</p> <ul style="list-style-type: none"> <input type="checkbox"/> a yarn ball against the wall <input type="checkbox"/> at a large target 	<p>Striking (long-handled instruments)</p> <ul style="list-style-type: none"> <input type="checkbox"/> a stationary ball (hockey/golf) <input type="checkbox"/> a puck/ball towards large targets <input type="checkbox"/> a ball off a batting tee (bats) <input type="checkbox"/> a puck scooted towards a goal <input type="checkbox"/> a puck pushed while traveling slowly

porate physical activity during school day is time. Teachers felt pressure to have their students academically ready and were afraid to reduce any academic time even when all six teachers believed in the importance of physical activity opportunities for their children and positive relationship between physical activity and academic learning. The concern for academic time or lack of time was evident in some of the teachers' reasons for why physical activity integration during class would be difficult. These included having two half day classes without any time for

recess, balancing Common Core, IEPs and learning, as well as managing issues with too many students and not enough adult help. In fact, over three-quarters of school principals throughout the United States report that taking away recess from students is a common classroom management strategy in schools (Turner, Chaloupka, Chriqui, & Sandoval, 2012).

One strategy for time management is to be proactive in preventing situations that promote problematic behavior during transition periods. Teachers can look at pos-

sible ideas on the Internet. Another option might be to play air guitar to a song on the SmartBoard or a CD player if her class just seemed distracted and needing to "get their sillies out". There are many more brain breaks like these each designed to be flexible to the needs of the classroom.

Another barrier to lack of physical activity integration in school may be due to the differences in teachers' perceptions of what actually constitutes physical activity. As explained in above sections of this paper (Table 1 in particular), physical activity consists of

Table 1 (continued): "Movement Possibilities For Children To Explore"

CONTROL PROFICIENCY LEVEL (SKILLED) CHECKLIST	
<p>Traveling</p> <ul style="list-style-type: none"> <input type="checkbox"/> using different locomotor patterns (run, leap, hop, skip, gallop, slide) <input type="checkbox"/> with music <input type="checkbox"/> an obstacle course <input type="checkbox"/> in different pathways <input type="checkbox"/> at different/challenging speeds 	<p>Catching</p> <ul style="list-style-type: none"> <input type="checkbox"/> in different places on the body <input type="checkbox"/> with a scoop <input type="checkbox"/> the rebound in throwing against a wall <input type="checkbox"/> and throwing with a partner
<p>Jumping</p> <ul style="list-style-type: none"> <input type="checkbox"/> and land using basic patterns (2 feet to 1 foot, 2 feet to 2 feet) <input type="checkbox"/> a standing long jump <input type="checkbox"/> over low obstacles, hoops <input type="checkbox"/> rhythmically <input type="checkbox"/> with a self-turned rope <input type="checkbox"/> forming a body shape during flight 	<p>Volleying</p> <ul style="list-style-type: none"> <input type="checkbox"/> by striking a ball non-continuously with different body parts <input type="checkbox"/> in striking a ball upward, underhand <input type="checkbox"/> in striking a ball toward a wall, underhand <input type="checkbox"/> to the wall, overhand <input type="checkbox"/> to the wall, overhand <input type="checkbox"/> to a partner, overhand <input type="checkbox"/> by playing Keep It Up
<p>Balancing</p> <ul style="list-style-type: none"> <input type="checkbox"/> with a counterbalance <input type="checkbox"/> with a stationary balance on equipment <input type="checkbox"/> with inverted balances <input type="checkbox"/> in traveling on a large apparatus <input type="checkbox"/> on a balance sequence <input type="checkbox"/> on stilts <input type="checkbox"/> on balance boards 	<p>Dribbling</p> <ul style="list-style-type: none"> <input type="checkbox"/> all the time <input type="checkbox"/> at different heights with the body in different positions <input type="checkbox"/> in different places about the body while still <input type="checkbox"/> and traveling around obstacles
<p>Kicking</p> <ul style="list-style-type: none"> <input type="checkbox"/> on the ground <input type="checkbox"/> in the air <input type="checkbox"/> for distance <input type="checkbox"/> to a distance zone <input type="checkbox"/> to targets <input type="checkbox"/> a rolling ball to a partner while still 	<p>Striking (rackets and paddles)</p> <ul style="list-style-type: none"> <input type="checkbox"/> up and <input type="checkbox"/> against the wall <input type="checkbox"/> on both sides of the paddle <input type="checkbox"/> to wall targets <input type="checkbox"/> a ball rebounding from a wall <input type="checkbox"/> continuously
<p>Throwing</p> <ul style="list-style-type: none"> <input type="checkbox"/> overhand, underhand, or sidearm <input type="checkbox"/> overhand at a stationary target <input type="checkbox"/> underhand to hoops <input type="checkbox"/> a Frisbee <input type="checkbox"/> for distance <input type="checkbox"/> and catching with a partner 	<p>Striking (long-handled instruments)</p> <ul style="list-style-type: none"> <input type="checkbox"/> a stationary ball on the ground <input type="checkbox"/> a ball into the air <input type="checkbox"/> for distance <input type="checkbox"/> suspended objects <input type="checkbox"/> while traveling, changing paths <input type="checkbox"/> after throwing ball into the air <input type="checkbox"/> a pitched ball

vigorous exercise or large muscle play (e.g., running, jumping, climbing, swinging). Two teachers interviewed, however, thought simply taking a walk down the hall during transition to specials or just being able to move around the classroom between centers or learning stations constituted physical activity (i.e., vigorous exercise). Children move during their time at school; however, just moving in and of itself is not as effective in helping children with their self-regulation and learning (Kirk, Vizcarra, Looney, & Kirk, 2014; Wittberg, Northrup, & Cottrell, 2012). Many preschool teachers incorporate finger play when singing during large groups to help “antsy” children calm down and focus on the upcoming large group instruction. Frances Carlson (2011) modified “I’m A Little Teapot,” a music and movement standby for early care and education teachers, to “I’m a Little Popcorn” to incorporate more vigorous big body movements. In Carlson’s “I’m a Little Popcorn” version, children huddle, jump up and down like popcorn one at a time, stand still, then continue jumping. Another strategy for getting children to exercise during center or station time is using technology. In the classrooms with SmartBoards, teachers can connect the SmartBoard to their smart phones or iPad and play physical activity apps for children. One of the apps is called “FitQuest Lite” <https://itunes.apple.com/us/app/fitquest-lite/id390974713?mt=8> (JogHop, 2010) where children help a little squirrel get around by moving. When the student holds the iPad or smart phone and jogs, the squirrel jogs when the squirrel needs to jump over a rock, the student jumps. Also, the student ducks when the squirrel needs to duck. For classrooms with less technology, teachers can provide directions for children to follow instead. This would be similar to “We are going on a bear hunt” but actually moving rather than remaining seated or stationary.

The primary focus for integrating physical activity is to have all or as many of the children in the classroom participate in the exercise. Traditional movement games like “Duck Duck Goose” or “Tisket and Tasket” allow only one child or two at most to engage in large muscle movements. Typically most of the children are just sitting during “Duck Duck Goose”, and only two children (current “it” and one child that got picked by “it”) get to move at time. An adapted

version of “Duck Duck Goose” (National Association for Education of Young Children, 2010) gets everyone moving by having children stand in a circle and walk in place as well as instituting a rule that the child who is “it” chooses someone who has not yet been the goose to ensure that everyone gets to move. The chosen child (i.e., goose) can then walk, run, or skip around the circle once or twice before choosing the next goose. A more active version of the “Telephone” game (Dow, 2010) is another way to sustain a combination of large and small muscle movements. The teacher would begin by saying, “We are going to play an imitation game with our bodies. This game is similar to follow the leader only we are going to stay standing here in our circle. First, one person does a movement, then the next person copies that movement, then the person after them copies the same movement until we have gone all the way around the circle and everyone has had a turn. I will start.” Subsequently, the teacher gets the telephone chain started with something simple like crossing and uncrossing arms. The first child watches, turns to his/her neighbor, and performs the same movement. Children pass it along until it goes all the way around the circle. Once it comes back around, the first child comes up with a new movement for the rest to imitate. The teacher can repeat until everyone gets a turn to choose a movement (if time permits). With older students, all the movements can be reviewed together, in order, adding music, so it becomes a dance.

Conclusion

Physical activity appears to be undervalued in schools, and many students are not engaging in nearly enough big body play despite research connecting the brain and the body as well as the positive impact of vigorous, aerobic play on children’s ability to learn. Some causes for lack of exercise or physical play are teachers being under pressure to do many tasks with limited resources; the tendency of recess being used as a punishment; a lack of training for teachers, inappropriate or insufficient equipment to provide their students developmentally appropriate movement education (Gagen & Getchell, 2006), and other factors such as easy access to video games, television, and the internet competing for children’s time and desire. The U.S. Department of Health and Human Services (2008) recommends a

minimum of one hour of physical play for children every day. Gallahue and Ozmun (2002) state that children who experience success in physical activity will have mastered the three levels of development (i.e., initial, elementary and mature). Therefore, integration of appropriate active play and exercise is critical to children’s success in school. The current practice in schools of reducing outside time or removing recess does not foster love for gross motor movement, especially vigorous exercise. Opportunities for free play for some children are not as prevalent, and even if children do engage in free play, some children may not choose to engage in physical activity or encounter setbacks in mastering proficiency in physical movement. Physical activity is vital to proper cognitive development. Teachers, especially those working with young children, must intentionally present these experiences to their students and help them and their children overcome the attitude: gross motor “play” is a treat. The research and child development theories support the importance of the brain-body connection; divorcing the body from the brain can negatively impact children’s physical, emotional, mental, and behavioral development.

ELIZABETH FRANXMAN is a therapist for children with autism in Indianapolis, Indiana. She was previously a preschool special education teacher in both Kentucky and Indiana.

JAESOOK GILBERT is a professor of Early Childhood Education Program (Birth-Kindergarten) at Northern Kentucky University. She has been a director, classroom teacher, special education facilitator, and a consultant to children’s programs and family engagement programs within the field of early care and education.

References

- Ayhan, A.B., Aki, E., Aral, N., & Kayihan, H. (2007). Correlations of conceptual development with motor skills for a Turkish sample of kindergarten children. *Perceptual Motor Skills, 105*, 261-264.
- Basch, C. (2011). Healthier students are better learners: A missing link in school reforms to close the achievement gap. *Journal of School Health, 81*(10), 593-598. doi: 10.1111/j.1746-1561.2011.00632.x
- Ben-Ari, R. (2002). Mindful movement: Toward enhanced intergroup relations in

- heterogeneous classrooms. *Curriculum and Teaching*, 17(2), 19-36.
- Carlson, F. (2011). *Big body play: Why boisterous, vigorous, and very physical play is essential to children's development and learning*. Washington, DC: National Association for Education of Young Children.
- Donaldson, M. (1978). *Children's minds*. New York, NY: W. W. Norton & Company.
- Dow, C. B. (2010). Young children and movement: The power of creative dance. *Young Children*, 65(2), 30-35.
- Gagen, L. & Getchell, N. (2006). Using "constraints" to design developmentally appropriate movement activities for early childhood education. *Early Childhood Education Journal*, 34(3), 227-232.
- Gallahue, D. & Ozmun, J. (2002). *Understanding motor development: Infants, children, adolescents, adults*. Boston, MA: McGraw-Hill.
- Gardner, H. (2011). *Frames of mind: The theory of multiple intelligences*. New York, NY: Basic Books.
- Graham, G., Holt-Hale, S., & Parker, M. (2001). *Children moving: A reflective approach to teaching physical education* (5th ed.). Mountain View, CA: Mayfield.
- Howard, J., & McInnes, K. (2012). The impact of children's perception of an activity as play rather than not play on emotional well being. *Child: Care, Health and Development*, 39(5), 737-742. doi:10.1111/j.1365-2214.2012.01405.x
- The Institute for Learning Styles Research (ILSR). (n.d.). *Overview of the seven perceptual styles*. Retrieved from <http://www.learningstyles.org/styles/kines-thetic.html>
- Institute of Medicine (2011). *Early Childhood Obesity Prevention Policies*. Washington, DC: National Academies Press.
- Jago, R., Baranowski, T., Baranowski, J. C., Thompson, D., & Greaves, K. A. (2005). BMI from 3-6 years of age is predicted by TV viewing and physical activity, not diet. *International Journal of Obesity*, 29, 557-564.
- Jensen, E. (2005). *Teaching with the brain in mind* (2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.
- JogHop. (2010). FitQuest Lite (Version 1.1) [software]. Retrieved from <https://itunes.apple.com/us/app/fitquest-lite/id390974713?mt=8>
- Kirk, S.M., Vizcarra, C.R., Looney, E.C., & Kirk, E.P. (2014). Using physical activity to teach academic content: A study of the effects on literacy in Head Start preschoolers. *Early Childhood Education Journal*, 42, 181-189. doi:10.1007/s10643-013-0596-3
- Klesges, R.C., & Klesges, L.M. (1995). A longitudinal analysis of accelerated weight gain in preschool children. *Pediatrics*, 95(1), 126-131.
- Kromholz, H. (2012). The impact of a 20-month physical activity intervention in child care centers on motor performance and weight in overweight and healthy-weight preschool children. *Perceptual and Motor Skills: Exercise & Sport*, 115(3), 919-932. doi:10.2466/06.10.25.PMS.115.6.919-932
- Leppo, M. & Davis, D. (2005). Movement Opens Pathways to Learning. *Strategies: A Journal For Physical And Sport Educators*, 19(2-), 11-16.
- Montessori, M. (1966). *Maria Montessori: The secret of childhood* (M. J. Costelloe, Trans.). New York, NY: Fides.
- Montessori, M. (1967a). *The absorbent mind* (C. Claremont, Trans.). New York, NY: Dell. (Original work published 1949)
- Montessori, M. (1967b). *The discovery of the child* (M. J. Costelloe, Trans.). Notre Dame, IN: Fides. (Original work published 1948)
- National Association for Education of Young Children (NAEYC). (2010). Cooperative games for preschoolers. *Teaching Young Children*, 4(2), 6-7.
- Piaget, J. (1952). *The origins of intelligence in children*. New York, NY: International Universities Press.
- Reiff, J.C. (1992). *Learning styles: What research says to the teacher series*. Washington, DC: National Education Association.
- Reilly, J.J., Kelly, L., Montgomery, C., Williamson, A., Fisher, A., McColl, J.H., LoConte, R., Paton, J.Y., & Grant, S. (2011). Physical activity to prevent obesity in young children: Cluster randomized controlled trial. *British Medical Journal*, 333(7577), 1041-1043. doi:10.1136/bmj.38979.623773.55.
- Shoval, E. (2006). *Activity—enhance learning—physical movement and its contribution to academic learning*. Haifa, Israel: Ach Publication.
- Shoval, E. (2010). Using mindful movement in cooperative learning while learning about angles. *Instructional Science*, 39(4), 453-466.
- Sibley B.A. & Etnier J.L. (2003). The relationship between physical activity and cognition in children: a meta-analysis. *Pediatric Exercise Science*, 15, 243-256.
- Taras H. (2005). Physical activity and student performance at school. *Journal of School Health*, 75(6), 214-218.
- Tompsonski, P.D., Davis, C.L., Miller., P.H., & Naglieri, J.A. (2008). Exercise and children's intelligence, cognition, and academic achievement. *Educational Psychology Review*, 20(2), 111-131. doi:10.1007/s10648-007-9057-0
- Trudeau, F., & Shepard, R.J. (2008). Physical education, school physical activity, sports and academic performance. *International Journal of Behavioral Nutrition and Physical Activity* 5(10). doi: 10.1186/1479-5868-5-10. Electronic version retrieved from <http://www.ijbnpa.org/content/5/1/10>
- Turner, L, Chaloupka, F.J., & Sandoval, A. (2012). *School policies and practices for improving children's health: National elementary school survey results: School years 2006-07 through 2009-10*. (Vol. 2). Chicago, IL: Bridging the Gap Program, Health Policy Center, Institute for Health Research and Policy, University of Illinois at Chicago. Retrieved from http://www.bridgingthegapresearch.org/_asset/3t94yf/ES_2012_execsumm.pdf
- Tversky, B. (2008). Spatial cognition: Embodied and situated. In P. Robbins and M. Aydede (Eds.), *The Cambridge handbook of situated cognition* (pp. 201-216). Cambridge, MA: Cambridge University Press.
- Wassenberg, R., Feron, F.J.M., Kessels, A.G.H., Hendriksen, J.G.M., Kalff, A.C., Kroes, M., ... Vles, J.S.H. (2005). Relation between cognitive and motor performance in 5- to 6-year-old children: Results from a large-scale cross-sectional study. *Child Development*, 76(5), 1092-1103.
- Wittberg, R.A., Northrup, K.L., & Cottrell, L.A. (2012). Children's aerobic fitness and academic achievement: A longitudinal examination of students during their fifth and seventh grade years. *American Journal of Public Health*, 102(12), 2303-2307.

Copyright of Dimensions of Early Childhood is the property of Southern Early Childhood Association and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.