


Expert  
Statement  
on Physical  
Activity and  
Brain Health  
in Children  
and Youth



For better brain health,  
*all* children and youth  
should be physically  
active on a regular basis.  
In addition to physical  
health benefits, physical  
activity also improves  
cognition, brain function  
and mental health.



## BACKGROUND

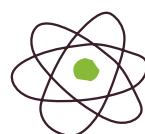
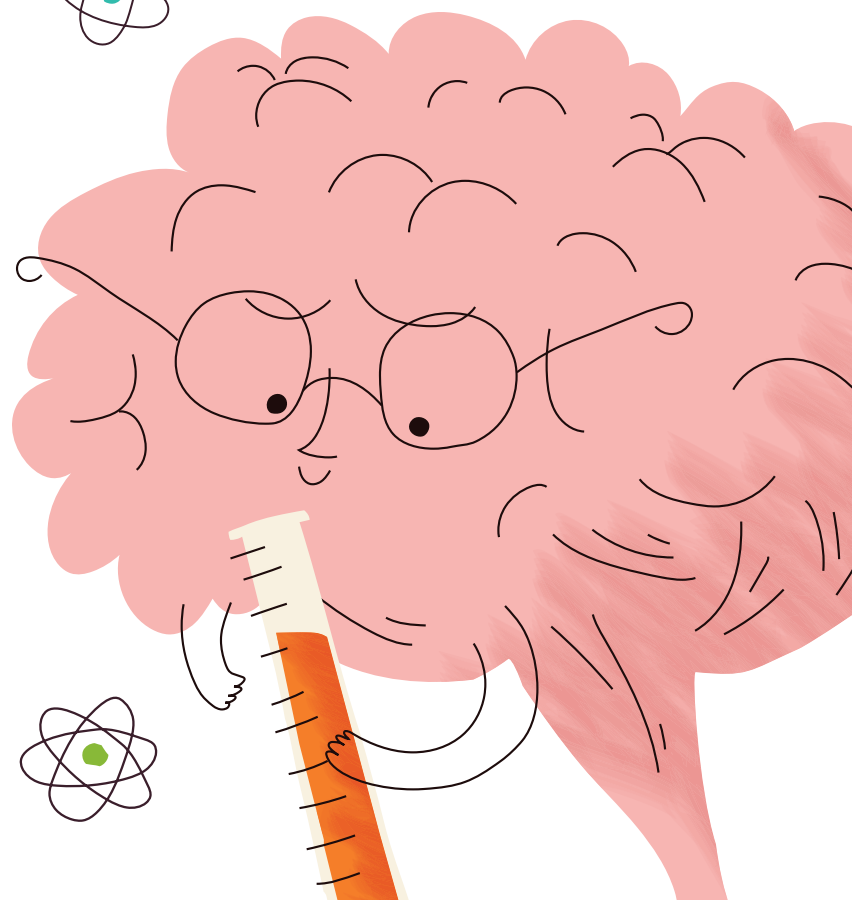
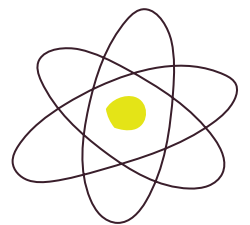
**A team of experts** in paediatric neuroscience and exercise science created this *Expert Statement*, looking at the relationship between **physical activity** and **brain health** in children and youth. The best available scientific evidence was used to inform the development of this report, and an expert advisory group provided feedback on its messaging. All members of the expert team approved this *Expert Statement*.


While the physical health benefits of childhood physical activity are well known (e.g., improved heart, bone and muscle health; prevention of type 2 diabetes),<sup>1,2,3</sup> a growing body of research has begun to examine the benefits of childhood physical activity in relation to brain health. Emerging evidence suggests that physical activity in childhood and adolescence is associated with better **cognition** (i.e., thinking and learning), **brain function** (i.e., how the brain works) and **mental health** (i.e., emotional, psychological and social well-being).

**The landscape of preventable chronic disease among children and youth is changing—and not for the better.** The prevalence of overweight and obesity,<sup>4</sup> diabetes,<sup>5</sup> and use of health services for mental illness<sup>6</sup> is high. These issues are more prominent in children and youth with **neurodevelopmental (brain-based) disabilities**,<sup>7</sup> where physical activity participation can be challenging, and social inclusion is limited<sup>8,9,10</sup> due to the initial diagnosis, inaccessible facilities, and financial constraints. Further, there is a lack of appropriate and modified equipment, as well as few professionals who are prepared or trained to promote physical activity among children and youth with brain-based disabilities.<sup>11,12,13</sup> The majority of research in this population has focused on children and youth with Down syndrome and autism spectrum disorder; however, based on the evidence, it is anticipated that all children and youth, regardless of disability type, will benefit from physical activity.

**Is inactive modern living hindering our children’s ability to develop optimally and perform well in all aspects of life?** Have we created physical and social environments that no longer promote physical activity to the point that they are negatively impacting the brain health of our children and youth? This is something that society—parents, governments, healthcare professionals, non-profits—should seriously consider.

This *Expert Statement* applies to all children and youth (under 18 years), including those with brain-based disabilities, regardless of sex, cultural background or socioeconomic status.





# How Does Physical Activity Help The Brain? The Evidence

## COGNITION, BRAIN FUNCTION AND BRAIN STRUCTURE

Physical activity is broadly beneficial to how the brain controls thoughts and behaviours, and even how the brain is structured. These brain benefits occur after short bouts of physical activity and become more apparent with regular physical activity.

### Improved Cognition and Behaviour

Participation in regular physical activity improves the ability of children and youth to meet academic expectations, with greater physical activity levels leading to better performance in subjects such as mathematics, reading/language, science and social studies.<sup>14</sup> Active children and youth are better able to pay attention<sup>15</sup> and to focus and concentrate on a given task for a longer period of time.<sup>16</sup> This also appears to be true for children and youth with attention deficit hyperactivity disorder (ADHD)<sup>17,18</sup> or autism spectrum disorder,<sup>19</sup> with even a single bout of physical activity improving attention and focus.<sup>17,20</sup> Physical activity has also been shown to be associated with better memory,<sup>21</sup> both in typically developing children and youth and in children with ADHD.<sup>22,23,24,25</sup>

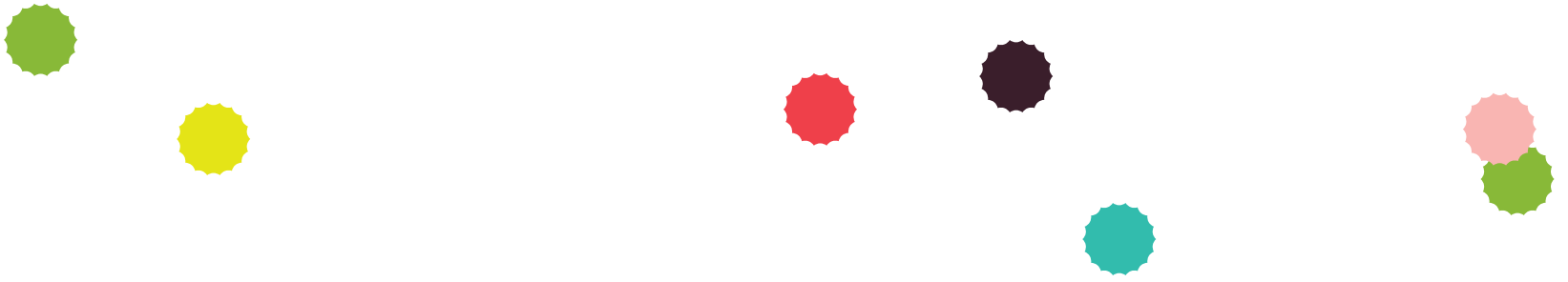
Physical activity also helps with **convergent** and **divergent thinking**,<sup>26</sup> leading to improvements in creative problem-solving and decision making.<sup>27</sup> Also, physical activity seems to beneficially impact the

cognitive aspects involved with behaviour regulation, known as **executive function**.<sup>24,28,29,30,31,32</sup> Less active children and youth seem to have more difficulty than active children and youth in performing challenging and demanding tasks,<sup>33,34,35,36,37,38</sup> and are also more likely to make more mistakes on these tasks.<sup>39</sup> It seems that children and youth who are less active or who have brain-based disabilities (such as autism spectrum disorder<sup>40</sup>) experience the greatest benefits in executive function as a result of physical activity.<sup>17,34</sup>

A primary goal for children and youth with brain-based disabilities is participation in regular physical activity. Physical activity has the potential to build the basic foundations to better communicate, socialize, increase self-control and maintain focus—leading to a healthier, higher **quality of life**.<sup>41</sup>

### Enhanced Brain Function and Structure

Research suggests that physical activity can change the structure and function of the brain. Children and youth who are physically active have larger brain volumes in the areas involved with memory and executive functions, including the hippocampus (deals with memory and emotions)<sup>42</sup> and basal ganglia (deals with routine/voluntary motor movements).<sup>43</sup> Physical activity can positively affect the amount of grey matter (i.e., the “living brain”)<sup>44</sup> as well as support better communication between grey and white matter (i.e., tissue that connects different parts of grey matter to each other).<sup>45,46,47</sup> Active children and youth are also better able to “switch on” the brain regions responsible for high-level thinking.<sup>35,48</sup> Markers of brain health appear to be sensitive to both single and repeated bouts of physical activity participation, with physical activity resulting in greater attention, motor skills and self-regulation.<sup>16,33,48,49,50,51</sup>

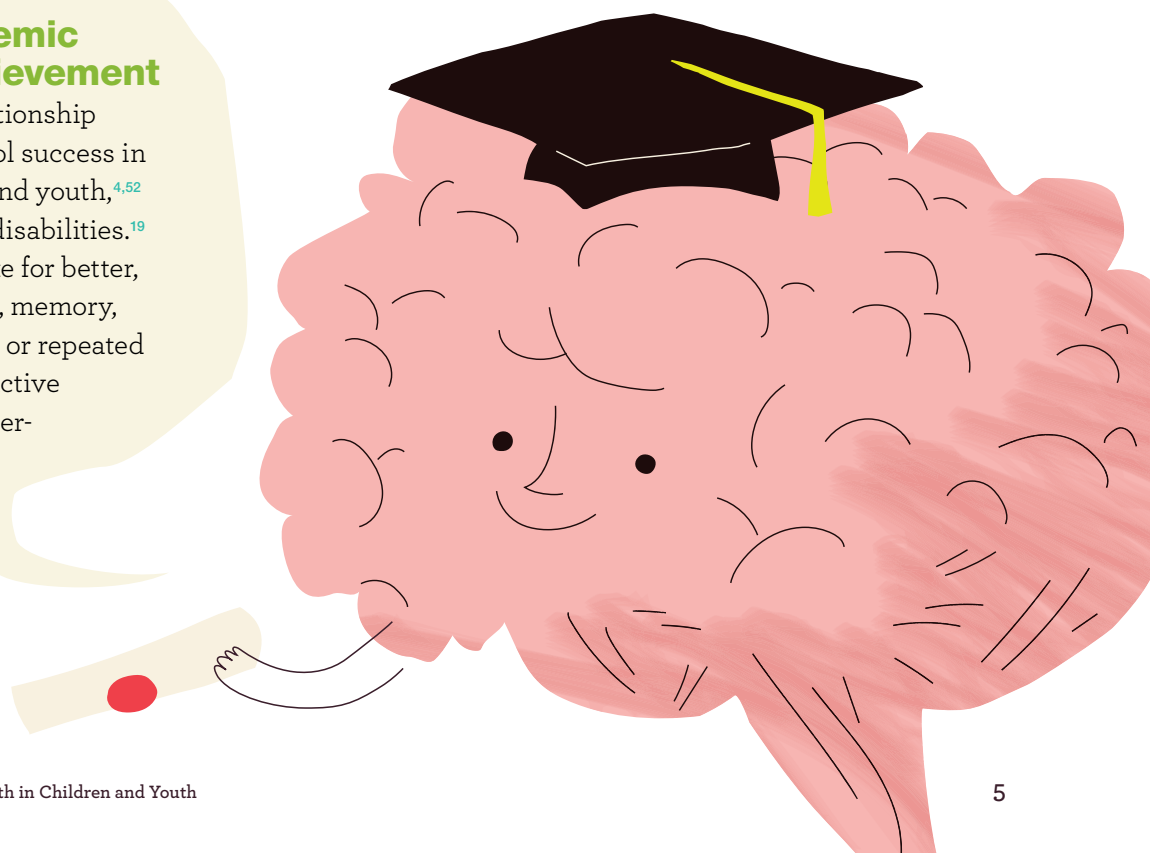


The current state of evidence highlights favourable relationships between physical activity and cognition. Many studies support a positive relationship between physical activity and brain function and structure.

Physical activity plays an important role in helping children and youth learn better, solve problems more creatively, and develop healthier brains. Children and youth who are least active or who have brain-based disabilities may have the most to gain.

### **A Tool for Academic and Scholastic Achievement**

Research suggests a positive relationship between physical activity and school success in both typically developing children and youth,<sup>4,52</sup> as well as children with brain-based disabilities.<sup>19</sup> Many of the brain processes that make for better, more efficient learners—such as focus, memory, and recall—are enhanced after single or repeated bouts of physical activity. Overall, active children and youth make for better-achieving students.<sup>53</sup>





## MENTAL HEALTH

Physical activity can help support mental health and wellness among children and youth. It can help manage and prevent negative symptoms from occurring in the first place, and also promote positive emotions and self-esteem.

### Reduction in Symptoms of Depression

Physical activity helps minimize **depressive symptoms** in children and youth.<sup>54,55,56,57,58,59,60</sup>

Perceptions of control and the social nature of physical activity are two of the most understood reasons for how physical activity contributes to reduced depressive symptoms in children and youth. Additionally, research suggests that the rush in serotonin and dopamine—**neurotransmitters** or “feel-good” brain chemicals that are released while being physically active—may also play a role in promoting feelings of happiness in children and youth.<sup>61</sup> Of note, children and youth with brain-based disabilities are at an increased risk for mental health problems,<sup>62</sup> and potentially have more to gain from participating in physical activity. Long-term participation in physical activity may help with neurotransmitter release and improve emotional health.<sup>63</sup>

While much of the published work highlights the effectiveness of physical activity in reducing depression,<sup>57,69</sup> more evidence is needed to examine the impact of physical activity in preventing depression in children and youth.

### Social Inclusion and Children with Disabilities

Children and youth with disabilities are less active.<sup>64</sup> Physical activity helps improve social integration which is a major challenge noted among children with brain-based disabilities.<sup>8,9,10,30,65,66</sup> Physical activity provides opportunities for these children to enhance their interaction and communication skills,<sup>67,68</sup> resulting in improved daily functions, health-related outcomes and quality of life.<sup>41</sup>

### Decreased Feelings of Anxiety

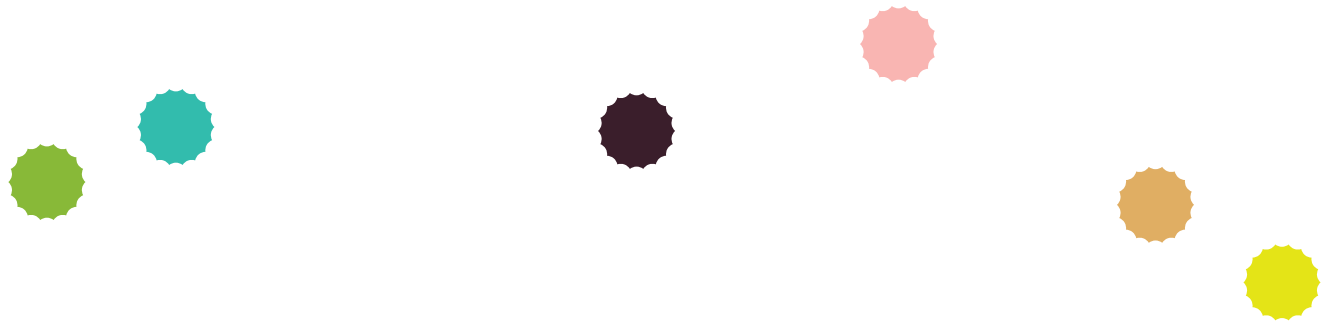
Though limited, preliminary evidence suggests that physical activity may play a role in the prevention and management of feelings of **anxiety** in children and youth,<sup>56,69</sup> including children and youth with brain-based disabilities, such as ADHD and autism spectrum disorder.<sup>70</sup> Activities such as dance and team sports have specifically been highlighted in the literature as reducing feelings of anxiety in children and youth with brain-based disabilities.<sup>19,30</sup> Physical activity can also serve as a short-term distraction from the anxious symptoms experienced by children and youth.<sup>71</sup>

### Improved Stress Response

Although the mechanisms are largely unknown, higher levels of physical activity in children and youth are associated with lower stress and reduced **stress reactivity** (i.e., the body’s reaction to stress).<sup>72,73</sup> Children and youth who have high levels of stress tend to spend more time being sedentary. In contrast, children and youth who participate in various types of physical activity seem to cope better with stress and display better resilience.<sup>73,74</sup> The teenage years are a particularly vulnerable time of development, as various regions of the brain are undergoing many changes, which are negatively affected by stress. Fortunately, physical activity may improve these stress-induced changes.<sup>75</sup>

### Enhanced Self-esteem, Self-concept and Self-perception

Children and youth who engage in regular physical activity report better perceptions of themselves, including having higher **self-esteem**.<sup>69,76,77,78,79,80,81</sup> Regular physical activity is associated with increased **self-concept** and **self-worth** in typically developing children and youth<sup>76,77,78,79,80,82</sup> and in children with brain-based disabilities.<sup>83,84,85</sup> Increased self-esteem can, in turn, promote better moods, increase life satisfaction, lessen symptoms related to anxiety and depression and shield children from the negative impacts of stress.



Collectively, the research indicates that physical activity plays a key role in preventing and reducing symptoms of depression and anxiety, in helping with stress management and in improving self-esteem in children and youth. Although initial evidence is promising, additional work is needed to clarify and confirm the relationship between physical activity and mental health in children and youth with brain-based disabilities.

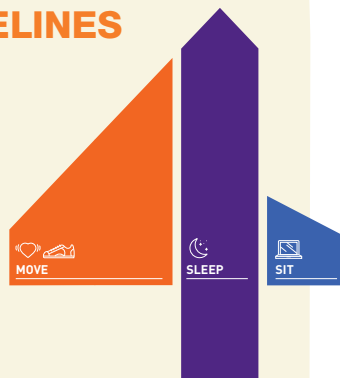
Overall, when it comes to mental health, physical activity can help children and youth who are experiencing low moods or stress, and can also provide benefits for all children and youth by helping them better manage stress and by promoting positive emotions. Physical activity supports and encourages mental and emotional wellness, with very little evidence suggesting harmful effects.

## CANADIAN 24-HOUR MOVEMENT GUIDELINES

### Physical Activity Recommendations

#### Under 1 Year

Being physically active several times daily in a variety of ways, particularly through interactive floor-based play—more is better. For those not yet mobile, this includes at least 30 minutes of tummy time spread throughout the day while awake.



#### 1–2 Years

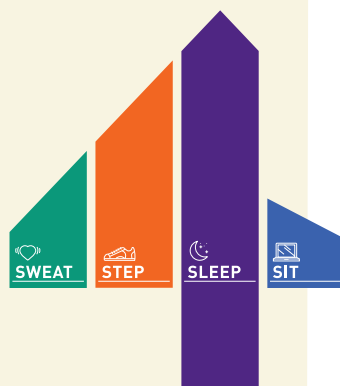
At least 180 minutes spent in a variety of physical activities at any intensity, including energetic play, spread throughout the day—more is better.

#### 3–4 Years

At least 180 minutes spent in a variety of physical activities spread throughout the day, of which at least 60 minutes is energetic play—more is better.

#### 5–17 Years

An accumulation of at least 60 minutes per day of moderate to vigorous physical activity involving a variety of aerobic activities. Vigorous physical activities, and muscle- and bone-strengthening activities, should each be incorporated at least 3 days per week.



[csepguidelines.ca](http://csepguidelines.ca)  
[BuildYourBestDay.com](http://BuildYourBestDay.com)

## Physical Activity Recommendations for Brain Health

For healthy brain development, children and youth should be encouraged to participate in at least the daily minimum of physical activity recommended by the Canadian 24-Hour Movement Guidelines.<sup>17,34,86,87</sup> However, some physical activity is better than none.

The benefits of physical activity can also build over time.<sup>88</sup> While some of the effects of physical activity are immediate, participation in regular physical activity supports long-term brain development and better mental health. In addition to immediately improving self-esteem, creativity and concentration, regular physical activity can increase **neuroplasticity** in children and youth,<sup>89</sup> creating new pathways in their brains and supporting better learning.<sup>14,17,21,44,70</sup> It also improves brain blood flow, which increases the amount of oxygen flowing to the brain, and releases **neurotrophins** and neurotransmitters that support better brain function.<sup>61,63,90,91</sup>

Children and youth with brain-based disabilities should be encouraged to engage in daily physical activity for improved brain health. With the prior approval of their healthcare provider, children and youth with brain-based disabilities should be encouraged to engage in a variety of activities at various intensities that are fun for them and appropriate for their skill-level and abilities. Supportive, accepting and modified environments, developmentally appropriate equipment, and trained coaching staff are essential.<sup>92</sup> Most importantly, promoting daily physical activity among children and youth with brain-based disabilities will help foster feelings of happiness and mental wellness,<sup>93,94,95</sup> as well as improve executive function.<sup>22,23,24,29,30,31,96,97,98,99,100</sup> Physical activity can also improve sleep, a particular benefit to children and youth with brain-based disabilities, who often experience sleep problems that can greatly hinder their quality of life.<sup>101,102</sup>





## Tips to Promote Brain Health

### Parents and Families

- Encourage children and youth to meet the daily physical activity guidelines for their age, and support them in their efforts.
- Promote age-appropriate outdoor play as a way of improving decision making, problem-solving and self-confidence.
- Become aware of sport and physical activities that are appropriate for the skill level and abilities of children and youth.
- Learn about funding opportunities for participation in sports and recreation activities by children and youth.
- Explain the child's strengths and needs to local physical activity and recreation providers so the instructors have the knowledge required to ensure an inclusive environment/experience.
- Be active as a family. This encourages physical activity, togetherness, social support and connectedness, which are all important for good mental health.
- Seek out quality programming with trained instructors that support **physical literacy**.

### Healthcare Professionals

- Recommend children and youth meet the Canadian physical activity guidelines to promote good brain health.
- Recommend and/or “prescribe” physical activity to complement the prescribed medical course of treatment for anxiety, depression and focus-related conditions (such as ADHD) among children and youth.<sup>103</sup>
- Be familiar with community-based inclusive programming (e.g., Special Olympics, ParaSport programs, disability-specific sporting organizations).
- Share information with community physical activity and recreation providers to help them better support children and youth with brain-based disabilities.
- Assist families with funding requests for specialized adapted sports equipment if required for independent participation.

### Educators

- Provide daily opportunities for physical activity and active play during school and childcare hours.
- Include active learning strategies in daily school curriculum and childcare programming.
- Interrupt long periods of sitting with active breaks.
- Educate children, youth and families that regular physical activity is good for the brain as well as the body.
- Avoid using the removal of opportunities for physical activity and outdoor play as punishment.
- Be informed about adaptations/modifications to physical education curriculum (e.g., FUNdamentals through Special Olympics, Canadian Paralympics Committee FUNdamental resource, ParaSport education and awareness opportunities) to increase inclusivity and participation.
- Personalize physical activity programs for children and youth with brain-based disabilities using a strength-based approach.

### Recreation, Coaching and Community Representatives

- Support the availability of specially trained staff and settings that facilitate physical activity for all children and youth, including those with disabilities.
- Encourage the development of inclusive and universally designed play opportunities, resources and spaces.
- Provide personalized, accepting and respectful play environments for all children and youth, including children with brain-based disabilities.
- Foster the growth and development of specialized and inclusive programming.
- Seek funding opportunities to support the development of inclusive and accessible programming for children and youth with disabilities.
- Provide programming during optimal timeslots for parents and their children and youth with disabilities.
- Create positive awareness and introductory events to introduce children and youth to available programming.

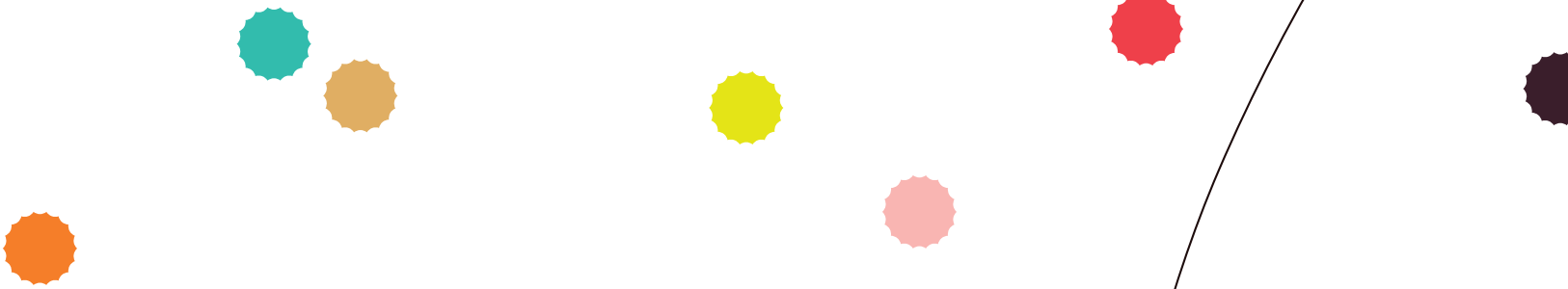
- Communicate with families and community members to ensure they are aware that children and youth with brain-based disabilities are welcome to participate in programs.
- Ensure instructors and coaches are trained in promoting physical literacy and strength-based programming.

### Government Officials

- Recognize physical activity as both a physical, cognitive and mental health promotion strategy at a population level.
- Continue to legislate and create policies that encourage and/or mandate physical activity during school and childcare hours.
- Provide additional funding and subsidies for low-income families as well as families with children and youth with disabilities, to help decrease barriers to participation.
- Recognize the need for, and provide additional funding for, specialized staff training and increased programming options/resources (e.g., community organizations, healthcare facilities).
- Provide training opportunities for educators about active learning strategies.
- Allocate additional granting opportunities to service providers to increase inclusion and accessibility.
- Provide increased funding for inclusive indoor and outdoor play spaces and equipment.
- Support awareness and education campaigns about the benefits of physical activity for child and youth brain health across all levels of abilities.

### Research Gaps and Future Directions

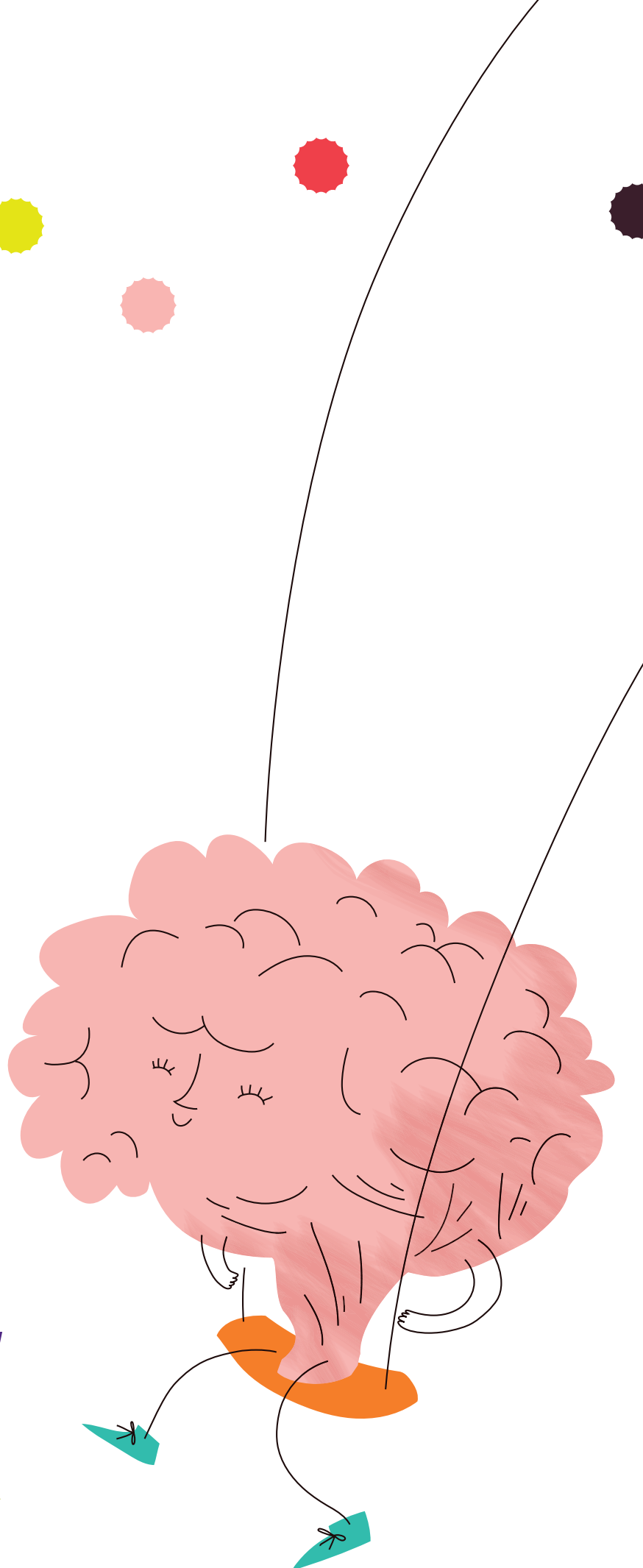
- More studies are needed to look at the long-term effects of physical activity on child and youth brain development.
- More investigations are needed to understand the amount and intensity of physical activity needed to improve and support positive brain health.
- More research examining the impact of physical activity on the mental health outcomes of children and youth with brain-based disabilities is needed.
- A more focused look at the relationship between physical activity and brain health across all disability categories is necessary.
- Further investigations into the development of physical literacy for long-term physical activity and its impact on brain health (especially cognitive function) are needed.
- Increased research is needed to understand the impact of physical activity on depression, anxiety, stress and stress reactivity.
- Additional research is needed to explore the impact of physical activity on social inclusion for children and youth with and without brain-based disabilities. This is especially important given that peer relationships become increasingly important from childhood to adolescence.<sup>104</sup>
- More information is needed on the types of physical activities (e.g., individual activities, group activities, indoor/outdoor activities, activities with therapy animals, water-based activities) that are associated with the greatest benefits in children and youth with and without brain-based disabilities.
- More research is needed to explore the impact of physical activity on brain health in younger children (under 6 years).
- More research is needed to explore how physical activity and sport experiences should be structured and delivered to more reliably promote positive mental health outcomes in children and youth.
- More collaborations are required with end/knowledge users and front-line staff to bring research to practice, and practice to research (e.g., evidence-based programs, clinician training).



## Our Expert Panel

- Dr. Mark S. Tremblay (Chair), Children’s Hospital of Eastern Ontario Research Institute
- Dr. Leigh M. Vanderloo (Co-Chair), ParticipACTION and The Hospital for Sick Children
- Dr. John Cairney, University of Toronto
- Louise Choquette, Best Start Resource Centre
- Dr. Jean-Paul Collet, Kids Brain Health Network
- Tom Davies, Special Olympics Canada
- Dr. Guy Faulkner, University of British Columbia
- Dr. Mojgan Gitimoghaddam, University of British Columbia
- Emily Glossop, Abilities Centre Ottawa
- Dr. Dan Goldowitz, Kids Brain Health Network
- Dr. Katie Gunnell, Carleton University
- Saskia Kwan, Ontario Brain Institute
- Dr. Jennifer Leo, Abilities Centre
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- Dr. Ali McManus, University of British Columbia
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## Our Partners and Funders



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# GLOSSARY OF KEY TERMS

Term	Definition / Description
<b>Anxiety</b>	Excessive worry (about school, friends, work, etc.) occurring more days than not, for at least 6 months. <sup>105</sup>
<b>Brain function</b>	How the brain works, and the processes and behaviours it controls.
<b>Cognition</b>	The mental action of acquiring knowledge and understanding (i.e., thinking and learning).
<b>Convergent Thinking</b>	The ability to solve standard problems with a single, correct answer.
<b>Depression</b>	Symptoms of depressed mood or loss of interest that have been present for at least 2 weeks (and represent a change from their usual selves). <sup>106</sup>
<b>Divergent Thinking</b>	The ability to solve problems with many possible solutions.
<b>Executive Function</b>	A set of cognitive skills that are critical for advanced development and the execution of complex tasks (e.g., planning, organization, judgment).
<b>Mental Health</b>	Emotional, psychological and social well-being.
<b>Neurodevelopmental (brain-based) Disabilities</b>	Brain-based disabilities such as problems with motor function, cognition, learning, language and/or communication. <sup>107</sup> Examples include ADHD, autism spectrum disorder, cerebral palsy, fetal alcohol syndrome and developmental coordination disorder.
<b>Neuroplasticity</b>	The brain's ability to reorganize itself by forming new neural connections. <sup>82</sup>
<b>Neurotransmitters</b>	Brain chemicals that transmit signals from one neuron to the next across synapses (point of communication between two neurons).
<b>Neurotrophins</b>	Proteins that regulate the development, maintenance and function of the brain and spinal cord.
<b>Physical Activity</b>	Any movement that uses energy and increases heart rate and breathing. <sup>108</sup>
<b>Physical Literacy</b>	The motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life. <sup>109</sup>
<b>Quality of Life</b>	A multi-dimensional concept that includes physical, mental, emotional and social functioning.
<b>Self-concept</b>	An individual's belief about themselves, including belief about their attributes, and who and what the "self" is. <sup>110</sup> Often includes self-esteem and self-worth.
<b>Self-esteem/Self-worth</b>	The extent (either positive or negative) to which an individual likes/accepts/ approves/values themselves in relation to others.
<b>Stress Reactivity</b>	The capacity or tendency to respond to a stressor (e.g., blood pressure rising in response to a stressor). <sup>111</sup>



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**PARTICIPACTION**