Spring 5-19-2018

Cross-Lateral Movement to Promote Motor Functioning and Executive Functioning in Young Adults with Autism Spectrum Disorder

Courtney Chow
Lesley University, cchow@lesley.edu

Option 1: Cross-Lateral Movement to Promote Motor Functioning and Executive Functioning in Young Adults with Autism Spectrum Disorder

Capstone Thesis

Lesley University

May 6, 2018

Courtney Chow

M.A. Clinical Mental Health Counseling: Dance/Movement Therapy

Tomoyo Kawano

Abstract

This capstone project sought to explore the relationship between dance/movement therapy and autism spectrum disorder by designing and implementing a cross-lateral movement method. Cross-lateral movement is oppositional locomotion that activates a diagonal pattern of connectivity (ex: top left to bottom right). Participants (*n* = 41) consisted of students aged 18-22, in a college-based transition program, who presented with a variety of intellectual and developmental disabilities including ASD. Participants were divided into three groups; the first two groups performed the method twice and the third group performed the method once. Outcomes observed included positive changes in participants' self-report of affect, motor function, and executive function. Further qualitative and quantitative research is needed in order to understand the effects of the cross-lateral movement method on the ASD population.

Keywords: autism spectrum disorder, motor function, executive function, dance/movement therapy, cross-lateral movement

Introduction

According to the American Psychological Association (2013), autism spectrum disorder (ASD) is characterized as persistent deficits in social communication and social interaction, as well as observed restricted, repetitive patterns of behaviour, interests, or activities. ASD affects one in 68 children in the United States alone, and has been shown to occur across all racial, ethnic, and socioeconomic groups (Center for Disease Control, 2016a). Furthermore, studies of ASD worldwide have similarly shown growing prevalence rates across Asia, Europe, and America (Elsabbagh et al., 2012).

As the prevalence of ASD continues to increase globally, ways to help these individuals succeed in life become of the utmost importance (CDC, 2016a). Non-traditional therapy styles such as the expressive arts therapies offer a creative alternative to talk therapy. The expressive arts provide specific assessments and interventions that cater to the strengths of those with ASD by emphasizing sensory integration, improvisational play, symbolic ways of thinking, and a body-based way of learning. Furthermore, art, drama, music, and dance/movement therapies can build skills to improve social communication challenges and increase an individual's ability to be adaptive and resilient.

Dance/movement therapy (DMT) is defined by the American Dance Therapy Association (2016) as the "psychotherapeutic use of movement to promote emotional, social, cognitive and physical integration of the individual." In other words, DMT is able to encourage growth in all aspects of an individual's life. DMT focuses on movement behaviour as it emerges within the therapeutic relationship (ADTA, 2016). Furthermore, clinicians who practice DMT are trained in movement observation and assessment skills, as well as movement intervention techniques (ADTA, 2016).

One of these techniques was developed by Irmgard Bartenieff; a dancer, physical therapist, and pioneer in dance/movement therapy (Levy, 2005). Bartenieff's work was founded in Laban movement analysis (LMA) as well as kinesiological concepts and principles (Levy, 2005). Using her history in dance and kinesiology, she created movement sequences that fostered corrective body alignment and developmental movement patterning. One particularly important pattern identified by Bartenieff was the cross-lateral movement connection. Cross-lateral movement is oppositional locomotion that activates a diagonal pattern of connectivity (ex: top left to bottom right). This pattern is thought to promote total psychophysical functioning by using the mind-body connection.

The mind-body connection is an embodied treatment approach that actively engages the brain via the body (Scharoun, 2014). In contrast to top-down models of processing, DMT is able to affect psychological changes through movement and dance. Homann (2010) states that DMT interventions engage "somatic, emotional, and perceptual processes simultaneously" (p. 81). This engagement is experienced by the therapist and the client through an embodied movement relationship that produces positive effects in arousal and rest, emotional regulation, implicit and explicit memory, and right/left brain integration (Homann, 2010).

The aim of the following paper was to provide evidence connecting motor difficulties and executive dysfunction in the ASD population, as well as to explore the impact of a cross-lateral movement intervention on motor function and executive function in young adults with ASD. The three major concepts are first defined: autism spectrum disorder, dance/movement therapy, and executive function. Next, existing evidence for executive dysfunction and motor impairments in children and adults with ASD is provided. Particular emphasis was placed on neurotypical motor development compared to motor development in children who were later diagnosed with ASD. Current research was then used to explore the relationship between motor skills and cognitive processes. This included an analysis of brain structures and neural processing. The literature concludes with DMT movement analysis concepts and how they can contribute to whole-brain integration in individuals with ASD.

The paper then took a deeper look at the cross-lateral movement method and the sources that informed its development. Each movement step is outlined with a detailed explanation of how to perform the movement, and for how long. Method outcomes were tracked using video recording, participant surveys, and the writer's own observations and reflections. Finally, results were analyzed and future implications for ASD treatment and dance/movement therapy are discussed.

Literature Review

Autism Spectrum Disorder

Autism spectrum disorder has come a long way from the initial observations first made by American psychiatrist Leo Kanner. In an article titled, *Autistic Disturbances of Affective Contact*, Kanner (1943) presented the cases of 11 children who exhibited unique symptomology never seen before. He described these children as having the "inability to relate themselves in the ordinary way to people and situations from the beginning of life" (p. 242). Kanner also observed various characteristics such as delayed language acquisition, literalness, sensory integration challenges, repetitive and obsessive speech or activities, and even insistence on sameness that are commonly associated with the ASD diagnosis today.

ASD is associated with other non-social characteristics as well, such as motor impairments and intellectual challenges (American Psychiatric Association, 2013; CDC, 2016b; Fournier, Hass, Naik, Lodha, & Cauraugh, 2010; Teitelbaum, Teitelbaum, Nye, Fryman, & Maurer, 1998). Kanner (1943) noticed that children presenting with autistic symptoms were slightly clumsy in gait and gross motor performance. Additionally, he recognized that children possessed a different kind of "cognitive potentiality," especially with regards to rote memory, despite being labelled as idiots, feeble minded, or imbeciles (p. 248).

Presently, ASD is an umbrella diagnosis that encompasses three previous DSM-IV diagnoses: autistic disorder, pervasive developmental disorder not otherwise specified (PDD-NOS), and Asperger syndrome (CDC, 2016b). Together, the three diagnoses can be identified by varying degrees of the characteristics listed above. In other words, it is ultimately a spectrum. No child, adolescent, or adult diagnosed with ASD will be exactly the same in their presentation, and while these individuals may struggle in traditional social or academic settings, each person possesses a uniqueness to be celebrated.

Dance/Movement Therapy

As mentioned previously, DMT offers an embodied approach to treating ASD. This approach has been shown to help individuals with difficulties related to sensory integration, social communication, and rigidity (Craig et al., 2016; Kanner, 1943). Another characteristic of ASD includes difficulties with empathy (Koch et al., 2015). Empathy is felt sensation; the ability to feel what another person is feeling. Empathy is also an important aspect for building and maintaining social relationships. As a result, DMT's embodied approach can help facilitate empathy via the mirror neuron system (Homann, 2010; Koch et al., 2015).

Mirror neurons, discovered in the early 1990s, provide neurological evidence for embodied intersubjectivity (Homann, 2010). These neurons located in the premotor cortex fire when an individual engages in a goal-directed behaviour, as well as when an individual observes others performing the same action (Homann, 2010). In DMT, mirroring is a technique that utilizes the mirror neuron system to promote self-other connection and understanding (Koch et al., 2015). Koch et al. (2015) performed a study that sought to examine the effectiveness of therapeutic mirroring with young adults with ASD. The intervention group reported improved well-being, improved body awareness, improved self-other distinction, and increased social skills. These results suggest that DMT is able to address primary developmental concerns associated with ASD and social interaction.

Other articles provide further research and support for the use of DMT and ASD. For example, Edwards (2015) explored sensory sensitivities in adults with ASD and found that these sensitivities actually impact their relationships with others. Additionally, Hartshorn et al. (2001) discovered that creative movement therapy can provide benefits for children in the classroom. These benefits included a reduction in time spent wandering, and increase in on-task behaviour, and a decrease in negative reactions to touch (Hartshorn et al., 2001).

Aside from creative movement interventions, DMT also has a foundation in movement observation and analysis. The Laban/Bartenieff Institute of Movement Studies (2018) defines Laban movement analysis (LMA) as a "method and language for describing, visualizing, interpreting, and documenting all varieties of human movement" (para. 1). Originally developed by Rudolf Laban, LMA is a interdisciplinary method that has been expanded by many others such as Lisa Ullmann, Irmgard Bartenieff, and Warren Lamb to include fields such as anatomy, kinesiology, psychology, and dance (LIMS, 2018).

Executive Function

Executive function can be defined as a set of higher cognitive processes that help to plan and modulate behaviour in order to achieve goals (O'Hearn, Asato, Ordaz, & Luna, 2008). These processes must integrate information, manage resources, and make decisions that ultimately enable individuals to live independently and be successful (Yogev-Seligmann, Hausdorff, & Giladi, 2008). While there are many facets of executive function, the main areas of focus include planning, inhibition, set-shifting, fluency, and working memory (Barnard, Muldoon, Hasan, O'Brien, & Steward, 2008).

Executive function occurs primarily in the frontal lobes of the brain, consisting of three main areas: the dorsolateral prefrontal cortex, anterior cingulate cortex, and the orbitofrontal cortex (McCalla, 2018; Yogev-Seligmann et al., 2008). The dorsolateral cortex is involved with active processing of information (McCalla, 2018). This region has been related to verbal fluency, set-shifting, planning, inhibition, working memory, organization, reasoning, problem solving, and abstract thinking (McCalla, 2018). The anterior cingulate cortex is responsible for managing emotional experiences and drives (McCalla, 2018). This is important for executive functioning because emotional regulation is necessary in order to inhibit inappropriate responses or behaviours. Lastly, the orbitofrontal cortex is involved in impulse control (McCalla, 2018). Being able to work towards a goal requires an individual to delay immediate gratification for more valued rewards in the future. Damages to the orbitofrontal cortex can result in disinhibition, impulsivity, and aggression (McCalla, 2018).

The neuroanatomy of executive functioning extends far beyond the frontal lobes. In fact full executive function requires lower level and higher level cognitive processes to work together (McCalla, 2018; O'Hearn et al., 2008). Lower level processes include attention and memory, and involves structures such as the limbic system and the cerebellum (O'Hearn et al., 2008; Yogev-Seligmann et al., 2008). A study performed by Yogev-Seligmann et al. (2008) demonstrate how simple movement tasks, such as walking, require executive function and attention. Furthermore, Fatemi et al. (2012) observed recent literature concerning the pathological role of the cerebellum in autism and discovered that cerebellar motor and cognitive deficits were indeed present in subjects with autism. Therefore, neural connections between motor areas such as the cerebellum and executive function are evident.

Another brain structure involved in executive functioning is the corpus callosum (O'Hearn et al., 2008). This integral structure connects the right and left hemispheres and thus enables the brain the communicate across and between systems. Efficient communication is supported by a process called myelination; when white matter grows around a neuron's axon to allow for quick transmission of information to other neurons (O'Hearn et al., 2008). Associated with myelination is another process called synaptic pruning. This is a process in which synaptic connections are eliminated due to lack of use or synaptic weakness (O'Hearn et al., 2008). In early childhood, billions synapses are created as infants rapidly grow, experience, and learn. However once something is learned, the brain seeks to keep strong synaptic connections while eliminating others. O'Hearn et al. (2008) discovered that individuals with autism present with an overgrowth of white matter followed by reduced white matter volumes in adolescence and adulthood. Furthermore, O'Hearn et al. also noted volumetric decreases in the corpus callosum. These findings may suggest that the myelination and synaptic pruning processes are hindered in ASD, which ultimately impacts information processing, executive function, and interhemispheric connectivity (O'Hearn et al., 2008).

Lastly, executive function cannot properly function without the nervous system, specifically the autonomic nervous system (ANS). The ANS can be conceptualized as control system with two branches: the parasympathetic and sympathetic nervous systems. It is responsible for regulating breath, heart rate, and metabolic processes, as well as reactionary responses to danger or stress (PubMed Health, 2016). Despite views that the ANS is involuntary or unconscious, recent studies have demonstrated autonomic activity actually accompanies attention, orienting, and learning (Hugdahl, 1996). Moreover, the ANS has shown to be intrinsically related to emotion and cognition (Critchley, Eccles, & Garfinkel, 2013). Starcke and Brand (2012) examined the relationship between decision making and stress in a selective review. Their results affirmed the assumption that stress affects decision making, however the outcome of stress depended on the specific task or situation. In other words, an individual's physiological state can influence their ability to make decisions. This suggests that an individual's capacity to regulate their ANS may have positive or negative outcomes on executive function (Starcke & Brand, 2012).

Autism Spectrum Disorder and Executive Functioning

The most recent estimates of intellectual ability suggest that approximately 24% of youth with ASD have an intellectual disability, 23% have low levels of cognitive functioning but not in the intellectual disability range, and the rest have at least average intellectual ability (Weiss, Baker, & Butter, 2016). In other words, almost half of all youth diagnosed with ASD also experience deficits in cognitive functioning.

While executive functions are not academic skills such as reading comprehension, it does impact an individual's ability to make decisions, plan for the future, self-regulate behaviours, adapt to new situations, and ultimately achieve personal goals (Craig et al., 2016). Consequently, executive functions play a very important role in the overall success of students in a school environment. Processes such as working memory, impulse control, mental flexibility, planning, and attention all work together in order to help students get to class on time, complete homework assignments, and engage in appropriate behaviour in classrooms (Barnard, Muldoon, Hasan, O'Brien, & Steward, 2008; Craig et al., 2016).

Hill (2004) reviewed a series of behavioural studies that focus on planning, mental flexibility, and inhibition in autism. Reports that utilized the Tower of London test suggest that children, adolescents, and adults with autism are impaired on planning tasks. Hill also found that individuals with autism exhibited difficulties with mental flexibility when compared to neurotypical controls. This was seen in perseverative behaviours or responses sometimes stereotypical of ASD, as well as presenting difficulties with adapting to change. A study that used the Wisconsin Card Sorting Test (WCST) on Taiwanese children found that children with autism scored significantly higher in number of perseverative responses and perseverative errors than controls (Shu, Lung, Tien, & Chen, 2001). This suggests that differences in mental flexibility also exist outside of Western cultures.

Connections between ASD and executive dysfunction are also made by Barnard et al. (2008). This study examined five executive function domains - planning, inhibition, set-shifting, fluency, and working memory - in 43 participants aged 18 to 45 years (Barnard et al., 2008). Subjects consisted of individuals with autism and comorbid learning disability, and learning disability with no autism. Both groups were matched for verbal IQ and performance IQ. Participants were assessed using various neuropsychological batteries such as the Tower of London test, the Mazes task, the Knock and Tap task, the modified Wisconsin Card Sorting Task, the Controlled Oral Word Association task, and the Spatial Span Task just to name of a few. Although results yielded few significant differences between groups, the authors used discriminant function analysis to discover that planning and working memory may be specific to autism (Barnard et al., 2008).

Similar findings were discovered in Craig et al.'s (2016) systematic review of executive function deficits in ASD and attention-deficit/hyperactivity disorder (ADHD). Studies indicated that there were similarities in the neurocognitive profiles of ASD and ADHD with regards to executive dysfunction in domains such as attention, working memory, and fluency. Children with ASD made more errors than neurotypical children in working memory tasks and exhibit difficulties with divided attention (Craig et al., 2016). Additionally, researchers found that children with ASD struggled with cognitive flexibility and planning. For example, individuals demonstrated a slower mean reaction time and a higher percentage of perseverative responses (Craig et al., 2016).

Consequently, the research supports the reality that children, adolescents, and adults present with difficulties in executive functioning. Common interventions that seek to improve executive functioning emphasize classroom strategies such as outlining instructions, establishing a routine, creating lists for homework and assignments, etc. (Morin, 2014). However, these accommodations reflect a narrow perspective of executive functioning processes (Diamond & Lee, 2011). Since acquiring executive skills is a developmental process, other interventions that focus on emotion, social, and physical development of the individual may provide a more holistic option (Diamond & Lee, 2011).

Autism Spectrum Disorder and Motor Functioning

A diverse set of literature supports the notion that ASD is associated with impaired or delayed motor functioning. Motor functioning is defined by motor skills such as gross motor, fine motor, postural control or stability, motor coordination, gait, arm movements, and even imitation/praxis (Bhat, Landa, & Galloway, 2011; Fournier et al., 2010; Teitelbaum et al., 1988). While it is hard to discern the exact reason why individuals with ASD develop motor challenges, studies have shown that motor disturbances are present across all age groups and diagnoses within ASD (Bhat et al., 2011; Fournier et al., 2010).

Fournier et al. (2010) sought to distinguish whether or not motor coordination deficits are a cardinal feature of ASD. Using a random effects model meta-analysis, the researchers analyzed 51 studies involving ASD, motor coordination, arm movements, gait, and postural stability. Results indicated a large, positive effect suggesting that ASD participants demonstrated greater motor impairments compared to their neurotypical peers. Furthermore, a within-subject comparison revealed that significant motor deficits were present across all diagnoses in the autism spectrum (Fournier et al., 2010). Thus this study clarifies impairments in motor functioning as an identifying feature in ASD.

A similar article was written by Bhat et al. (2011) describing motor functioning in ASD over the lifespan. A variety of literature was compiled by the researchers concerning performance on standardized movement assessments, functional activities, early gross and fine motor development, motor stereotypies, postural control, and imitation and praxis. Some key findings of this article include poor upper limb and lower limb coordination as well as poor cross-lateral coordination in children and adults. Additional research has demonstrated that in infancy, gross motor delays are evident in the acquisition of supine, prone, and sitting skills which later developed into delayed onset of walking. All of these gross motor delays result in impairments in gait and postural control, and reflect results that point to poor coordination of tasks requiring balance, agility, and speed (Bhat et al., 2011).

These findings are of particular importance to characterizing a movement profile of individuals with ASD. Early intervention is the primary form of treatment for children diagnosed with ASD, and therefore finding new markers for ASD is of high interest (Bhat et al., 2011). A study performed by Teitelbaum et al. (1988) examined video recordings of 17 children who were later diagnosed with autism. Videos of each child in infancy were donated by the parents and compared to 15 typically developing infants filmed in nurseries in Israel. Clear differences were found between movement patterns exhibited by autistic children and neurotypical children. Videos revealed disturbances in almost all of the milestones of development, including lying, righting, sitting, crawling, and walking (Teitelbaum et al.,1988).

Similar to findings in Bhat et al. (2011), Teitelbaum et al. (1988) also discovered postural asymmetries in children. For example, a child left his right arm caught underneath his chest even when engaged in reaching for objects. Disturbances specifically in relation to righting, crawling, and walking emphasize impairments in cross-lateral movement development suggesting difficulties with cross-lateral coordination develops quite young (Teitelbaum et al.,1988). As a result, interventions that emphasize cross-lateral connection may provide the necessary motor training to prevent later disturbances in coordination, postural control, and gait.

Movement, Learning, and Executive Functioning

From birth, movement provides a way to interact and learn from the environment (Piaget, 1953). Gross motor skills enable movement from place to place and fine motor skills help to manipulate objects and convey facial expressions (Leonard, 2016). Without movement, novel experiences would be hard to come by. Thus, when motor skills are delayed or absent it can significantly impact an individual's social and cognitive development.

The relationship between motor skills and cognitive processes is explored in an article by Leonard (2016). Leonard (2016) argues that motor skills affect higher level processes such as perception and cognition via an embodied process; a theoretical orientation that emphasizes the role of the body in shaping the mind. Leonard (2016) also indicates that motor development and cognitive processes are part of a dynamic system that involves not only higher level systems such as the prefrontal cortex, but also underlying mechanisms such as the cerebellum. This interaction between lower and higher level processes in the brain suggests an underlying neural pathway connecting movement and executive functioning.

Other connections between executive functioning and motor coordination have been made in a review by Yogev-Seligmann, Hausdorff, and Giladi (2007). The article counters the historical assumption that gait is an automated motor task that does not require conscious attention. In fact, Yogev-Seligmann et al. (2007) provide evidence from other studies that gait speed, balance, and mobility are correlated with executive functioning and memory (Hausdorff, Yogev, Springer, Simon, & Giladi, 2005; Holtzer, Verghese, Xue, & Lipton, 2006). Gait is also associated with another aspect of executive functioning: attention. Studies have shown that gait speed is reduced when individuals are engaged in a second task (Yogev-Seligmann et al., 2007). This is evident when someone is walking down the street and texting at the same time. Texting performance is often decreased while gait speed is reduced in order to manage dual tasking (Yogev-Seligmann et al., 2007).

Gait is of particular interest because it is a fundamental example of cross-lateral movement. Efficient gait performance requires coordination of both sides of the body in order to maintain gait speed and balance. As mentioned previously in Fournier et al. (2010), individuals with ASD display impairments in motor coordination which include gait. Accordingly, interventions that focus on improving motor coordination may also address presenting issues with executive function.

A meta-analysis by Verburgh, Königs, Scherder, and Oosterlaan (2013) reviewed the relationship between physical exercise and executive functions in preadolescent children, adolescents, and young adults. A total of 25 studies were used to calculate effect sizes for acute or chronic physical exercise on executive functioning. The study found that acute physical exercise had a moderate positive overall effect, with specific improvements in inhibition and working memory in the young adult group (Verburgh et al., 2013). These positive effects are especially useful when thinking of the success of young adults with ASD. Inhibition is thought to play a role in behaviour regulation which is essential for adapting to various settings such as school, work, etc (Verburgh et al., 2013). Both working memory and inhibition also play a role in the learning process.

With regards to chronic physical exercise, Verburgh et al. (2013) found inconsistent results. Yet the authors still provide possible mechanisms for the positive long-term effects of physical exercise on executive functioning. One of these mechanisms is the improved structural connectivity and increased white matter in the prefrontal brain areas (Verburgh et al., 2013). In other words, physical exercise creates new neural networks while also strengthening current neural connections. Since executive functioning has been shown to be primarily controlled by the prefrontal cortex, these observations suggest that chronic physical exercise can strengthen executive functioning as well.

Authors within the field of educational kinesiology and neurophysiology point to the benefits of movement programs on the attainment of cognitive and academic skills (Dennison & Dennison, 1986; Hannaford, 2007). Paul Dennison, an educator and pioneer in the field of kinesiology, developed a movement-based learning program called Brain Gym (Brain Gym International, 2016b). The core program, consisting of 26 activities for learning and moving, represent the culmination of Dennison's research regarding the interdependence of physical development, language acquisition, and academic achievement (Brain Gym International, 2016a). Some of these activities include: Lazy 8s, Hook-Ups, the Cross-Crawl, the Thinking Cap, and Brain Buttons (Hannaford, 2007).

Dennison's movement program has been established around the world and also researched within classroom and academic settings (Edu-Kinesthetics, 2017). For example, Brain Gym exercises have shown to help adults achieve their goals, improve reading comprehension in children, increase response time in college students, and enhance dynamic balance in rhythmic gymnasts (Hafez, 2017; Kariuki & Kent, 2014; Marpaung, Sareharto, Purwanti, & Hermawati, 2017; Sifft & Khalsa, 1991; Wolfsont, 2002). Furthermore, Brain Gym activities have been successful with individuals with learning and developmental disabilities, dyslexia, as well as students with speech and motor impairments (Dennison & Dennison, 1986; Hannaford, 2007).

Bartenieff Fundamentals, Cross-lateral Movement, and Whole-Brain Integration

While some Brain Gym activities focus on cross-lateral movement, such as the cross-crawl, not all movements actively cross the midline. Cross-lateral movements are of special importance to ASD due its critical contribution to the development process. As mentioned previously, children with ASD demonstrate clear movement delays in infancy compared to typically developing infants (Teitelbaum et al., 1998). These delays are observed in righting, crawling, and walking, suggesting that infants demonstrating these patterns may be at risk for developing autism later in life (Teitelbaum et al., 1998).

Bartenieff believed that cross-lateral movement expressed the most complex level of evolution, and contributed to the total integration and interconnectedness of the individual (Hackney, 1998). Similar to the Dennisons' Brain Gym curriculum, Bartenieff's patterns of total connectivity were also created from a developmental perspective. Rather than imitating movements typically seen in early years, Bartenieff drew knowledge from her physical therapy background to create a framework based on internal connections (Bartenieff & Lewis, 1980). Her patterns consist of breath, core-distal, head-tail, upper-lower, body-half, and cross-lateral (Bartenieff & Lewis, 1980).

Breath is the first internal connection and the first form of movement in a newborn baby who lacks locomotion (Bartenieff & Lewis, 1980). It can be observed in the rise and fall of the abdomen as well as the expansion and contraction of the chest. It is the life force that is constantly shaping the body. Core-distal becomes evident once the baby begins to manipulate arms and legs in space. This pattern also identifies the core as the grounding center of the body which no only provides stability, but also builds strength against gravity. The head-tail connection further develops strength in the upper body and spine. The head-tail connection is what enables babies to twist on to their bellies and eventually sit up and crawl. Upper-lower and body-half defines the stage in which the child can now make distinctions between body segments and utilize them in movement. Bartenieff defines lower unit function as postural control and locomotor activity, as well as the transport and support of body weight. In contrast the upper unit serves exploring, manipulating, and gesturing activities. Finally, the cross-lateral connection enables the child to seek out their environment through crawling or walking. Cross-lateral connection represents dynamic, three-dimensional movement in space (Bartenieff & Lewis, 1980)

Hackney (1998) writes that cross-lateral connection also facilitates right and left brain integration. Motor function is controlled by the primary motor cortex (M1) located in the frontal lobe of the brain (Schwerin, 2013). Neural impulses generated by the M1 begin in one hemisphere of the brain, then cross the corpus callosum to activate skeletal muscles on the opposite side of the body (Hannaford, 2007). Thus, motor functions are controlled in a cross-lateral fashion.

Connectivity between brain hemispheres has been referred to as maximal functioning (Hannaford, 2007). In fact, phenomenons such as creativity and innovation require technique and logic from the left hemisphere, and image and emotion from the right hemisphere to work together (Hannaford, 2007). In an interview with Walter Isaacson, he states that individuals referred to as "geniuses" engage in cross-disciplinary work. For example, Steve Jobs took an interest in neuroscience and art, whereas Leonardo da Vinci studied anatomy and engineering to inform his paintings (as cited in Schawbel, 2017). In other words, the ability to access both hemispheres allows the brain to function more efficiently (Hannaford, 2007).

In order to achieve whole-brain integration, neural pathways between the two hemispheres need to strengthened. One way to do this is by practicing cross-lateral movement patterns. Hannaford (2007) states that coordinated and balanced movements tend to promote the growth of existing nerve cells, initiate new cell growth, and ultimately increase neural connections in the brain. This is important because individuals with ASD have been shown to exhibit brain structure differences in areas such as the cerebral cortex, limbic structures, and the cerebellum (O'Hearn, Asato, Ordaz, & Luna, 2008). Additionally, brain development in individuals with ASD suggest pathologic volume enlargement thought to be due to an early overgrowth of neural and dendritic connections and a later deficiency of neural pruning (O'Hearn e al., 2008). Of specific interest are the structural differences documented in the cerebellum, which is not only crucial for motor function integration but has also been found to play a role in cognitive function (O'Hearn et al., 2008).

Other evidence supporting the need to strengthen neural pathways has to do with differences in myelination (O'Hearn et al., 2008). Myelination surrounding axonal dendrites work to make information processing fast and efficient. Furthermore volume in the corpus callosum, the structure which connects both hemispheres, has been shown to be low in individuals with ASD. As a result, brain structures involved in whole-brain integration are deficient or lacking (O'Hearn et al., 2008).

Cross-lateral movement, as described above, enables complex three-dimensional movement. Activities such as sports, dance, tai chi, and many more utilize cross-lateral movement patterns throughout their practice. An article by Diamond and Lee (2011) discuss the benefits of diverse activities such as aerobics, martial arts, and yoga on children's executive functioning. They suggest that these activities support executive functions such as attention, working, and inhibition simply through participation. Furthermore, the social aspect of activities also promote the overall emotional, social, and physical growth of young individuals (Diamond & Lee, 2011).

As ASD continues to become more prevalent in children, early interventions that seek to address presenting issues related to social and cognitive development are in high demand (CDC, 2016a). As evident from much of the research provided above, a wealth of literature exists trying to understand the developmental and neurological foundations of ASD. Yet while researchers study ASD in children, support aimed at helping adults with autism are lacking. Impairments in motor and cognitive functioning develop in childhood but persist over the lifetime. Therefore the development of an intervention that emphasizes cross-lateral movement connection can address chronic concerns with motor abilities and executive functioning. Furthermore, an integrative movement program provides an experiential environment where adults with ASD can continue to grow emotionally, socially, and physically.

Method

The intention behind the cross-lateral movement method was to promote whole body functioning and whole brain integration in young adults with ASD. It was developed from a variety of sources including Bartenieff's fundamental exercises, Brain Gym, as well as other fields such as yoga, dance, and pilates. During the beginning stages of method formation, it was tested on this writer as well as a group of DMT peers. Once completed, the cross-lateral method was introduced to the participants in a fitness class setting. In the initial sessions, it was noticed that the movement method contained some redundancies and a few awkward transitions. Thus, the movement method was altered for all subsequent sessions. Video recordings tracked changes in participant movement, whereas participant surveys tracked self-reported changes in affect, motor function, and executive function. Overall, the method was performed across three different participant groups for a total of five participant sessions.

Participants

Participants were gathered from a fitness class for young adults with diverse learning and developmental disabilities. Fitness classes operated within a college-based program of which this writer was an intern and teaching assistant. Each session was conducted with the permission of the fitness instructor.

Forty-one participants, aged 18 to 22, performed the cross-lateral movement method from three separate fitness classes. The first group consisted of 18 participants, seven of which are diagnosed with ASD. The second class consisted of 12 participants, three of which are diagnosed with ASD. The third class consisted of 11 participants with seven diagnosed with ASD. Total number of participants diagnosed with ASD was 17. Other diagnoses present in the population included: learning disabilities (*n* = 13), intellectual disabilities (*n* = 11), attention deficit hyperactivity disorders (ADHD) (*n* = 8), and others such as cerebral palsy, sensory processing disorder, genetic disorders, anxiety disorder, Tourette syndrome, fetal alcohol syndrome, Landau-Kleffner syndrome, as well as a variety of birth-related traumas. Multiple participants presented with co-morbid or multiple diagnoses.

Out of the 41 participants, 23 were female and 18 were male. Each group had varying female to male ratios. Most participants were from the New England area, with a few from other states such as Florida, Maryland, Texas, and one participant from Nassau, Bahamas. While exact socioeconomic status for each participant is unknown, middle to high socioeconomic status can be assumed due to the type of education program participants attended.

Procedure

During method formation, cross-lateral movements were chosen intentionally to reinforce movement patterns found in early development such as righting, crawling, and walking. Additionally, movement across the three planes replicated movement progression in a neurotypical child. As mentioned previously, diverse sources were consulted for method design. For example, Bartenieff's diagonal knee drop with arm circle was an exercise from her "Basic 6" (Moore, 2014, p. 54). Other examples such as the cross-lateral crunch and skip were similar to movements such as the cross crawl and skip-a-cross identified in the Brain Gym curriculum (Dennison & Dennison, 1986). The cross-lateral wring was a movement commonly found in yoga practice. Finally, the 12-step program began and ended with breath. Bartenieff believed that movement is inseparable from breath (Bartenieff & Lewis, 1980). While breath was constant throughout the movement program, starting with breath centered and focused participants prior to moving. Further details about each movement step will be discussed in the intervention section below.

Sessions took place in the same predetermined classroom. Participants were told to bring a yoga mat because the floor was hard on their hands and knees. Upon first meeting, the purpose of the method and the procedure were explained with time given for any questions or concerns. Participants were told to try their best but also to be aware of their own bodies. Participants were free to take a break at any point, or if they were experiencing pain, they were told to stop.

Next, participants were asked for permission to videotape the session. Participants who agreed to be videotaped signed consent forms (see Appendix A) which outlined the purpose for recording the session, affirmed participants' confidentiality, and explained what the video would be used for. Participants who refused to be recorded, but wanted to try the method, were removed from the view of the camera. The video was taken using the iMovie application on a laptop computer. The computer was placed on top of a tall filing cabinet in order to include as many participants in the camera view as possible. The videos were then saved and stored on the writer's computer only to be watched by the writer for academic purposes. Videos enabled the writer to track participant progress over time, as well as note any movements of particular difficulty.

Intervention

Outlined below was the initial 12-step movement program:

1) *Breath:* The individual should be laying with their back to the floor with arms and legs resting beside the body. This is initial movement should be relaxing and without stress. The individual should be instructed to take three deep breaths.

2) *Cross-Lateral Stretch:* Individuals should continue lying on their back. Instruct individuals to lift their arms above their heads such that they are resting on the floor again. If individuals are not already in an "X" position, carefully instruct individuals to open their legs and arms slightly in order to create the "X" shape on the floor. Once complete, opposite arm and opposite leg will be lifted to hover as if the person is being pulled in opposite directions. It is important for the limbs not to come too far off the ground. Hovering elicits a contraction in the abdomen, thus engaging the core muscles of each individual. Participants should be encouraged to feel the cross-lateral connection all the way across the body. This movement will be repeated at least three times on each side, alternating right and left limbs.
3) *Cross-Lateral Twist:* The movement engages the thigh-pelvis connection as well as the head-tail connection. While remaining on the floor, instructions will be given to assume a "T" like position with arms outstretched perpendicular to the trunk of the body. With a leg bent or straight, the leg is lifted up into the air and then dropped across the body's midline. This creates a twist in the spine while shoulders are meant to stay touching the floor. If shoulders come up off the ground, the individual can reduce the intensity of the twist enabling both shoulders to rest. This movement should be repeated at least three times on each side.
4) *Cross-Lateral Knee-drop with Arm Circle:* Remaining on the back, legs are brought to a bent position with heels close to the sit bones. Upper body can be kept in the "T" position with arms extended away from the torso. This ensures stability during the movement. Knees are then dropped together to one side of the body. The opposite arm is circled up

and around the body, tracing a circle on the floor. From the "T" position, the arm moves upwards above the head, down and across the body, the back up to the starting "T" position. This movement pairing is repeated at least three times on each side, with the last arm circle used as momentum to come to a seated position.

5) *Cross-Lateral Reach:* Seated firmly on the sit bones with both legs outstretched in front, legs are spread into a v-shape. The larger the v-shape, the greater the stretch. With the right hand, reach for the left foot. Hold for a few moments then switch to the other side. If flexibility is limited, focus on reaching in the cross-lateral connection rather than flexibility alone. Repeat at least three times on each side.
6) *Cross-Lateral Wring:* Staying seated, bring both legs together in front. Cross the left leg over the right leg, placing the left foot flat on the floor with the knee pointing up to the ceiling. Keeping the spine long, rotate to the torso to the left and hook the right elbow behind the left knee. Use the left hand to stabilize the position by placing it behind the torso on the floor. If able, rotate the head. This movement should be repeated at least three times on each side.
7) *Cross-Lateral Extension:* Slowly come out of the cross-lateral wring and move onto hands and knees. Place hands and knees shoulder and hip width apart. Begin to lift the right arm and left leg simultaneously to create one long straight line parallel to the ground. Both arm and leg should be lifted no higher than 90 degrees. Refrain from breaking the spine by engaging the core muscles. Repeat movement at least five times on each side. As movements from horizontal plane into the vertical and sagittal planes, movements become faster in pace and therefore repetitions are also increased.

8) *Cross-Lateral Crunch:* Once cross-lateral extensions are completed, come back to a stationary position on hands and knees and come up to standing. Similarly to the extensions, the right elbow is tapped onto the left knee. This means the left knee is lifted using the thigh-pelvis connection up to meet the right elbow. Both elbow and knee meet in front of the individual's stomach. The same is repeated on the opposite side. Movement is repeated at least five times on each side.
9) *Cross-Lateral Punch:* From standing position, extend the right arm straight up into the air. Fist can be clenched like a superman pose. At the same time, the left knee is lifted the same way as in the cross-lateral extensions. When in motion, the movement looks similar to a march with arms extending upwards. The movement should be repeated at least five times on each side.
10) *Cross-Lateral Jump:* Individuals are instructed to come to a stand still. The cross-lateral jump requires the person to jump while simultaneously twisting the upper and lower body in opposite directions. Similarly to doing a standing twist, this movement is more dynamic and requires the coordination of the body-half connection. Movement should be repeated at five times on each side.
11) *Cross-Lateral Skip:* The cross-lateral skip initiates travelling out into space. With emphasis on the cross-lateral connection, individuals are instructed to begin skipping around the room. The arm-scapula connection, thigh-pelvis, and heel-coccyx connections should all be active during this movement. The swinging of the arms should move in opposition to the movement of the legs. Focus on creating a natural rhythm with skips

that can be as large or as small as the person desires. After 20-30 seconds, movers can be instructed to begin to slow down and assume a comfortable walk.

12) *Cross-Lateral Walk:* The final movement in the 12-step sequence is the "simple walk" (Hackney, 1998). This movement allows for the heart to slow down and for individuals to catch their breath. Movers should take notice of the small cross-lateral movements within their walking; a normal, everyday functional movement. This is also a good time for the observer to take notice of gait. Laban movement analysis and the effort factors are a good tool for this. After 20-30 seconds, movers will be instructed to come to a stopping place to rest.

Instruments of Pre/Posttest

Participants were given a survey to track their experiences before and after the method. The survey was printed on a piece of paper; identical front and back (see Appendix B). Participants were then instructed to circle either "pre" or "post," and to fill out three questions using their own personal responses or using the word bank provided. Words consisted of pairs of antonyms. Questions were: "I am ____," "I feel ____," and "My body is _____."

Results

Implementing the cross-lateral movement method was an evolving process which ultimately impacted the results of this paper. Results were divided into two main categories: video observations and participant survey responses. In the video recordings, it was observed that participants appeared to have difficulty performing the same movements across all groups. Movements that involved a rotation of the spine presented as more difficult to some students than others. Additionally, movements that were performed without visual aid were harder than movements where participants could see themselves. Responses from participant surveys demonstrated a wide range of experiences including positive and negative changes in affect, motor function, and executive function. Some participants reported no change, while other responses suggested subtle changes that did not clearly fit into a positive or negative category. The results section concludes with an updated version of the cross-lateral movement method after adjustments made from initial sessions.

Video Observations

All groups entered the space with pretty high energy due to having come from the fitness center. It was noticed that starting the movement program with breath was beneficial because it helped participants calm down and focus their attention on the movement tasks.

For the first session, across all groups, the cross-lateral “X” was observed to be difficult for all participants to grasp. Multiple students in each group lifted their limbs up to a 90 degree angle, as if it touch their hand to their leg. With adjustments, all students were able to perform this movement with accuracy. In second sessions, cues such as lifting limbs “slightly” off the ground, as well as encouraging participants to imagine being a starfish, proved to help reduce the number errors performed.

In all groups and all sessions, participants experienced difficulty with the cross-lateral leg drop. Instructions were to bend at the knee, keeping the foot planted on the floor. Instead, participants tended to lift the leg with a bent knee, then place the foot on the outside of the other leg. This hindered their ability to drop the knee across the body and achieve a twist up their spine. Furthermore, many participants tended to curl up onto their sides into a fetal position rather keeping their shoulders on the ground. With assistance, almost all participants were able to perform this movement accurately with varying degrees of spinal flexibility. In later sessions, clearer instructions were provided along with instructions to keep shoulders grounded.

The cross-lateral wring was observed to be complex for participants. Few participants were familiar with this yoga-based movement due to the fact that they have taken yoga before. However, other participants clearly struggled with the oppositional twist between upper and lower body. For example, the leg crossed over the other was easily done. However, hooking the opposite elbow to the knee and twisting the spine provoked confusion. Often times, participants would use the same arm as leg, activating the body-half connection rather than the cross-lateral connection. Similar to previous movements, assistance and manual adjustments helped participants to complete the movement accurately, as well as evoking images such as the "pretzel."

Next, the cross-lateral stretch appeared to be quite easy for participants. In contrast, the cross-lateral extension was challenging. At first, many students lifted the same leg and arm indicating a clear preference for iposilateral movement. As participants continued to repeat the movement with verbal and visual cues by this writer, almost all participants were able to perform the cross-lateral extension. The primary difficulty observed was balance; which not only required participants to lift limbs simultaneously but to also engage their core muscles. In later sessions, cues that helped performance included suggestions to engage their abdominals and to focus on a single spot. A few participants were unable to complete the movement because of reported pain in their knees. While all participants were told to bring yoga mats with them, many forgot and were performing the movement on the hard classroom floor.

It was noticed that only two students across all groups and sessions struggled with the cross-lateral crunch. This indicated that it was a simple movement for the group. Only minor challenges were observed in two students who walked with their arms held during the cross-lateral walk. Some participants found the cross-lateral skip too infantilizing so they refrained from participating in this step. For the most part, all students performed these three movements with ease. Unfortunately, the cross-lateral punch demonstrated greater problems. Many students were observed lifting the same arm and leg up into the air, again suggesting a dominance for body-half connections. Yet, all students were able to accurately perform the punch with assistance. Cues such as, “imagine you are marching,” helped with performance dramatically.

The last movement that was observed to be challenging was the cross-lateral jump. A total of seven participants, across all groups and all sessions, were able to perform this movement accurately. A single participant was able to perform the movement after some coaching. All other participants struggled, and while coaching was helpful, these individuals failed to perform the movement properly before the session ended. Challenges were noticed in isolating the upper-lower connections, as the twist requires the upper body to move in the opposite direction of the lower body. Participants were seen jumping from side to side with no rotation in their trunk. Legs would sometimes cross each other rather than moving in parallel. Imagery such as “moguls” or “skiing” helped some individuals, but not others. This difficulty was surprising at first, however can be related to previous challenges in movements like the cross-lateral leg drop.

Overall, the video results indicated that a learning curve did exist with regards to the movement method, however participants did improve over time. Furthermore, the use of imagery to describe movements, as well as a predetermined script, notably changed participant performance. A clear improvement was observed between session 1 and session 2. This was evident in the way participants' moved with greater ease and efficiency. This writer also noticed that some participants who struggled initially were able to access greater cross-lateral connection the second time around.

Other interesting observations were made regarding which movements were more difficult and which movements were easier. As mentioned previously, movements that required a twisting of the spine were particularly challenging for the participants. These movements included the cross-lateral leg drop, the cross-lateral wring, as well as the cross-lateral jump. These challenges could be related to early motor impairments in the righting reflex, which has been found to be atypical in infants later diagnosed with autism (Teitelbaum et al., 1988). Additionally, movements that required participants to move using the mind's eye were more difficult than movements where participants could see what they were doing. For example, the cross-lateral "X" and the cross-lateral leg drop take place on the participants' backs, and therefore they cannot see the movement of their legs. One participants stated, "It's hard for me to do it because I can't see." These observations may suggest that participants lack a sense of body awareness; to know where their limbs are in space without actually seeing them. Finally, movements where opposite limbs did not touch were more difficult than movement where limbs did touch. For example, the cross-lateral stretch and the cross-lateral crunch were both movements that participants performed with ease. However, movements such as the cross-lateral extension and the cross-lateral punch provided no point of physical connection. Thus, these movements were more difficult for participants to coordinate.

Survey Responses

Surveys completed by participants before and after the method were organized via an excel worksheet. The question, “I am___,” was assigned to denote executive functioning. The question, “I feel___,” was assigned to denote participant affect. The question, “My body is___,” was assigned to indicate changes participants noticed in their bodies (motor function). Responses were categorized into positive or negative words, and then assessed for a positive, negative, or neutral change over time. Responses categorized into “other” include participants who were either absent during the session or failed to complete the pre/post survey (see Appendix D, E, F).

Some participant responses were categorized as a nuanced change. This was decided because many participants who demonstrated a neutral change, actually contributed answers that suggested a positive change in executive functioning, affect, or motor functioning. For example one participant wrote, “I am calm,” in their pre survey and, “I am awake,” in their post survey. Since the words calm and awake, separately, are positive words describing executing function, the response was categorized as a neutral change. However looking at the response, it is clear that this could also be a positive change for this individual. Therefore in the process of making data analysis easier, some more nuanced responses were lost. While these nuanced changes were not included in the final results, they have been highlighted in each table so that readers can identify them.

Group 1. Out of 16 participants, only 14 attended the first session. Results indicated that three participants experienced a positive change in executive function, five participants experienced a positive change in affect, and three participants experienced a positive change in relation to their body. In contrast, one student experienced a negative change in executive function, one participant experienced a negative in affect, and two participants experienced a negative change in their bodies.

In the second session, again only 14 participants performed the movement method due to two participants being absent. This time four participants experienced a positive change in executive function, five students experienced a positive change in affect, and three students experienced a positive change in their bodies. In contrast, one student experienced a negative change in executive function, two participants experienced a negative change in affect, and one participant experienced a negative change in relation in motor function. In both sessions, the majority of students experienced no change. For a more detailed look at data analysis and results, see Appendix D.

Group 2. Out of 14 participants in the first session, only one student was absent. Results indicated that two participants experienced a positive change in executive function, four experienced a positive change in affect, and four participants experienced a positive change related to motor function. No participants in this session experienced a negative change.

In the second session, all participants performed the movement method. This time two participants experienced positive changes in executive function, with three participants experiencing positive changes in affect and in motor function. Negative changes occurred in the second session, with one participant reporting a negative change in executive function and three students reporting a negative change in affect. Across both sessions, the majority of participants experienced no change. For a more detailed look at data analysis and results, see Appendix E.

Group 3. The third group consisted of 10 participants, however only nine performed the movement method. Results indicated that only one student experienced a positive change in their body, whereas two participants reported negative changes in executive function. One participant reported a negative change in affect and two participants reported negative changes in relation to their bodies. The third group only performed the movement method once. For a more detailed look at data analysis and results, see Appendix F.

Updated Intervention

A few changes were made to the names and the sequencing of the cross-lateral movement method. First, it was noticed that the cross-lateral twist and the cross-lateral knee drop with arm circle were redundant. Both movements required participants to move the lower limbs across the midline and rotate the spine. This writer decided to remove the cross-lateral knee drop with arm circle and change the name of the cross-lateral twist to the cross-lateral leg drop.

Second, it was observed that participants began to naturally walk after completing the cross-lateral punch. Therefore, the sequence of the movement program was changed to accommodate a more natural progression of walking, skipping, then jumping.

Third, this writer felt it was important to close the cross-lateral movement method the same way it started. Since a previous movement step was removed, it allowed room for breath to be the final step. Names of each step were also altered to better reflect the movement quality. The cross-lateral stretch was changed to the cross-lateral "x." The cross-lateral twist was changed to the cross-lateral leg drop. Finally, the cross-lateral reach was re-named to the cross-lateral stretch. The updated intervention is listed below:

1) *Breath*: Expansion and contraction of the chest.

2) *Cross-Lateral "X"*: Laying down on the floor, with arms and legs spread slightly apart like a starfish.
3) *Cross-Lateral Leg Drop*: Bending one knee and dropping it across the body's midline. Shoulders should be kept on the ground while the spine rotates.
4) *Cross-Lateral Stretch*: The opposite hand reaches for the opposite foot while seated firmly on the sitz bones.
5) *Cross-Lateral Wring*: Right elbow hooks behind a bent left knee in order to create an elongated, seated twist of the spine.
6) *Cross-Lateral Extension*: Opposite arm and leg are lifted simultaneously from a hands and knees position to create one horizontal line parallel to the floor.
7) *Cross-Lateral Crunch*: Elbow touches the opposite knee in the front of the person's abdomen.
8) *Cross-Lateral Punch*: Opposite arm and opposite leg lift up simultaneously in an exaggerated march-like movement.
9) *Cross-Lateral Walk*: Bring attention to the natural cross-lateral connection between arms and legs while walking.
10) *Cross-Lateral Skip/Run*: Just like the previous movement, but faster paced.
11) *Cross-Lateral Jump*: Upper and lower body move in separate directions to create a jumping twist.
12) *Breath*: Movement intervention finishes and ends with breath.

Discussion

From video observations, it was noticed right away that the size of the room was small for the number of participants. This influenced participants' ability to fully extend their limbs in space which is required for many of the movements. When engaging in the cross-lateral skip/run, participants mostly walked fast rather than actually running. The small room size also exacerbated feelings of claustrophobia, which resulted in some participants stopping midway through the movement method.

Another observation made after the initial sessions was that communicating the movements to participants was quite difficult. Transitions were awkward and participants finished movements at different times. A script was created in order to convey clear and precise instructions, while also ensuring consistency over multiple trails (see Appendix C).

Social factors also played a role participant results. A lot of time was spent controlling or quieting participants. Furthermore, certain individuals required more attention than others and it was hard for this writer to spend an equal amount of time monitoring each participant. Participant arguments negatively influenced participation as well as survey results. For example in group 3, one participant stormed out of the room because a few others would not settle down and be quiet. Since the participant population present with a variety of developmental and intellectual disabilities, many students struggle with sensory processing and can be easily startled or overwhelmed. For this particular individual, the amount of noise was too much for him to stay and participate. In the same group, it was clear that tensions were high between members. One participant's behaviour was quite loud and boisterous, and his affect was hyper. Another participant became frustrated with this individual to the point where she sat down on the floor, cross-legged, with her arms folded, and refused to participate further. These experiences can be easily noticed in the survey results with responses such as aggravated, hyper, tense, and silly (see Appendix F). As a result, the social and emotional environment influenced what participants wrote down as their post-reponses; focusing on how they were feeling in the moment rather than on how the movement method made them feel.

Group 3 was unable to perform the movement method twice. This writer observed noticeable improvement between session 1 and session 2 for the earlier groups. Unfortunately various unforeseen factors, including time, did not allow for a second session with group 3. A second session would have been a more accurate representation of the group's experience, especially due to the social dynamics described above.

Upon analyzing survey responses, this writer became aware of flaws in the data collection instrument. The three questions (I am, I feel, and My body is) were open ended, and thus made responses highly variable. The word bank was provided with words the writer felt related to affect, motor function, and executive function. However due to the nature of the questions, the words could be used for multiple answers. For example, I am in control relates to executive function but my body is in control changes the meaning to be motor-related.

Other observations were that the "I am__" statement was too vague. Since it's intended purpose was to track changes associated with the mind, a better leading statement would have been, "My mind is___." If repeated in the future, changes would be tracked using a likert scale with specific words correlating to specific categories of affect, motor function, and executive function. For an example see Appendix G.

In order to manage all the responses produced by the participant survey, data was analyzed using a simple positive-negative paradigm. As mentioned previously, responses for each individual question were analyzed for either positive, negative, or neutral changes. While this strategy for data analysis was simplest, it failed to capture more nuanced changes experienced by participants. For example, one participant's answered, "My body is in control," in the pre survey and then, "My body is balanced," in the post survey. The words "in control" and "balanced" were both assigned to be positive words, and therefore this participant was deemed to exhibit neutral change. In reality, the two words mean different things, suggesting the participant may have actually experienced a positive change. Yet due to nature of the data analysis, these types of responses were not recorded.

One major limitation was the lack of access to standardized tests for assessing executive function. Since this writer only had access to qualitative methods of data collection and analysis, results were based on the subjective experiences of the participants. However, many quantitative assessments exist for evaluating executive function. One of these assessments is the Delis-Kaplan Executive Function System (D-KEFS) which is a neuropsychological test used to measure a variety of high-level cognitive functions in children and adults (Delis, Kaplan, & Kramer, 2001). This test has been nationally standardized and consists of 9 tests that can either be given separately or in combination with each other (Delis, Kaplan, & Kramer, 2001). If this method was to be performed in the future, access to assessments such as the D-KEFS would provide a more concrete way of tracking changes in executive function across participants.

Another limitation was the size of each group. The smallest group size was 10 and the largest was 17. Therefore, the large participant-to-facilitator ratio made it hard to monitor the movements of every individual. Some may have been performing the movements incorrectly without being corrected, and while assistance was provided by the fitness instructor, his primary role was maintaining classroom composure. It was noted that when the writer performed the movement directly in front of the participant, the participant was more likely to exert effort as well as perform the movement correctly. This phenomenon may be related to the mirror neuron system and speaks to the benefit of relational movement over isolated exercise (McCleery, Elliott, Sampanis, & Stefanidou, 2013). If group size would have been smaller, this writer may have been able to interact individually with each person and produce more positive results.

Conclusions and Future Study

This paper sought to discover whether a cross-lateral movement method could not only improve motor function, but also executive function in young adults with ASD. The literature outlined above supports the connection between motor development and cognitive development, suggesting that cognitive function can be affected through movement. The literature also suggests that engaging in cross-lateral movement activates both hemispheres of the brain simultaneously, thus promoting brain integration. In response, a 12-step movement program was created to promote inter-hemispheric connectivity while also re-activating movement patterns found in early development. As mentioned previously, individuals with ASD present with motor difficulties from infancy that persist into adolescence and adulthood. Individuals with ASD tend to also exhibit comorbid intellectual or learning disabilities. As a result, it was proposed that a cross-lateral movement method could potentially address motor impairment and executive dysfunction in this population.

The results suggest that the cross-lateral movement method can promote positive changes in participant affect, motor function, and executive function. Many participants reported feeling focused, awake, and in control after performing the movement method, just to name a few. While the results remain subjective to each person, the openness of the participant surveys allowed for more nuanced changes to be tracked and reported. It is these types of responses that need to be valued and explored in the future, along with the execution of standardized assessments for executive function.

Motor impairments are becoming important indicators of ASD in early childhood (McCleery et al., 2013; Teitelbaum et al., 1998). This is because motor delays often appear much earlier than deficits in social communication (McCleery et al., 2013). As a result, a variety of early intervention techniques have been developed to meet this need. One of these techniques is called reciprocal imitation training (RIT). RIT was developed based on the idea that natural action imitation is a "critical social learning tool that contributes to rapid advances in social and cognitive development in infants and children" (McCleery et al., 2013, p. 12). Furthermore, the RIT has also demonstrated improvements in language development and social communication due to its ability to activate the mirror neuron system.

The cross-lateral movement method similarly targets natural movements performed in early motor development such as righting, crawling, and walking behaviour. This can be seen in the cross-lateral leg drop, the cross-lateral extension, the cross-lateral crunch, and of course, the cross-lateral walk. The method also activates the mirror neuron system when being performed by the writer and the participant simultaneously. As stated in the video observations, movements were performed with more accuracy when mirroring with the participant. These observations suggest the cross-lateral movement method should also be able to contribute to social and cognitive growth when performed in relationship with others.

In DMT practice, many early pioneers included a physical warm-up in their methodologies. For example Marian Chace, the mother of DMT, highlighted the importance of developing whole body movement in order to integrate a fragmented sense of self (Levy, 2005). Blanche Evan implemented a functional technique which included “postural work, coordination, placement of body parts, and rhythmicity” (Levy, 2005, p. 34). She believed that functional work was required in order to rehabilitate the body and promote a full range of strength and motion needed for emotional expression. Similar to Evan, Liljan Espenak used a physical warm-up to loosen and relax tense body parts and facilitate full body awareness (Levy, 2005). Lastly, Trudi Schoop stressed that teaching proper body use was crucial not only to an individual’s capacity for self-expression and exploration, but also intricately related to one’s self-esteem and body image (Levy, 2005).

The cross-lateral movement method can be used as a functional technique in clinical DMT practice. Its focus on cross-lateral movements activate many of the areas touched upon by Evan, including postural stability, coordination, and placement of body parts. Furthermore, the movement method can prepare the individual physically and cognitively for deeper clinical work. Most importantly, use of the movement method is not restricted purely to early intervention. As mentioned before, physical and cognitive impairments persist across the lifespan for individuals with ASD.

To date, there exists very few interventions for adults with ASD. Despite scientific evidence for neural plasticity and neurogenesis (Verburgh, 2013), ASD treatment efforts focus primarily on children. Verburgh (2013) states that physical exercise has been observed to produce "neurostructural changes at the level of the synapse, dendrites, and cell formation" (p. 1). In addition, neurotrophic factors, which play an important role in neural growth and neuron survival, have been found to be upregulated in individuals who engage in physical exercise (Verburgh, 2013). While DMT is not physical exercise, it too has the ability to get people energized and active. In theory, the benefits of DMT should exceed those of physical exercise because of its ability to engage emotional, cognitive, and social aspects of an individual simultaneously.

In conclusion, this paper has important implications for the assessment and treatment of young adults with ASD. The results suggest that cross-lateral movement can promote positive changes in participant affect, motor function, and executive function just after one session. The results also indicate that participants can experience more nuanced changes in their emotion and how they feel about their bodies. While other interventions for ASD focus primarily on characteristics such as social or behavioural deficits, this paper explores a movement-based method to address cognitive delays also displayed in the ASD population. Unlike Brain Gym or RIT, this movement method focuses primarily on cross-lateral movement as a way to foster greater motor coordination and function, and as a result, greater executive function. At the same time, the cross-lateral movement method derives its foundation from DMT practices that emphasize social interaction as well as models of human motor development. As participants perform cross-lateral movement, existing neural pathways between hemispheres are being strengthened while new neural connections are being created simultaneously. Ultimately this cross-lateral movement method offers individuals with ASD an intervention that can encourage neurological, physical, emotional, social, and cognitive growth across a lifetime.

References

American Dance Therapy Association. (2016). *What is dance movement therapy?* Retrieved from https://adta.org/faqs/

Barnard, L., Muldoon, K., Hasan, R., O'Brien, G., & Steward, M. (2008). Profiling executive dysfunction in adults with autism and comorbid learning disability. *Sage Journals, 12*(2), 125-141. https://doi.org/10.1177/1362361307088486

Bartenieff, I. & Lewis, D. (1980). *Body movement: Coping with the environment.* New York: Gordon and Breach.

Bhat, A. N., Landa, R. J., & Galloway, J. C. C. (2011). Current perspectives on motor functioning in infants, children, and adults with autism spectrum disorders. *Physical Therapy, 91*(7), 1116–1129.

Brain Gym International. (2016a). *Brain gym studies.* Retrieved from http://www.braingym.org/studies

Brain Gym International. (2016b). *History*. Retrieved from http://www.braingym.org/history

Center for Disease Control. (2016a). *Autism spectrum disorder: Data and statistics.* Retrieved from https://www.cdc.gov/ncbddd/autism/data.html

Center for Disease Control. (2016b). *Autism spectrum disorder: Signs & symptoms.* Retrieved from https://www.cdc.gov/ncbddd/autism/signs.html

Craig, F., Margari, F., Legrottaglie, A. R., Palumbi, R., de Giambattista, C., & Margari, L. (2016). A review of executive function deficits in autism spectrum disorder and attention-deficit/hyperactivity disorder. *Neuropsychiatric Disease and Treatment*, *12*, 1191-1202. doi:10.2147/NDT.S104620

Critchley, H. D., Eccless, J., & Garfinkel, S. N. (2013). Chapter 6 - Interaction between cognition, emotion, and the autonomic nervous system. *Handbook of Clinical Neurology, 117,* 59-77. https://doi.org/10.1016/B978-0-444-53491-0.00006-7

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis-Kaplan executive function system™ (D-KEFS™).* Retrieved from https://www.pearsonclinical.com/psychology/products /100000618/deliskaplan-executive-function-system-d-kefs.html

Dennison, P. & Dennison, G. (1986). *Brain gym: Simple activities for whole brain learning.* Glendale, California: Edu-Kinesthetics, Inc.

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4–12 years old . *Science, 333*(6045), 959–964. http://doi.org/10.1126/science.1204529

Edu-Kinesthetics. (2017). *International.* Retrieved from https://www.braingym.com/international/

Edwards, J. (2015). Exploring sensory sensitivities and relationships during group dance movement psychotherapy for adults with autism. *Body, Movement, and Dance in Psychotherapy, 10*(1), 5-20. DOI: 10.1080/17432979.2014.978894

Elsabbagh, M., Divan, G., Koh, Y.-J., Kim, Y. S., Kauchali, S., Marcín, C., Montiel-Nava, C., Patel, V., Paula, C. S., Wang, C., Yasamy, M. T., & Fombonne, E. (2012). Global prevalence of autism and other pervasive developmental disorders. *Autism Research, 5*(3), 160-179. DOI: 10.1002/aur.239

Fournier, K. A., Hass, C. J., Naik, S. K., Lodha, N., & Cauraugh, J. H. (2010). Motor coordination in Autism Spectrum Disorders: A synthesis and meta-analysis. *Journal of Autism and Developmental Disorders, 40*, 1227–1240.

Hackney, P. (1998). *Making Connections - Total Body Integration through Bartenieff Fundamentals*. Amsterdam: Gordon and Breach.

Hafez, R. (2017). Effect of brain gym on manipulating skills and balance for beginners in rhythmic gymnastics. Ovidius University Annals, Series Physical Education and Sport/Science, Movement and Health, 17(1), 66+. Retrieved from http: //link.galegroup.com/apps/doc/A497911189/AONE?u=les_main&sid=AONE&xid=ebdeeccf

Hannaford, C. (2005). *Smart moves: Why learning is not all in your head* (2nd ed.). Salt Lake City, UT: Great River Books.

Hartshorn, K., Olds, L., Field, T., Delage, J., Cullen, C., & Escalona, A. (2001). Creative movement therapy benefits children with autism. *Early Child Development and Care*, *166*(1), 1-5. doi: 10.1080/0300443011660101

Hill, E. L. (2004). Executive dysfunction in autism. *Trends in Cognitive Science, 8*(1), 26-32. https://doi.org/10.1016/j.tics.2003.11.003

Homann, K.B. (2010). Embodied concepts of neurobiology in dance/movement therapy practice. *American Journal of Dance Therapy, 32*(2), 80-99. doi:10.1007/s10465-010-9099-6

Hugdahl, K. (1996). Cognitive influences on human autonomic nervous system function. *Current Opinion in Neurobiology, 6*(2), 252-258. https://doi.org/10.1016/S0959-4388(96)80080-8

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child*, *2,* 217–250.

Kariuki, P. N. & Kent, H. D. (2014, November 6). The effects of brain gym activities and traditional teaching strategies on students' performance in comprehension in a 4th grade classroom. *ERIC.* Retrieved from https://eric.ed.gov/?id=ED550515#?

Koch, S. C., Mehl, L., Sobanski, E., Sieber, M., & Fuchs, T. (2015). Fixing the mirrors: A feasibility study of the effects of dance movement therapy on young adults with autism spectrum disorder. *Autism*, *19*(3), 338-350. doi:10.1177/1362361314522353

Laban/Bartenieff Institute of Movement Studies. (2018). *Laban movement analysis*. Retrieved from https://labaninstitute.org/about/laban-movement-analysis/

Leonard, H. C. (2016). The impact of poor motor skills on perceptual, social and cognitive development: The case of developmental coordination disorder. *Frontiers in Psychology*, *7*, 311. doi: 10.3389/fpsyg.2016.00311

Levy, F. J. (2005). *Dance movement therapy: A healing art.* Reston, VA: National Dance Association, American Alliance for Health, Physical Education, Recreation, and Dance.

Marpaung, M. G., Sareharto, T. P., Purwanti, A., & Hermawati, D. (2017). Brain gym to increase academic performance of children aged 10-12 years old (experimental study in Tembalang elementary school and Pedalangan elementary school Semarang). *IOP Conference Series: Earth and Environmental Science, 55(1).* doi:10.1088/1755-1315/55/1/012017

McCalla, A. (2018). *Executive functioning - Where it is controlled and how does it develop? / Remediation techniques for deficits and dysfunction.* Retrieved from https://www.rainbowrehab.com/executive-functioning/

McCleery, J., Elliott, N., Sampanis, D., & Stefanidou, C. (2013). Motor development and motor resonance difficulties in autism: Relevance to early intervention for language and communication skills. *Frontiers in Integrative Neuroscience, 7*. doi:10.3389/fnint.2013.00030

Moore, C. (2014). *Meaning in motion: Introducing Laban movement analysis.* Denver, Colorado: MoveScape Center.

Morin, A. (2014). *At a glance: Classroom accommodations for executive functioning issues.* Retrieved from https://www.understood.org/en/school-learning/partnering-with-childs-school/instructional-strategies/at-a-glance-classroom-accommodations-for-executive-functioning-issues

O'Hearn, K., Asato, M., Ordaz, S., & Luna, B. (2008). Neurodevelopment and executive function in autism. *Development and Psychopathology, 20*, 1103–1132.

Piaget, J. (1953). *The origin of intelligence in the child*. London: Routledge and Kegan Paul.

PubMed Health. (2016, August 19). *How does the nervous system work?* Retrieved from https://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0072574/

Scharoun, S. M., Reinders, N. J., Bryden, P. J., & Fletcher, P. C. (2014). Dance/movement therapy as an intervention for children with autism spectrum disorders. *American Journal Of Dance Therapy*, *36*(2), 209-228. doi:10.1007/s10465-014-9179-0

Schawbel, D. (2017, October 16). *Walter Isaacson: What we can learn about innovation from Leonardo da Vinci.* Retrieved from https://www.forbes.com/sites/danschawbel/2017/10/16/walter-isaacson-what-we-can-learn-about-innovation-from-leonardo-da-vinci/#2624a19c3d6a

Schwerin, S. (2013, March 5). *The anatomy of movement.* Retrieved from https://brainconnection.brainhq.com/2013/03/05/the-anatomy-of-movement/

Shu, B.C., Lung, F.W., Tien, A.Y., & Chen B.C. (2001). Executive function deficits in non-retarded autistic children. *Autism, 5*(2), 165-174. DOI: 10.1177/1362361301005002006

Sifft, J. M. & Khalsa G. C. K. (1991). Effect of educational kinesiology upon simple response times and choice response times. *Perceptual and Motor Skills, 73*(3), 1011-1015. https://doi.org/10.2466/pms.1991.73.3.1011

Starcke, K. & Brand, Matthias. (2012). Decision making under stress: A selective review. *Neuroscience & Biobehavioral Reviews, 36*(4), 1228-1248. https://doi.org/10.1016/j.neubiorev.2012.02.003

Teitelbaum, P., Teitelbaum, O., Nye, J., Fryman, J., & Maurer, R. G. (1998). Movement analysis in infancy may be useful for early diagnosis of autism.*Proceedings of the National Academy of Sciences of the United States of America*, *95*(23), 13982–13987.

Verburgh, L., Königs, M., Scherder, E. J. A., & Oosterlaan, J. (2013). Physical exercise and executive functions in preadolescent children, adolescents, and young adults: a meta-analysis. *British Journal of Sports Medicine, 48*(12), 973-979. http://dx.doi.org/10.1136/bjsports-2012-091441

Wolfsont, C. (2002). Increasing behavioral skills and level of understanding in adults: A brief method integrating Dennison's brain gym balance with Piaget's reflective processes. *Journal of Adult Development, 9*(3), 187-203.

Weiss, J. A., Baker, J. K., & Butter, E. M. (2016, September). *Mental health treatment for people with autism spectrum disorder.* Retrieved from http://www.apa.org/pi/disability/resources/publications/newsletter/2016/09/autism-spectrum-disorder.aspx

Yogev-Seligmann, G., Hausdorff, J. M., & Giladi, N. (2007). The role of executive function and attention in gait. *Movement Disorders, 23*(3), 329-342. DOI: 10.1002/mds.21720

Appendix A

Video Consent Form

VIDEO CONSENT FORM

I, ____, give consent for Courtney Chow to video tape me in dance class.

I understand that this video will be used for observation purposes only and will only be seen by Courtney Chow. __________

I am aware that video observations may be used in Courtney Chow's capstone thesis project, however personal identifying information (ex: name, address, email, etc.) will be omitted to protect confidentiality. __________

I understand that my participation is voluntary and that I can refuse participation at any time. __________

Student Signature: ________________________________ Date: __________

Administrator's Signature: ____________________________ Date: __________

Appendix B

Participant Survey

NAME: DATE: PRE / POST

Awake	Tired	Connected	Disconnected	
Lethargic	Energized	Focused	Light	
Distracted	Strong	Free	Bound	Hyper
Calm	Clumsy	Loose	Tight	
Coordinated	Balanced	Open	Closed	Lost
Integrated	Scattered	Whole	In Control	
Organized	Stressed	United		

I AM

____

I FEEL

____

MY BODY IS

____

Appendix C

Script

We are going to start on the floor, laying down flat on our backs. Let you arms and legs relax by your sides. If you are comfortable, you can close your eyes. Let's take three deep breaths together: inhaling for one, and exhale...inhaling for two, and exhale...inhaling for three, and exhale.

Now raise your arms above your head, letting them rest on the floor. Imagine yourself as a large "X" shape, or a starfish on the floor. Lift the right arm and left leg slightly off the floor. Try to imagine that you are being pulled in opposite in directions. Relax and switch sides. Picture one straight line extending diagonally across across from the tips of your fingers all the way down to the opposite foot. You should feel a connection with your core muscles. We are going to repeat this twice more on each side.

Lower your arms and legs but remain in your back. The next movement requires you to bend your right right knee. Next, open your arms into a "T" position to stabilize your upper body. Slowly drop your knee across your body, creating a twist your spine. If your knee cannot touch the ground it's okay. Do what is comfortable and try to keep both shoulders on the ground. Slowly bring the knee back up and straighten your leg. Do the same thing on the other side - bending your left knee and drop it across your body. Switch sides again. We are going to do it twice more in each side.

Let's all come up to seated position, sitting firmly on both sitz bones. Keep your legs extended straight in front of you. We are going to open our legs slightly into a "V" shape. The wider the V, the bigger the stretch. Take your right hand and reach across to your left foot. If you cannot reach your foot, it's okay. Place your hand on your shin, knee, or thigh, whatever is most accessible for you. You should feel a stretch in your lower back and your hamstrings. Switch sides and reach your left hand to your right foot. We are going to repeat it twice more in each side.

For the next move, we are going to stay seated on the ground. Bend the right knee and place the foot on the outside of your left leg. Next, take your left elbow and hook it on the outside of your right knee. You may recognize this movement from yoga practice. Use your right arm to stabilize your upper body as your twist your torso to the right. If you can, look behind you. We are going to repeat this six times.

When you're finished, come up onto your hands and knees. Slowly lift the right arm and the left leg off the floor. It does not have to be super high - they should create one straight line parallel to floor. If you use your core muscles and focus on a single spot, it will help you keep your balance. Let's switch to the other side. We are going to do this ten times all together.

From your hands and knees, come up to standing. This next move is like a standing crunch. Take your right elbow and touch it to your left knee. Make sure you are doing opposite elbow to opposite knee. Let's do it together ten times.

Come back to standing. The next move is like a punch in the air. Lift your right arm, make a fist, and punch it straight up above your head. At the same time, lift your left knee up. This movement kind of looks like a march. Let's do it together 10 times.

Relax your arms and legs. From here let's all start to move around the room simply walking. Let yourself relax into a comfortable rhythm. Take notice how the opposite arm moves with the opposite the leg and vice versa. We all do this naturally without thinking.

Now let's pick up the pace. You can either skip or begin to jog or run. Keep focusing on the opposite connections I was talking about before and be aware of others in the room.

Okay! Let's begin to slow down and find a place to stop. You can either come back to your original spot or find a new spot in the room. Once again, make sure there is enough room around you so that you do not hit others. The final movement is a jumping twist. When your jump, your two feet will twist left while your arms and upper body will twist right. Make sure you are twisting your spine. Let's do this all together ten times.

To calm ourselves down we are going to end just like we began, with breath. So let's all take one deep inhale in, now exhale. Another inhale in, and exhale. The last inhale in, and exhale. Thank you everyone for participating today!

Appendix D

Group 1

Legend	
(green)	Positive change
(orange)	Negative change
(white)	Neutral change
(blue)	Nuanced change

Table D1.1

Group 1, Session 1 (n = 16)

Participant	"I am" (pre)	EF	"I am" (post)	EF	"I feel" (pre)	Affect	"I feel" (post)	Affect	"My body is" (pre)	Motor	"My body is" (post)	Motor
1	Motivated	positive	Great	positive	Determined	positive	Relieved	positive	Strong	positive	Relaxed	positive
2	Strong	positive	Strong	positive	Stressed	negative	Calm	positive	Tired	negative	Energized	positive
4	Tired	negative	Open	positive	Stressed	negative	Calm	positive	Distracted	negative	Light	positive
5	Lost	negative	Strong	positive	Clumsy	negative	Free	positive	In Control	positive	Balanced	positive
6	Calm	positive	Awake	positive	Strong	positive	Energized	positive	Tired	negative	Loose	positive
7	Connected	positive	In Control	positive	Energized	positive	Calm	positive	Strong	positive	Awake	positive
8	Awake	positive	Stressed	negative	Free	positive	Tight	negative	Tight	negative	Lost	negative
9	Tired	negative	Loose	positive	Clumsy	negative	Calm	positive	Awake	positive	Awake	positive
10	Calm	positive	Awake	positive	Tired	negative	Good	positive	In Control	positive	Strong	positive
11	Ready to work out	positive	Calmer than before	positive	Happy	positive	Happy that I did yoga	positive	Energized	positive	Calm	positive
12	In Control	positive	Awake	positive	Energized	positive	Strong	positive	Calm	positive	Balanced	positive
13	Clumsy	negative	Scattered	negative	Stressed	negative	Stressed	negative	Strong	positive	N/A	N/A
14	Strong, Clumsy, Awake,	negative	Clumsy	negative	Energized, Stressed	negative	Stressed	negative	In Control	positive	Hyper	negative

	Hyper											
15	Clumsy, Focused, Hyper	positive	Tired, Connected	positive	Distracted, Awake, Tired	negative	Balanced, Clumsy	negative	Light, Loose, Whole	positive	Loose, Lost	negative
16	Absent	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	Absent	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table D1.2

Group 1, Session 1 (n = 16)

Result	"I am"	"I feel"	"My body is"
Positive	3	5	3
Negative	1	1	2
Neutral	10	8	8
Other	2	2	3

Table D2.1

Group 1, Session 2 (n = 16)

Participant	"I am" (pre)	EF	"I am" (post)	EF	"I feel" (pre)	Affect	"I feel" (post)	Affect	"My body is" (pre)	Motor	"My body is" (post)	Motor
1	Energized	positive	Energized	positive	In Control	positive	Connected	positive	Focused	positive	Organized	positive
2	Lost	negative	Balanced	positive	Tired	negative	Light	positive	Distracted	negative	Focused	positive
4	Absent	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	Lost	negative	Focused	positive	Clumsy	negative	In Control	positive	Free	positive	Sore	negative
6	Tired	negative	Loose	positive	Focused	positive	Free	positive	Stressed	negative	Tired	negative
7	Awake	positive	Calm	positive	Focused	positive	Energized	positive	Energized	positive	Awake	positive
8	Calm	positive	In Control	positive	Stressed	negative	Loose	positive	Tight	negative	Free	positive
9	Stressed	positive	Tired	negative	Tired	negative	Stressed	negative	Calm	positive	Love	positive
10	Energetic	positive	Calm	positive	Great	positive	Strong	positive	Strong	positive	Balanced	positive
11	Happy	positive	Happy	positive	Ready to work out	positive	Calm	positive	Awake	positive	Awake	positive
12	Connected	positive	Focused	positive	Energized	positive	Hyper	negative	Awake	positive	Organized	positive
13	Absent	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	Loose	positive	Free	positive	In Control	positive	Hyper	negative	Focused	positive	Clumsy	negative
15	Awake, Connected, Strong	positive	Whole	positive	Hyper, Calm	negative	In Control, Open	positive	Loose, Free, Balanced	positive	Focused	positive
16	Stressed	negative	Free	positive	Tired	negative	Awake	positive	Dancing	positive	Balanced	positive
17	Balanced	positive	Calm	positive	Energized	positive	Balanced	positive	Tight	negative	Connected	positive

Table D2.2

Group 1, Session 2 (n = 16)

Results	"I am"	"I feel"	"My body is"
Positive	4	5	3
Negative	1	2	1
Neutral	9	7	10
Other	2	2	2

Appendix E

Group 2

Legend	
(green)	Positive change
(orange)	Negative change
(white)	Neutral change
(blue)	Nuanced change

Table E1.1

Group 2, Session 1 (n = 14)

Participant	"I am" (pre)	EF	"I am" (post)	EF	"I feel" (pre)	Affect	"I feel" (post)	Affect	"My body is" (pre)	Motor	"My body is" (post)	Motor
18	Very tired, Back hurting, Anxiety	negative	Good	positive	Very sleepy, Anxiety, Claustophobic	negative	Like it didn't help me	negative	Very tired, Lazy	negative	Like it didn't help me	negative
19	Fit	positive	Relaxed	positive	N/A	N/A	At Ease	positive	A Temple	positive	Calm	positive
20	Calm	positive	Calm	positive	Good	positive	Free Bird	positive	Calm	positive	Wood Rocklober	positive
21	Tired	negative	Relaxed	positive	Ugh	negative	Energized	positive	Tired	negative	Sore	positive
22	Strong	positive	Strong	positive	Distracted	negative	Focused	positive	Tired	negative	Loose	positive
23	Awake	positive	Calm	positive	Good	positive	Focused	positive	Tight	negative	Clumsy	negative
24	Fast	positive	Balanced	positive	Strong	positive	Free	positive	Clumsy	negative	Tired	negative
25	In Control	positive	Strong	positive	Agitated	negative	Agitated	negative	Tense	negative	Tight	negative
26	Good	positive	Calm	positive	Great	positive	Great	positive	Fine	negative	Focused	positive
27	Creative	positive	Successful	positive	Relaxed	positive	Open minded	positive	Work in Progress	positive	Healthy	positive
28	Calm	positive	Awake	positive	Calm	positive	Open	positive	Balanced	positive	Strong	positive

29	Focused, Hopeful	positive	Focused, Awake	positive	Stressed, Distracted	negative	Distracted, A Little Calm	positive	Chill, Tired	negative	In Control	positive
30	Absent	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
31	Calm	positive	Calm	positive	Tired	negative	Good	positive	Relaxed	positive	Good	positive

Table E1.2

Group 2, Session 1 (n = 14)

Results	"I am"	"I feel"	"My body is"
Positive	2	4	4
Negative	0	0	0
Neutral	11	8	9
Other	1	2	1

Table E2.1

Group 2, Session 2 (n = 14)

Participant	"I am" (pre)	EF	"I am" (post)	EF	"I feel" (pre)	Affect	"I feel" (post)	Affect	"My body is" (pre)	Motor	"My body is" (post)	Motor
18	Ready to work	positive	Okay	positive	Okay	positive	Hungry	negative	Awake	positive	Good	positive
19	Tired	negative	Relaxed	positive	Stressed	negative	Balanced	positive	Calm	positive	Loose	positive
20	Calm	positive	Free	positive	Good	positive	Powerful	positive	Tight	negative	Light	positive
21	Tired	negative	Tired	negative	Tired	negative	Refreshed	positive	Tired	negative	Refreshed	positive
22	Tired	negative	Tight	negative	Calm	positive	Awake	positive	Stressed	negative	In Control	positive
23	In Control	positive	Tired	negative	Lost	negative	Connected	positive	Focused	positive	Calm	positive
24	Calm	positive	Calm	positive	Free	positive	Tired	negative	Clumsy	negative	Clumsy	negative
25	In Control	positive	Calm	positive	Strong	positive	Energized	positive	Awake	positive	Open	positive
26	Focused	positive	Strong	positive	Strong	positive	Calm	positive	Awake	positive	Focused	positive
27	Connected	positive	One Person	positive	Excited	positive	Great	positive	Strong	positive	Relaxed	positive
28	Tired	negative	Awake	positive	Calm	positive	Free	positive	Free	positive	Balanced	positive
29	Tired	negative	Tired	negative	Stressed	negative	Scattered	negative	Distracted	negative	Distracted	negative
30	Focused	positive	Organized	positive	Tired	negative	Tired	negative	Awake	positive	Whole	positive
31	Tired	negative	Dizzy	negative	Calm	positive	Tired	negative	Good	positive	Okay	positive

Table E2.2

Group 2, Session 2 (n = 14)

Results	"I am"	"I feel"	"My body is"
Positive	2	3	3
Negative	1	3	0
Neutral	11	8	11
Other	0	0	0

Appendix F

Group 3

Legend

Legend
Positive change
Negative change
Neutral change
Nuanced change

Table F1

Group 3, Session 1 (n = 10)

Participant	"I am" (pre)	EF	"I am" (post)	EF	"I feel" (pre)	Affect	"I feel" (post)	Affect	"My body is" (pre)	Motor	"My body is" (post)	Motor
32	A Tiger	positive	A Tiger	positive	Tired	negative	Tired	negative	Calm	positive	Calm	positive
33	Energized	positive	Strong	positive	Focused	positive	Balanced	positive	Scattered	negative	In Control	positive
34	Organized	positive	Awake	positive	In Control	positive	Calm	positive	Relaxed	positive	Strong	positive
35	Calm	positive	Strong	positive	Strong	positive	In Control	positive	In Control	positive	Free	positive
36	Awake	positive	Hyper	negative	Loose	positive	Energized	positive	In Control	positive	Silly	negative
37	Tired	negative	Sick	negative	Sick	negative	Tired	negative	Lost	negative	Lost	negative
38	Tired	negative	N/A	N/A	Light	positive	N/A	N/A	Balanced	positive	N/A	N/A
39	Awake	positive	Tired	negative	Loose	positive	Loose	positive	Loose	positive	Hyper	negative
40	Calm	positive	Awake	positive	In Control	positive	Balanced	positive	Loose	positive	Calm	positive
3	Aggravated	negative	Aggravated	negative	Like a Unicorn	positive	Aggravated	negative	Tired	negative	Tense	negative

Table F2

Group 3, Session 1 (n = 10)

Results	"I am"	"I feel"	"My body is"
Positive	0	0	1
Negative	2	1	2
Neutral	7	8	6
Other	1	1	1

Appendix G

Future Participant Questionnaire Example

Name:
Date:

Pre / Post

Participant Questionnaire

Please take a moment to answer the following questions. Circle the number that best describes how you are feeling. You can only circle one. If you have questions, raise your hand so that a facilitator may assist you.

1. I feel...

Tired	1	2	3	4	5	6	7	8	9	10	Awake
Hyper	1	2	3	4	5	6	7	8	9	10	Calm
Stressed	1	2	3	4	5	6	7	8	9	10	Relaxed
Lazy	1	2	3	4	5	6	7	8	9	10	Energized

2. My body is...

Tight	1	2	3	4	5	6	7	8	9	10	Loose
Closed	1	2	3	4	5	6	7	8	9	10	Open
Weak	1	2	3	4	5	6	7	8	9	10	Strong
Lost	1	2	3	4	5	6	7	8	9	10	In Control
Bound	1	2	3	4	5	6	7	8	9	10	Free
Clumsy	1	2	3	4	5	6	7	8	9	10	Balanced

3. My mind is...

Disconnected	1	2	3	4	5	6	7	8	9	10	Connected
Distracted	1	2	3	4	5	6	7	8	9	10	Focused
Scattered	1	2	3	4	5	6	7	8	9	10	Integrated
Chaotic	1	2	3	4	5	6	7	8	9	10	Organized
Bored	1	2	3	4	5	6	7	8	9	10	Motivated