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ARTICLE

The Impact of Circus Arts Instruction in Physical Education on the Physical Literacy of Children in Grades 4 and 5

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Objective: To examine the impact of circus arts instruction in physical education (PE) on the physical literacy of children in Grades 4 and 5. ***Methods:*** A clustered, quasi-experimental design was used comparing children in schools with circus arts instruction in physical education ($n = 101$) with children in socioeconomic status-matched schools using standard PE instruction ($n = 110$). Physical literacy assessments performed at the beginning and end of one semester using the Physical Literacy Assessment for Youth tools. ***Results:*** Significant improvements in motor competence for both groups; endpoint differences favored the circus arts instruction in physical education schools for 15 of 18 movement skills for Grade 5 and 7 of 18 skills for Grade 4 ($p < .05$), with corresponding increases in children's confidence and comprehension of movement terminology, as well as active participation. The gap in motor competence between girls and boys in the circus arts instruction in physical education schools was smaller than in standard PE schools. ***Conclusions:*** Circus arts instruction enriched PE can effectively aid in the development of physical literacy in children with greater gender equity.

Keywords: confidence, elementary school, gender, motor competence

Physical literacy (PL) refers to the competence to perform movement skills, but also the confidence, comprehension, and motivation to allow one to lead a physically active life (Cohen, Morgan, Plotnikoff, Callister, & Lubans, 2014). Other definitions have also included the importance of social context to the development of PL (Dudley, Cairney, Wainwright, Kriellarrs, & Mitchell, 2017; Edwards et al., 2017), as well as the affective components of movement, such as enjoyment, fun, and friendship (Cairney, Bedard, Dudley, & Kriellaars, 2016; Edwards et al., 2017). When considered holistically, PL is a multidimensional construct that transcends fundamental motor skills to include cognitive, emotional, and social elements that collectively influence movement experiences across the course of life (Whitehead, 2010). A recent series of systematic reviews by Edwards et al. (2017, 2018) identifies strong subthematic commonality among PL definitions, but also discusses some of the philosophical debates and tensions remaining in the evolution of the PL construct and measurement thereof. Although PL is broader than movement skills alone, the importance of developing competence in movement skills is nevertheless a critical part of a child's early development (Hulteen, Morgan, Barnett, Stodden, & Lubans, 2018) and an integral component of PL. In order to develop PL, children need to be exposed and allowed to repetitively perform a variety of movements in a range of physical environments and social settings throughout their childhood (Jurbala, 2015; Whitehead, 2010). Children with greater competence in locomotor skills have significantly less sedentary time than those with poorer locomotor skills, and total motor skill performance is significantly associated with time spent in moderate to vigorous physical activity (Logan, Webster, Getchell, Pfeiffer, & Robinson, 2015; Williams, Pfeiffer, & O'Neill, 2008; Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006). Typically, children who enjoy a variety of different physical activities are more likely to grow into adults who are also physically active (Faigenbaum, Stracciolini, & Myer, 2011; Keegan, Keegan, Daley, Ordway, & Edwards, 2013; Logan et al., 2015).

Due to the observed "tracking" of physical activity (PA) patterns noted throughout adolescence and adulthood, it is important to focus on interventions during childhood, not only to address PL, but also to assist in breaking the cycle of physical inactivity that is so prevalent in society today (Keegan et al., 2013; Ng & Popkin, 2012; Telama et al., 2005). The majority of children in Canada do not achieve the published minimum PA guidelines (Guthold, Cowan, Autenrieth, Kann, & Riley, 2010; Lopes et al., 2011; Nader, Bradley, Houts, McRitchie, & O'Brien, 2008; Tremblay, Kho, Tricco, & Duggan, 2010). It is clear that a physical inactivity crisis is resulting in serious health implications and a massive economic burden to health care and society (Janssen, 2012).

Historically, physical education (PE) in Canada and the United States has focused on a sport-centric model, with sport skill instruction and competitive games being the foundation of most PE curricula offerings (Berryman, 2010). There is a need to shift away from this emphasis toward a public health approach (McKenzie & Lounsbery, 2014). A focus on sport and traditional forms of athleticism can exclude many children from participation, especially if they are not confident in their abilities being compared with those of their peers (Telama, 2009). Achieving the PE curriculum goals of increasing active participation and motor skill competence

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has proven to be challenging, not only when led by generalist school teachers (Carney & Chedzoy, 1998; De Corby, Halas, Dixon, Wintrup, & Janzen, 2005; Janzen et al., 2003), but also with trained (specialist) PE teachers (Smith, Lounsbery, & McKenzie, 2014). Outside of structured PE settings, research has consistently shown a large gender gap in both PA participation and motor competence (Barnett et al., 2016). Boys are found to spend more time in PA throughout the day (Cohen et al., 2014; Troiano et al., 2008), and are more active than girls overall, regardless of age, from a 6- to 11-year age group continuing on into adolescence and adulthood (Smith et al., 2014). Boys have also been shown to outperform girls in movement skills, especially object control skills in childhood and adolescence (Cairney et al., 2018). Moreover, girls consistently report lower levels of enjoyment in PE than boys (Barr-Anderson et al., 2008; Wallhead & Buckworth, 2004), which may, in part, be due to lower levels of perceived motor competence (Cairney et al., 2012). With notable gender/sex gaps in both skill and participation, and the seeming inability for traditional, sport-based PE to address both this gap and increase participation and skill more generally for both sexes, alternative approaches are required.

In response to these challenges, in part, PE teachers in Canada and the United States (Edwards et al., 2018) are shifting to using a PL approach in curricula, rather than a strong sport focus, in the hopes of achieving curriculum learning objectives and downstream improvements in healthy lifestyle adoption with adequate PA levels (Edwards et al., 2018; Longmuir et al., 2015). A new approach that shows promise for promoting the development of PL and, therefore, potentially increasing PA, is circus arts. Circus arts instruction (CAI) involves the development of movement skills across five families of circus disciplines (acrobatics, manipulation, equilibrium, aerials, and clowning) for the artistic expression of individual and/or group movement. Some examples of circus skills suitable for children and youth include: diablo, scarves, poi, flower sticks, pins, plates, balls, and hoops for manipulation; unicycle, Rola Bola, stilts, pogo sticks, and hand-to-hand for equilibrium; and straps, ropes, silks, trapeze for aerials, and a standard "gymnastic like" elements for acrobatics. Bolton (2004) mapped CAI to the essentials of childhood development through its obligatory features to include aspiration, fun, trust, constructive risk, self-individualization, and hard work. Similarly, Maglio and McKinistry (2008) identified core features of CAI to include creativity, leadership, self-discipline, self-confidence, and team work. The Finland Effective Circus project reported that circus creates an environment where it is possible to fail without losing face or feeling inferior, where a variety of movement skill domains with a wide range of levels provide a challenge to every level of ability are present, and where it is possible to work alone or in a group to enhance social cohesion (Kinnunen, Lidman, Kakko, & Kekalainen, 2013). As such, CAI is wholly consistent with PL in the psychological, physical, cognitive, and social domains, and is an inclusive, noncompetitive, and a safe environment for participants, where "everyone is good at something" (Kinnunen et al., 2013). CAI has been delivered in education and recreation settings in many countries including Australia (Bolton, 2004), France (Coasne, 2013), and Brazil (Ontañón, 2016). From an educational perspective (Hotier, 2003), one of the goals of CAI is to enhance movement skills competency in not only circus-based movements, but also in most curriculum-linked land-based movement skills (e.g., balance, body control, manipulative, locomotor, and transport; social interaction, spatial awareness, etc.). Therefore, CAI may have great potential to enhance the achievement of the specific and global learning objectives of PE, namely, in movement, fitness, safety, social and personal management, and healthy lifestyle practices (Manitoba Education and Training, 2008).

Of note, over 160 school-based circus programs exist or are a part of Quebec schools, positioning Montreal, Quebec, as the "circus hub" of Canada, if not the world (Leroux & Batson, 2016). Given the number of schools participating in circus, this establishes the possibility of a natural experiment for investigation of circus as a form of instruction in the PE setting. To date, there have been no studies that examine the effect of CAI on children using quantitative approaches in either recreation or PE settings. As the vast majority of children attend school, PE provides a window of opportunity to influence children's early movement experiences (Keegan et al., 2013). Due to some of the shortcomings in the delivery of the current PE curriculum, CAI may provide an unexplored means for delivery of PE consistent with PL philosophy and PE curriculum objectives (Government of Quebec, 2009), and contribute to improving public health (McKenzie & Lounsbery, 2014). Therefore, the primary aim of this study was to examine the impact of CAI compared with traditional PE instruction delivered in PE classes of children in Grades 4 and 5. Secondarily, the impact of CAI on reducing gender inequities in PL was also examined.

Methods

This study used a prospective, clustered, quasi-experimental design to compare three schools with CAI in PE class (CAI-PE) with three matched schools whose PE curriculum followed standard physical and health education (S-PE) based on Quebec provincial polices (Kilborn, Lorusso, & Francis, 2015). All schools participating were restricted to the public school setting, which are schools funded by the provincial government and open to all students at no cost. The schools with CAI were selected using a purposeful sampling approach with maximum variation of schools within the Montreal area using an expert panel consisting of representatives from the national circus school, Cirque du Soleil, and the Circus Research Group of Montreal. Comparison schools were then pairwise matched geographically to the same neighborhood, as well as using the Index of the Low Income Cutoff and the Index of Socioeconomic Background (Government du Québec, 2015).

The parents provided consent, and children provided assent prior to participation. Approval by the board, principal, and teachers was obtained for all schools. Ethical approval was obtained from the human research ethics board, University of Manitoba (H2013:450).

Participants

A total of 211 students, 9–12 years old ($M = 10.07$; $SD = 0.768$), participated in the study: 106 fourth graders (50%) and 105 fifth graders (50%). Of these 211 students, 116 were female (55%) and 95 were male (45%); 101 students were in the three S-PE schools (48%), while 110 students were in the three CAI-PE schools (52%).

Sample size was calculated for both within- and between-group comparisons using the average motor competence from Physical Literacy Assessment for Youth Fun (PLAY Fun) total score (averaged across the 18 movement skills). The *SD* was derived from a validation study (Cairney et al., 2018). We used an alpha value of .05 and a beta corresponding to 0.2. From this, it was determined that a sample of 28 per group was required to

detect weak-to-moderate effect size differences between groups (G*Power V3.1; Dusseldorf, Germany).

Description of Schools and Curriculum

All schools continued with their scheduled allotments for PE classes (three to four) per week and class durations (50–90 min), allowing for a variable amount of time spent in S-PE/CAI-PE for each school. All schools had PE specialist teachers teaching PE class. Table 1 provides general characteristics of the S-PE and CAI-PE schools, as well as detailed characteristics of the CAI programming in the CAI-PE schools. All of the participating schools were required to follow the provincial curriculum that provides general learning objectives, as well as specific learning objectives for these grades (Government of Quebec, 2009). This provincial PE curriculum has three general competencies: one related to movement skills (Competency 1—to perform different skills in different PA settings), one related to affective/social (Competency 2—to interact with others in different PA settings), and one related to acquiring knowledge related to healthy lifestyles practices and the effects of sedentary behavior (Competency 3—adopting a healthy lifestyle; Government of Quebec, 2009). In the case of CAI-PE schools, the context of movement skill development involved the circus disciplines, whereas, in the S-PE, it was a combination of sports and small- and medium-sized games. In both cases, the specific learning objectives required the development of land-based movement skills that were assessed by the PLAY Fun tool.

S-PE schools. The S-PE schools used traditional sports-centric PE curriculum and instruction methods. For example, the emphasis was on the acquisition and practice of foundational sport-specific skills (e.g., striking a ball). Instruction, in turn, was focused on refining techniques to achieve entry-level competency and application to the sport context. Lesson plans included segments with repetition-based learning using "explain, demonstrate, observe, and correct" sequencing followed by small-sided games requiring the movement skill of focus. The students received a mean duration of 68 min per PE class, 3.3 times/week, for a total of 225 min (3.75 hr) of PE per week (Table 1). All three S-PE schools offered other physical activity opportunities (e.g., after school sports).

CAI-PE schools. The three CAI-PE schools delivered a wide range of circus disciplines from the five major circus families

Table 1 Schools Characteristics

S-PE schools	1	2	3
PE classes/week	3	4	3
Duration of PE class	55 min	60 min	90 min
PE teachers	1	2	1 teacher and 1 assistant
Generalist/PE trained	PE specialist	PE specialist	PE specialist (teacher) Generalist (assistant)
PE teacher changes in the year?	No	Yes	No
Special activity programs in school	Yes	Yes	Yes
Total amount of PE/week	2.75 hr	4 hr	4.5 hr
CAI-PE schools	1	2	3
PE classes/week	3	3	3
Duration of PE class	60 min	60 min	50 min
No. of CAI periods/week in PE class	2×/week (5 months)	3×/week (all school year)	1×/week (10 weeks)
Duration of CAI	60 min	60 min	50 min
No. of teachers for PE	1 teacher 1 circus instructor	2 teachers 2 circus instructors	2 teachers
Generalist/PE trained	Teacher = PE specialist	3/4 PE specialists	PE specialists
Training for circus instructors	PE special interest group	National circus school	No specific training; previously Cirque du Soleil artist
PE teacher changes in the year?	No	No	No
Circus equipment used	Juggling balls and scarves, rola bola, stilts, unicycle, trampoline, and flower sticks	Flower sticks, trapeze, juggling balls and scarves, unicycle, rola bola, rope climbing, hoops, wire, German wheel, and stilts	Rola bola, diabolo, flower sticks, juggling balls and scarves, wire, stilts, and unicycle
History of circus program in the school	12 years	>30 years	4 years
Circus show in school	No	Yes	Yes
Circus arts opportunities outside of PE	None	Training offered at lunchtime or after school (3 hr/week)	None
Special activity programs in school	Yes	Yes	Yes
Total amount of PE/week	3 hr	3 hr	2.5 hr
Total amount of circus instruction/week	2 hr (of PE time)	6 hr (3 of PE time)	50 min (of PE time)

Note. CAI-PE = circus arts instruction in physical education; PE = physical education; S-PE = standard PE.

(clowning, manipulation, equilibriums, aerials, and acrobatics). The instructional methods used in this delivery of this curriculum included student-centered focus using competency progression checklists for all circus skills. Artistic movement expression, technical variations in expression, and choice of progressions were fostered to encourage self-challenges and ownership of movement. Table 1 illustrates key features of the CAI delivery in PE classes. The teachers varied in their circus training background, and each school had a different length of history for including the circus arts program in their school (from 4 to 30 years). Like the S-PE schools, all CAI-PE schools offered other PA opportunities (e.g., after school sports). The students in the CAI-PE schools received a mean duration of 56.6 min per PE class, three times per week, for a total of 169.8 min (2.83 hr) of PE per week (Table 1). However, the delivery of CAI within PE classes varied from one to three times per week across the schools.

Data Collection and Measures

The PL of the children was evaluated by the use of the PLAY tools (Cairney et al., 2018). The PLAY tools are open-source tools available online that were developed at the University of Manitoba. From the suite of tools, the following three were deployed in this study: PLAY Fun, an assessment of motor competence, confidence, and comprehension of 18 PE curriculum-linked movement skills; PLAY Inventory, a self-reported checklist of participation in PA; and Play Self, a self-report of PL.

The PLAY tools were developed using the consensus-based standards for the selection of health measurement instrument (COSMIN) tool checklist (Mokkink et al., 2010), as well as using a modified Delphi approach and consensus panels. Overall, very good reliability and concurrent validity have been demonstrated for the PLAY Fun tools (Stearns, Wohlers, McHugh, Kuzik, & Spence, 2018). Strong validation of the PLAY Fun tools for assessment of motor competence was reported using confirmatory factor analysis in children aged 7–14 years of age (Cairney et al., 2018). Further, the PLAY tools had to have meaningful interpretability in a PE setting due to the direct ties to curricular general and specific learning outcomes (Government of Quebec, 2009; Manitoba Education and Training, 2008). A subcomponent of the overall study revealed very good concurrent validity of comparable movement skills ($r = .82$) with the Test of Gross Motor Development version 2 in Grades 4 and 5 children (Ulrich, 2000).

Nine trained research assistants performed PLAY Fun assessments in pairs during regular PE classes in the gymnasium; approximately 2 hr of assessment was required per classroom. A one-way, random effects model was used to compute intraclass correlation for interrater reliability, with a mean value of .864 (95% confidence interval [.794, .934]). The research assistants assessed all children in the classes, and were not privy to the baseline data during endpoint collection to minimize bias. PLAY Self and PLAY Inventory were completed during one class period, in the classroom, and administered by the classroom teacher. Data collection for each assessment time period (baseline and endpoint) took approximately 2 weeks across all schools.

For PLAY Fun, the average motor competence was computed as the mean of all the 18 skills assessed. For PLAY Fun, a flag is set by the trained observers when the participant demonstrates low confidence prior to or during execution for each of the 18 movement skills. Low confidence is assessed by observer based on external behavioral cues (e.g., apprehension to engage). For comprehension, up to three flags (needed the instruction repeated, needed additional verbal prompting, and asked for clarification of the terminology) were set related to the ability to understand movement terminology for each of the 18 movement skills. The total number of flags was tallied for the confidence and comprehension across the 18 movement skills.

There are three sections that are completed for the PLAY Self tool: environmental participation (gym, water, ice, snow, outdoors, and playground), self-description of PL (12 items), and valuing literacies (reading and writing, math, and movement). An overall score is computed for environmental participation and PL self-description from the associated items. For PLAY Inventory, the total number of PA pursuits was tallied as an indicator of the diversity of activities that the participant was engaged in.

An alpha level of ≤.05 was set for detecting statistical significance, although, for exploratory purposes, variables with an alpha level of ≤.10 were also tracked for trending effects. Since the study was powered for the PLAY Fun variables, the sample size would potentially create an underpowered circumstance (possibility of Type II errors) for the self-reported measures (PLAY Self and PLAY Inventory). A mixed model, repeated-measures analysis of variance was performed with sex, grade, and group (CAI-PE or S-PE), including Tukey's post hoc comparisons. Effect size is reported for main effects. Missing values were not imputed, and pairwise deletion was used for analysis. All analyses were conducted using SPSS (version 23; IBM Corp., Armonk, NY).

Results

Table 2 presents the successful data collection of primary measures for baseline and endpoint. Overall, the three PLAY tools had a high response rate for both baseline and endpoint (71–97%). The overall rate of loss due to follow-up was very low (<5%). At baseline, there were no significant differences in PLAY Fun, PLAY Self, and PLAY Inventory.

PLAY Fun—Motor Competence, Confidence, and Comprehension

A significant group effect was demonstrated ($d = 0.512$, $p < .01$, CAI-PE > S-PE): a sex effect ($d = 0.23$, $p < .001$, male > female); a grade effect ($d = 0.235$, $p < .01$, Grade 5 > 4); and a group by grade interaction ($p < .05$). Based upon average motor competence, within-subject changes over time revealed significant improvements for S-PE of 2.9% and CAI-PE of 7.8% ($p < .001$), with no average differences at baseline. Using average motor competence, there was a group difference for Grade 5 ($p < .001$), but it was only on the verge for Grade 4 ($p = .065$).

Table 3 illustrates the endpoint differences between S-PE and CAI-PE for the 18 movement tasks for Grades 4 and 5. For Grade 5, a total of 15 of 18 tasks revealed significant differences, with an

Table 2 Number (%) of Participants that Completed Each PLAY Tool for Baseline and Endpoint

Total ($N = 211$)	Baseline	Endpoint
Fun	205 (97)	195 (92)
Self	182 (86)	171 (81)
Inventory	164 (78)	149 (71)

Note. PLAY = Physical Literacy Assessment for Youth.

Table 3 Differences at Endpoint in Motor Competence in 18 Movement Skills for Grades 4 and 5

		Grade 5		Grade 4	
Movement category	**Movement task**	**Difference (%)**	***p***	**Difference (%)**	***p***
Locomotor	Run a square	9.5	.003	2.1	NS
Locomotor	Run there and back	8.6	.007	4.7	NS
Locomotor	Run, jump, and land on two feet	8.5	.009	5.1	NS
Transport	Crossovers	7.1	.028	0.5	NS
Transport	Skip	11.1	.001	–1.8	NS
Transport	Gallop	6.1	.035	2.4	NS
Transport	Hop	8.6	.002	4.7	.1
Transport	Jump	10.3	<.001	7.3	.03
Manipulation upper	Overhand throw	8.5	.01	6.5	.04
Manipulation upper	Strike with a stick	6.9	.035	7.5	.025
Manipulation upper	One-handed catch	7.5	.037	8.2	.001
Manipulation upper	Hand dribble	5.5	NS	–0.75	NS
Manipulation lower	Kick ball	9.8	.003	3.4	NS
Manipulation lower	Foot dribble	1	NS	1.2	NS
Balance	Balance forward	10.1	.002	8.8	.003
Balance	Balance backward	5.5	.042	6.5	.05
Body control	Drop to ground and up	10.2	.002	8.9	.004
Body control	Lift and lower	7	.091	2.1	NS

average difference relative to S-PE schools of 7.9%. For Grade 4, the overall difference was 4.3%, with seven skills significantly improved. These were primarily associated with manipulation and body control skills. Of note, for both grades, there were three tasks (hand dribble, foot dribble, and lift and lower) that were not significantly different between groups. These three tasks are not constituent parts of a circus program.

Figure 1 shows the average motor competence score from PLAY Fun at baseline and at endpoint for Grade 5, separated by sex. The improvement in boys' motor competence was nearly twice that of the females in the S-PE schools (male = 3.9%; female = 2.1%), whereas the girls just exceeded the improvement for males' motor competence in the CAI-PE schools (male = 7.5%; female = 8.1%). Initially, the gender gap in motor competence was similar in magnitude at baseline (2.5% CAI-PE vs. 3.6% S-PE), but at endpoint, the gender gap was magnified in the S-PE schools (5.4%) and was slightly decreased in the CAI-PE schools (1.95%).

A group-by-time effect was observed, revealing a decrease in the number of low-confidence flags ($p = .008$) and a decrease in number of poor comprehension flags ($p = .05$) elicited during children's movement testing during PLAY Fun in the CAI-PE, as compared with the S-PE schools in both Grades 4 and 5.

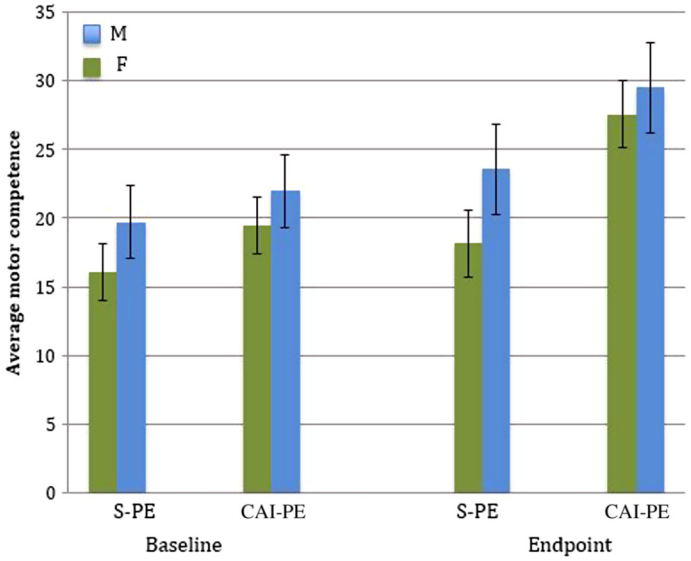

Figure 1 — Average PL motor competence (PLAY Fun; (95% CI)) scores for baseline and endpoint for Grade 5. Repeated-measures analysis of variance revealed a sex effect ($p < .001$) and a group effect ($p < .001$) with post hoc tests indicating an endpoint difference ($p < .001$) in favor of CAI-PE. PLAY =Physical Literacy Assessment for Youth; PL = physical literacy; PE = physical education; S-PE = standard PE; CAI-PE = circus arts instruction in PE; M, male; F, female.

PLAY Inventory—Participation in Activities

Based upon the total number of physically active pursuits reported in PLAY Inventory, at endpoint, the CAI-PE schools revealed a significantly greater number (26 vs. 20, $p = .05$) than the S-PE schools. At baseline, there were no differences in total number of PA pursuits. Correspondingly, using the environmental participation score of PLAY Self, there was a greater self-reported environmental participation across the contexts of participation (gym, water, ice, snow, outdoors, and playground) in the CAI-PE schools than the S-PE schools at endpoint ($p = .02$).

PLAY Self—Self-Assessment of PL

Overall, there was a significant group-by-time effect for the PL self-assessment score, with children in the CAI-PE schools reporting higher scores when compared with those in the S-PE schools at endpoint ($p < .05$). For individual PLAY Self items, the CAI-PE

children felt more talented ($p = .051$), indicated that they comprehended movement terminology ($p = .035$), and indicated they were happier during PA ($p = .002$). A group by sex specific effect ($p < .05$) was observed for eagerness to participate in PA, where the females in the CAI-PE schools were more eager to participate than the females in the S-PE schools.

In terms of valuing literacies, children in the CAI-PE group reported a higher level of valuing movement in their schools ($p = .004$). Interestingly, there was a significant improvement in valuing reading at school for the CAI-PE group ($p = .027$). A group by sex interaction was observed where females in CAI-PE valued reading and writing at home ($p = .009$) and with friends ($p = .001$) to a greater extent than the females in the S-PE schools. Similarly, the females in CAI-PE valued math in school greater ($p = .03$) than the female children in the S-PE schools.

Discussion

Previous qualitative studies have reported positive aspects of circus arts when delivered in a PE setting (Bolton, 2004; Coasne, 2013; Maglio & McKinstry, 2008; Ontañon, 2016). This study provides strong quantitative data to lend further support that CAI in PE has many positive impacts on children leading to holistic development of their PL and, as importantly, to curriculum-linked objectives. Although there were significant improvements in motor competence over time for both school settings, the magnitude of change for the CAI-PE group was substantially greater and was associated with a greater participation level in community-based physically active pursuits. These improvements in motor competence detected by assessors were also matched, with positive self-reported changes in cognition (comprehension) and affect (confidence) in the children. This study illustrates that the pedagogical methods used by PE teachers in the delivery of CAI is a strong facilitator of the PL process likely by concomitant and deliberate provision of competence, with confidence through provision of positively constructed movement challenges. Circus provides a wide range of progressions in a variety of movements, where any child can find an appropriate level of challenge and enter along a mastery progression. Further, the challenges provided to children through CAI instruction bolsters inclusive social and enjoyable participation. Since CAI necessarily involves artistry, individual variations are encouraged, resulting in ownership of movement, which further enhances motivation to participate and progress along a competency progression. This was particularly evident in females in CAI-PE which reported a greater interest in participating in PA. These putative mechanisms underlying the benefits of CAI in PE align well with research grounded in self-determination theory, showing that a classroom environment that fosters student need satisfaction results in improved relatedness and autonomy (Sanchez-Olivia, Pulida-Gonzalez, Leo, Gonzalex-Ponce, & Garcia-Calvo, 2017), and one that employs competence feedback (Mouratidis, Vansteenkiste, Lens, & Sideridis, 2008) leads to improved self-determined motivation to participate. This also aligns well with previous qualitative findings related to CAI (Bolton, 2004; Maglio & McKinstry, 2008), and the results of this study related to children's increased confidence, increased happiness with movement, increased talent self-efficacy, increased participation, and desire to participate.

Importantly, a number of positive benefits of CAI on females were revealed, including a substantive improvement in motor competence relative to comparison schools. In comparison to S-PE schools, the gender gap in motor competence actually decreased by endpoint. These findings are noteworthy, since previous studies of arts-based teaching in PE, such as dance, indicate greater acceptance and participation among girls (Shen, Chen, Tolley, & Scrabis, 2003). The substantive improvement in motor competence (observed among Grade 5 students), and differences observed for confidence and comprehension at endpoint, may be due to the inclusive and participatory nature of circus (Bolton, 2004), where all children will find a place and an appropriate challenge level (Price, 2012). Thus, the CAI approach may have remediated the issues (lack of enjoyment, lack of confidence, and noninterest in activities provided) that have been identified in PE in previous research (Barr-Anderson et al., 2008; Cairney et al., 2012; Wallhead & Buckworth, 2004) by providing enjoyment in participation, a variety of participation options that suit participant interests, a level of challenge for all levels of ability and interests, and concurrent development of confidence with competence.

It is important to note that circus skill proficiency was not assessed in this study, but rather the demonstration of curriculum-linked movement skills. This was done to facilitate comparisons to noncircus schools, but also to evaluate whether a circus approach in this context could be used to achieve provincial movement standards in PE. The focus on circus skills development in the CAI-PE schools would concurrently require the development of the basic movement skills assessed in order to perform the circus tasks, such as requiring balance and body control to mount and dismount a unicycle, or the need to run, jump, and land on two feet when using a minitrampoline. Clearly, for CAI schools, there would be direct link between participation in upper limb manipulation tasks (ball juggling alone or in groups, flower sticks, diabolo, and Chinese plate spinning) in developing not only basic throw and catch skills, but also requisite spatial awareness to safely control the movements in group activities. At endpoint, in both Grades 4 and 5 children, there were no differences between groups in three movement skills (hand dribble, foot dribble, and lift and lower) for which participation in any of the circus skills would not be expected to improve nor, for that matter, would be expected to improve based upon standard PE delivery in these grades.

Children in the CAI-PE schools reported being involved in more PA endeavors than those in the S-PE schools. This supports the belief that CAI helps children to develop skills and motor competencies that they may not otherwise acquire, because they are exposed to different activities than those offered in a conventional school with the standard PE delivery method. This increase in participation reported by the CAI-PE children likely arose as a result of the host of positive changes they reported through PLAY Self. A change in participation due to external factors, such as proximity to external opportunities (swimming pools, recreation complexes, etc.), or differences in economics, is unlikely due to the pairwise matching of the schools on geography and socioeconomic status.

Children in the CAI-PE schools reported that they understood more movement terminology, consistent with the comprehension improvement detected by assessors using PLAY Fun. The children overall felt as if they were more talented. The girls reported associating happiness with movement and being more eager to participate in PA. These are very impressive and encouraging findings that, when combined with improvements in motor competence, bode well for fostering continued participation in PAs (Sallis, Prochaska, & Taylor, 2000). A substantial impact was the difference in self-ranked importance (value) of movement at school, where, compared with children in S-PE schools, the

children in the circus environment equated importance of movement to that of literacy and numeracy.

Girls in CAI-PE schools reported valuing reading and writing more at school and at home than those in S-PE schools, and they reported valuing math more than girls in PE schools. In fact, in CAI-PE schools, females valued numeracy equivalent to males. Again, these are intriguing results suggesting the possibility that a quality PL experience has more importance than simply impacting PL and movement. These results suggest a carryover effect, one that impacts the valuing of different literacies, especially literacy and numeracy. Plausible explanations for this finding relate to how PE may help to shape or reproduce overall sex role perceptions across school settings (Hedlin, 2013). Alternatively, CAI-PE may play an important role in ameliorating attitudinal differences toward "traditionally" male subjects, such as mathematics (Hargreaves, Homer, & Swinnerton, 2008). This helps to illustrate the benefit of PL for the person as a whole, and hopefully will promote more buy-in by those who are simply interested in performance in academics (Whitehead, 2013). These results may have very important implications for the inclusion of females in an overall context within school and society, but this remains to be tested using a more rigorous experimental design.

In this study, CAI has shown to improve overall physical literacy self description including happiness to participate, talent, comprehension of movement terminology, confidence and environmental participation. Circus arts allows individuals to perform *for* an audience (Spiegel & Parent, 2017), unlike sport, where individuals are performing *in front* of an audience. The difference is subtle, but it has an important effect that allows for the development of confidence and realization of talent. Circus arts are consistently noted as being all inclusive (Coasne, 2013; Price, 2012), for all types of people and abilities (Ontañón, Duprat, & Bortoleto, 2012). It is noncompetitive, enabling children who are less confident in their skills, and who shy away from competition, to become engaged and develop their motor competence while having fun and realizing their own potential.

This study has shown substantial benefits in terms of motor competence for students engaged in CAI in Grades 4 and 5, as well as the progress toward decreasing the gender gap between girls' and boys' competence. These findings hold promise for aiding to improve the current dismal physical inactivity rates in children, assisting in opening the door for PA for life. The S-PE schools also had an advantage of having 37 hr per year of more exposure time to PE instruction than the CAI-PE schools, and yet still did not achieve equivalent results to CAI-PE.

By developing one's motor competence, confidence, motivation, and comprehension through an added quality PL experience, such as circus arts, this is hopefully the beginnings of encouraging PA for life, with exposure to more activities and interests. For future studies, an objective measure of PA would be useful in combination with the participation inventory as an indicator of engagement in diversity of movement experiences. A low correlation (.1) between fundamental movement skills (assessed using the Test of Gross Motor Development, version 2) and PA (measured by accelerometer) has been mentioned (Cohen et al., 2014). However, we would expect that the use of the PLAY tools, which have greater sensitivity and virtually no ceiling effect, would have a much higher correlation with objectively measured PA. Future study is warranted.

Limitations

This study has a number of limitations. First, the dosage of PE instructional time was not under experimental control and was, therefore, not consistent among the schools in either group. The impact of the lower instructional time would likely be to increase variability leading to a decreased ability to detect differences. However, this variability in instructional time between schools reflects the current circumstances of PE implementation, increasing the external validity of the results. Related to this was the dosage of CAI time, which was also varied between the schools utilizing circus. This would likely contribute to increasing the variability of the data, reducing the ability to detect differences. Second, this study was quasi-experimental, so limitations such as lack of randomization and the potential for school selection bias, are present. For instance, the children in Grade 5 would have had previous CAI prior to commencement of the study, which did not allow the comparison of "equal" students from a PL viewpoint at the beginning of the study. Each CAI-PE school had a different length of history with CAI programming; therefore, some schools had more experience and a further developed (stronger) program than others whose program was just emerging. It is difficult to control instructional ability or even teacher self-efficacy in any context; even having the same credentials does not ensure quality teaching. We did not have an assessment of teaching quality in the study. Similarly, we did not assess teacher efficacy by auditing lesson plans or by classroom observation. Some of the positive results in CAI-PE might be explained by increased motivation and drive to succeed, and drive to succeed, as well as a likely association with different teaching pedagogy. Similarly, the CAI-PE instructors did not all have the same CAI training background, nor did the CAI-PE schools all have the same equipment available to them. Therefore, delivery of CAI would vary depending on these factors, with some schools having more formal expertise and equipment than others. The impact of this would be to increase variability between schools, resulting in a decreased ability to detect real differences. Finally, the assessors were not blinded to the schools, which could lead to bias. The greatest protection against this bias was that on second assessment, the assessors were blind to the results of the first assessment. Further, it would be impossible for an assessor to recall 18 individual visual analogue scores per student, and any systematic scoring bias would have resulted in all skills being graded upward for the circus program, and this was not observed.

Given each of the limitations mentioned that would contribute to enhanced variability in both groups, the fact that differences were observed gives some confidence that the program may have been effective. However, there were a number of differences that verged on significance ($p < .1$) and were likely Type II errors. In order for these findings to be detected as significant, an increased control of key interventional variables is required and/or an increase in sample size.

Conclusions

This study demonstrated that children in schools with CAI in PE class had enhanced motor competence and overall increased confidence and comprehension, as well as increased activity participation, in comparison with a standard PE curriculum. These findings were consistent with the self-report of the children. CAI methods seem to deliver a quality PL experience in PE classes leading to achievement of curriculum objectives. Overall, CAI can serve as a PL developmental approach that has meaningful and substantial benefits to children. The findings from this study provide insight to allow for further development of effective PE curricular delivery methods in schools, and provide quantitative

research-based support of the positive effects of circus arts, previously only revealed in qualitative evaluations.

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