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Does the Animal Fun program improve motor performance in children aged 4–6 years?

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ABSTRACT

The Animal Fun program was designed to enhance the motor ability of young children by imitating the movements of animals in a fun, inclusive setting. The efficacy of this program was investigated through a randomized controlled trial using a multivariate nested cohort design. Pre-intervention scores were recorded for 511 children aged 4.83 years to 6.17 years ($M = 5.42$ years, $SD = 3.58$ months). Six control and six intervention schools were compared 6 months later following the intervention, and then again at 18 months after the initial testing when the children were in their first school year. Changes in motor performance were examined using the Bruininks-Oseretsky Test of Motor Proficiency short form. Data were analyzed using multi-level-mixed effects linear regression. A significant Condition × Time interaction was found, $F(2, 1219) = 3.35$, $p = .035$, demonstrating that only the intervention group showed an improvement in motor ability. A significant Sex × Time interaction was also found, $F(2, 1219) = 3.84$, $p = .022$, with boys improving over time, but not girls. These findings have important implications for the efficacy of early intervention of motor skills and understanding the differences in motor performance between boys and girls.

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1. Introduction

Research has demonstrated that if children feel confident about their motor ability they engage more often in physical activities such as dancing and sports compared with those children who lack confidence in this area (Hay, Hawes, & Fraught, 2004; Mandich, Polatajko, & Rodger, 2003). This suggests that targeting motor skills development may be a suitable approach to increasing physical activity participation in children, known to be important for the prevention of obesity and cardiovascular disease (Biddle, Gorely, & Stensel, 2004).

Interventions have targeted physical activity participation in an effort to improve health outcomes (Marcus et al., 2006). Increased participation in physical activities in turn results in practice which is essential for motor skill development. It also leads to social skill development by providing opportunities to interact with other children in a play situation. Schoemaker and Kalverboer (1994) established a link between motor coordination difficulties and social and affective problems in children as young as 6 years. Piek, Bradbury, Elsley, and Tate (2008) found that kindergarten children's level of motor coordination was negatively related to anxious/depressed behavior as reported by the mother, which is consistent with the finding for older children (Pearsall-Jones, Piek, Rigoli, Martin, & Levy, 2011; Rigoli, Piek, & Kane, 2012). This is a serious concern as these children were only between 4 and 5 years of age. Furthermore, Bart, Hajami, and Bar-Haim (2007) found a relationship between motor ability in five year old children at kindergarten, and scholastic, social and emotional development a year later in their first year of school. It appears that targeting motor skill development prior to children commencing school may have many beneficial consequences for children.

Few physical activity programs have targeted the pre-school age despite the evidence to suggest that the transition from pre-school/kindergarten to the first year of formal schooling is a critical period in terms of development (Entwisle & Alexander, 1998; La Paro, Pianta, & Cox, 2000). Targeting fundamental movement skills (FMS), the FMS program (Hands & Martin, 2003) includes pre-school age children and targets body management, locomotor skills and object control. However, this program does not have any published reviews of its efficacy. It is based on a task-specific approach (Revie & Larkin, 1993) which argues that "repeated exposure to a given task, under the right constraints (task and environmental)" (Wilson, 2005, p. 816) will result in stable patterns of movement emerging, provided the child is ready in terms of maturational and biomechanical development. This approach is based on dynamical system theory (Thelen, 1995), which has been applied extensively in the investigation of motor coordination.

The Animal Fun program (Piek et al., 2010) was designed by a multidisciplinary team of researchers and health practitioners to promote both motor coordination and social skills in young children aged 4–6 years by imitating the movements of animals in a fun, inclusive setting. The program uses a task-specific approach based on dynamical systems theory (Thelen, 1995) and is administered by pre-school/kindergarten teachers following comprehensive training. Animal Fun is an inclusive, universal program involving all children within the class. This reduces any stigma that may result from particular children being chosen for a 'special' program. The program promotes both gross and fine motor skills training together with social/emotional development. This program is based on several key principles in relation to motor skill development. First, children need to feel competent and confident in their ability to perform particular activities (Sugden & Chambers, 2003). Next, although appropriate technique is important and forms part of the program, more importantly, children must enjoy what they are doing so they will continue to practice and improve their skills (Chambers & Sugden, 2006). What they are doing must also be meaningful. Young children love to imitate, and by imitating animals with which the children are familiar they attach meaning to the tasks as well as having fun and enjoyment (Piek et al., 2010).

In order to evaluate the Animal Fun program (Piek et al., 2010), a randomized cluster controlled trial, registered in the Australian and New Zealand Clinical trials registry (ACTRN1209000869279) was carried out. This program evaluated the motor, social and emotional changes that occurred as a result of the Animal Fun program. In the current paper, the findings for the children's motor skill development are presented, comparing the scores on motor ability at pre-intervention, around 6 months later following the intervention and then 18 months after the initial testing as a follow-up.

2. Methods

2.1. Participants

This study included 511 children (257 boys and 254 girls) ranging from 4 years, 10 months to 6 years 2 months of age (M = 5 years 5 months, SD = 3.58 months) at baseline, recruited from 12 schools across metropolitan and regional Western Australia in low socio-economic areas. Full study protocol details are published in Piek et al. (2010). All children enrolled in Pre-Primary classes at the selected schools together with their parents were invited to participate in the study. At the six months post-test, 450 children from the original sample were tested, and a total of 335 children completed all three phases of testing with the follow-up phase in year 1 of school being conducted 18 months after the initial testing (see Fig. 1). There was no significant difference between completers and dropouts in initial Bruininks-Oseretsky Test of Motor Proficiency-version 2 Short Form (BOT-2SF) scores, $t(501) = 0.94$, $p = .348$, or Movement Assessment Battery for Children-version 2 (MABC-2) scores, $t(489) = 0.10$, $p = .918$. Hence, dropouts were not more severely motor impaired. Also, there was no tendency for dropouts to be of a particular sex, $\chi^2(1) = 0.01$, $p = .927$.

2.2. Materials and measures

2.2.1. Animal fun program

By imitating the movements of animals in a fun, non-competitive way, the Animal Fun program (Piek et al., 2010) aims to develop motor and social skills, and increase children's confidence in their physical abilities. It is an inclusive program which can be used by the entire class regardless of individual levels of competence. Activities are grouped into nine modules (see Table 1) and into difficulty levels within the modules giving teachers the freedom to (1) graduate children's learning; (2) group children according to their physical activity level and (3) challenge more advanced children with more difficult movements.

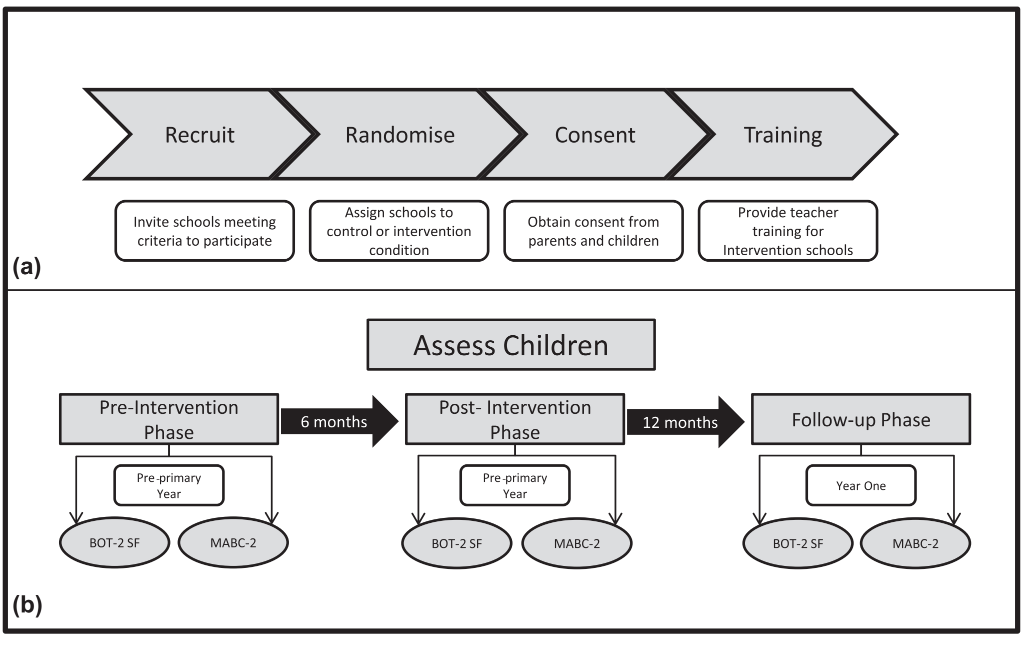

Fig. 1. A description of (a) the study recruitment and (b) the study design.

Table 1
The Animal Fun program modules.

Number	Name	Description
1	Body Management 1: Trunk and Lower Limb	Static Balance, Dynamic Balance, Climbing
2	Locomotion	Walking, Jumping, Hopping, Skipping
3	Object Control 1	Throwing, Catching, Kicking
4	Body Sequencing	Trunk and lower Limbs
5	Body Management 2: Trunk and Upper Limb	Trunk and girdle stability: strengthen shoulder, elbow, wrist and hand muscles
6	Fine Motor Planning	Sequencing of fine motor activities
7	Object Control 2 – Manual skills	Pre-scissor/Scissor Skills, manipulation of tools; in-hand manipulation
8	Hand Skills	Functional use of pencils, scissors, keyboards and mouse
9	Social/Emotional	Laughter, Identifying and Labelling Feelings, Breathing, Relaxation

Teachers participated in a one-day training course prior to embedding the program into their normal curriculum for 30 min a day, four days a week for a minimum of 10 weeks. Dosage sheets were provided for teachers to record the times and number of activities included each day, and all teachers elected to continue the program for the entire period prior to the post-testing. Teachers were encouraged to increase the difficulty level of the activities according to the level of competence of their class and to creatively embed Animal Fun Activities (Piek et al., 2010) into other curriculum areas of learning.

2.2.2. Bruininks–Oseretsky Test of Motor Proficiency-version 2 Short Form (BOT-2SF)

Motor performance was measured using the BOT-2SF (Bruininks & Bruininks, 2005). The long version, described as the most widely used test of motor proficiency (Bruininks & Bruininks, 2005) contains 53 items, whereas the short form has 14 items. As the long form takes at least 40–60 min to administer, the short form was chosen for this study, given the young age of the children. The long form has excellent test–retest and inter-rater reliability (Slater, Hillier, & Civetta, 2010). Although few studies have examined the psychometric properties of the short form, Bruininks and Bruininks (2005) reported the inter-rater reliability to be greater than .90, test–retest reliability greater than .80, and internal consistency as generally acceptable (>.80), although at ages 4 and 8 years correlations ranged from .60 to .92. According to Dietz, Kartin, and Kopp (2007), the short form is generally a reliable and valid measure of general motor ability.

2.2.3. Movement Assessment Battery for Children-version 2 (MABC-2)

The MABC-2 (Henderson, Sugden, & Barnett, 2007) was used to group children according to their level of motor proficiency (i.e., no problems, at risk, and definite motor problems) as defined by the MABC-2 manual. This test has been described as one of the most often used assessments by health professionals to identify motor impairment (e.g., Geuze, Jongmans, Schoemaker, & Smits-Engelsman, 2001). It includes 8 items which produce three component standard scores (manual dexterity, aiming and catching, and balance) in addition to a total standard score. The tests are divided into three separate age bands of 3–6, 7–10 and 11–16 years, the first of which was used in the current study. Given the testing time is generally between 20 and 40 min, it is suitable for young children. Test–retest reliability was reported by the test authors to be between .86 and .91 for a sample of 20 3-year old children, and a recent study (Smits-Engelsman, Niemeijer, & van Waelvelde, 2011) also reported reasonable reliability for the MABC-2 in a small study of 50 children aged 3 years.

2.3. Procedure

This study abided by the ethical guidelines set out by the National Health and Medical Research Council of Australia and was granted ethics approval from the Human Research Ethics Committee of Curtin University.

A list of government schools was used to identify those with more than 50 students aged 4 and 5 years in their pre-primary classes and located in areas of low socio-economic status (SES). From this, a total of 24 schools were identified that could be paired and matched as closely as possible for geographical location, SES and enrolled student numbers. Of these 12 pairs, six agreed to participate. Schools from each pair were randomly assigned to either the intervention or control condition using a coin toss. Apart from the three testing sessions, schools assigned to the control condition followed their normal curriculum, and were offered the Animal Fun program (Piek et al., 2010) and teacher training at the conclusion of the assessment.

Following approval from the school principal, parents were invited to participate in the study. They were provided with a detailed written description of the purpose and procedures of the project together with information about possible risks and benefits of participation. Written consent was obtained from both parents and children.

Teachers from the intervention schools were provided with intensive training prior to implementing the Animal Fun Program (Piek et al., 2010) by attending a full day workshop. This was followed by a number of class visits by the researchers to observe the Animal Fun activities in progress and to provide support to teachers as required. Teachers were asked to complete a weekly dosage report to indicate which modules/activities they had completed within class and to monitor progress across the modules.

2.4. Data analysis

Data were analyzed with multi-level mixed effects linear regression (MLM) (Bryk & Raudenbush, 1987; Dimitrov & Rumrill, 2003; Hofman et al., 2007; Holden, Kelley, & Agarwal, 2008) as implemented through SPSS's (version 19) Generalized Linear Mixed Models (GLMM) procedure. GLMM tested for intervention effects within the context of a hierarchical design in which time (3 levels) was nested within children, children ($N = 511$) were nested within teachers (29 levels), and teachers were nested within schools (12 levels). The initial model treated time (pre, post, follow-up), condition (intervention versus control), motor problems (definite, at risk, none), and sex (male, female) as fixed effects; and children, teacher, and school as random effects. The analysis examined all 2-way interactions and two 3-way interactions. The 4-way interaction would be difficult to interpret in terms of pre-existing theory and was therefore omitted from the analysis. In order to make the model robust to violations of sphericity, the covariance matrix was changed from the default of compound symmetry to autoregressive.

3. Results

3.1. Descriptives

Table 2 gives the means and standard deviations for the standard scores on the BOT-2SF for the two conditions over the three assessment times. Scores for boys and girls are provided separately as well as the total standard scores.

Table 2
Mean (SD) BOT-2SF standard scores at T1 (pretest), T2 (posttest), and T3 (follow-up) for boys and girls in each condition.

Condition	Time	Boys	Girls	Total
Intervention	1	51.94 (8.75)	51.22 (9.46)	51.57 (9.11)
	2	54.90 (8.75)	52.60 (8.98)	53.73 (8.93)
	3	58.18 (9.53)	54.35 (10.46)	56.22 (10.18)
Control	1	53.85 (8.97)	55.06 (8.55)	54.43 (8.77)
	2	53.78 (8.45)	55.40 (8.51)	54.55 (8.50)
	3	57.09 (9.25)	58.21 (8.95)	57.62 (9.09)

3.2. MLM analysis

The results of the MLM analysis are summarized in Table 3.

3.2.1. Intervention effects

The significant Condition × Time interaction, $F(2,1219) = 3.35$, $p = .035$, indicates an intervention effect. This effect is illustrated in Fig. 2. LSD post hoc comparisons were conducted to locate the source of the interaction. The pre-post comparisons and the post-follow-up comparisons were not significant for the control group ($p = .291$, $p = .692$) or the intervention group ($p = .077$, $p = .080$). The pre-follow-up comparison for the control group was also non-significant ($p = .435$); however, the pre-follow-up comparison for the intervention group was significant ($p = .001$).

However, the non-overlapping confidence intervals at pre-test indicate that the intervention group had significantly poorer baseline motor skills than the control group. The 3-way interactions were non-significant indicating that the Condition × Time interaction (i.e., the intervention effect) was not moderated by motor problems or sex.

3.2.2. Motor problems

There was a significant main effect for motor problems, $F(2,1219 = 29.415$, $p < .001)$. This result is predicted, as it indicates that children with more severe motor problems (as assessed by the MABC cut-offs) have lower BOT-2SF standard scores. The motor problems effect was not involved in any interactions. It can therefore be generalized across condition, sex and time.

3.2.3. Sex effects

There was a significant Time × Sex interaction, $F(2,1219) = 3.84$, $p = .022$, shown in Fig. 3. This suggests that the rate of improvement in motor skills across time is greater for the boys. According to the LSD post hoc tests, the pre-post comparisons and the post-follow-up comparisons were not significant for girls ($p = .735$, $p = .612$) or boys ($p = .981$, $p = .085$), respectively. The pre-follow-up comparison for the girls was also non-significant ($p = .833$); however, the pre-follow-up comparison for the boys was significant ($p = .047$). The time × sex interaction did not interact with Motor Problems or condition, and can therefore be generalized across these factors.

There was also a significant Condition × Sex interaction, $F(1,1219) = 5.205$, $p = .023$, as indicated in Fig. 4. LSD post hoc comparisons indicated that boys had better motor skills than girls in the intervention condition ($p = .042$), but there was no significant difference between boys and girls in the control condition ($p = .620$). The Condition × Sex interaction did not interact with motor problems or time. The lack of a 3-way Condition × Sex × Time interaction means that the Condition × Sex effect is stable across time and is therefore unlikely to have confounded the intervention effect.

Table 3
Results of the multi-level mixed effects linear regression (MLM). The dependent variable is the standard score for the BOT-2SF.

Source	Numerator df[a]	*F*-value	*p*-value
Condition	1	0.06	.814
Time	2	0.88	.414
Motor Problems (MP)	2	29.42	.000
Sex	1	0.32	.574
Condition × Time	2	3.35	.035
Condition × MP	2	0.30	.740
Condition × Sex	1	5.21	.023
Time × Sex	2	3.84	.022
Time × MP	4	1.37	.244
Sex × MP	2	0.04	.966
Condition × Time × MP	4	1.51	.198
Condition × Time × Sex	2	1.21	.300

[a] *Note:* The denominator *df* is 1219 for all values.

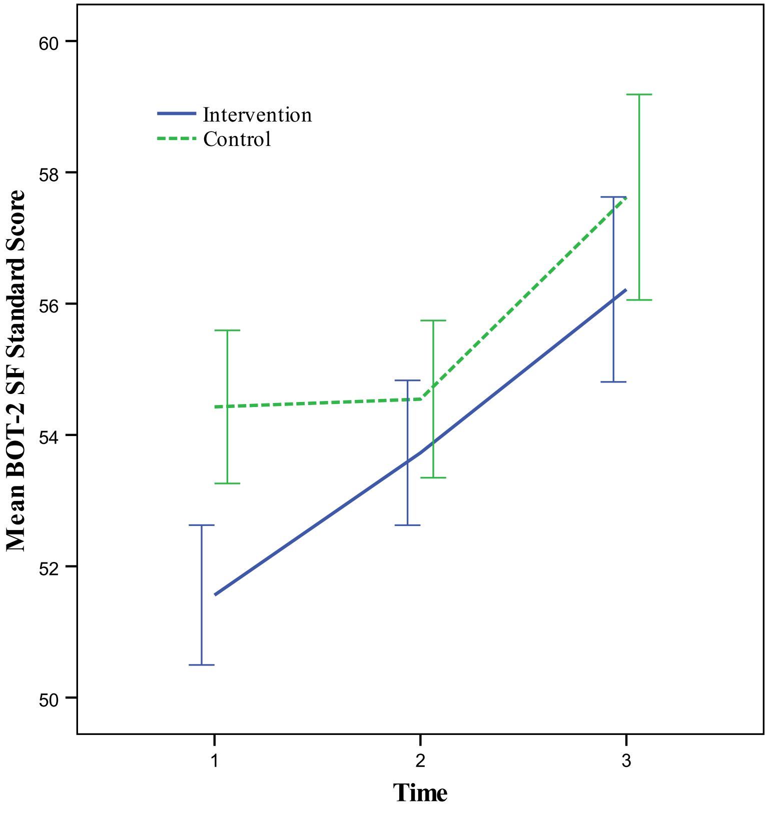

Fig. 2. Mean BOT-2SF standard scores at T1 (pretest), T2 (posttest), and T3 (follow-up) for each condition. Error bars, which represent 95% confidence intervals, are offset horizontally to make them visible.

4. Discussion

Given the relationship between physical activity participation and motor performance (Hay et al., 2004; Mandich et al., 2003), intervention programs that improve children's motor skills are essential to ensure that they have the best opportunity to increase their physical activity participation. The early years are an important time to develop appropriate skills, and as the transition from pre-primary/pre-school or kindergarten to the first year of formal schooling has been identified as a crucial time in a child's development (Entwisle & Alexander, 1998; La Paro et al., 2000), the preschool year seems an appropriate time to provide interventions to improve children's motor skills. The current study investigated one such intervention, the Animal Fun program (Piek et al., 2010), and found a significant improvement in children's motor skills when assessed 18 months after the initial pre-test. This improvement was not found for the children in the control condition. This movement skills program was administered four days a week for 30 min each day, and was designed to be fun for the children.

It is now well established that boys and girls differ in their motor ability, even in the early ages (e.g., Anastasi, 1981; Capute, Shapiro, Palmer, Ross, & Wachtel, 1985; Pedersen, Sigmundsson, Whiting, & Ingvaldsen, 2003; Piek, Gasson, Barrett, & Case, 2002; Thomas & French, 1985; van Waelvelde, de Weerdt, de Cock, & Smits-Engelsman, 2003). Overall, boys have been found to perform better on motor skills such as running, jumping and catching, whereas girls have better fine motor skills (Thomas & French, 1985). Although it has been suggested that such differences may result from sociological

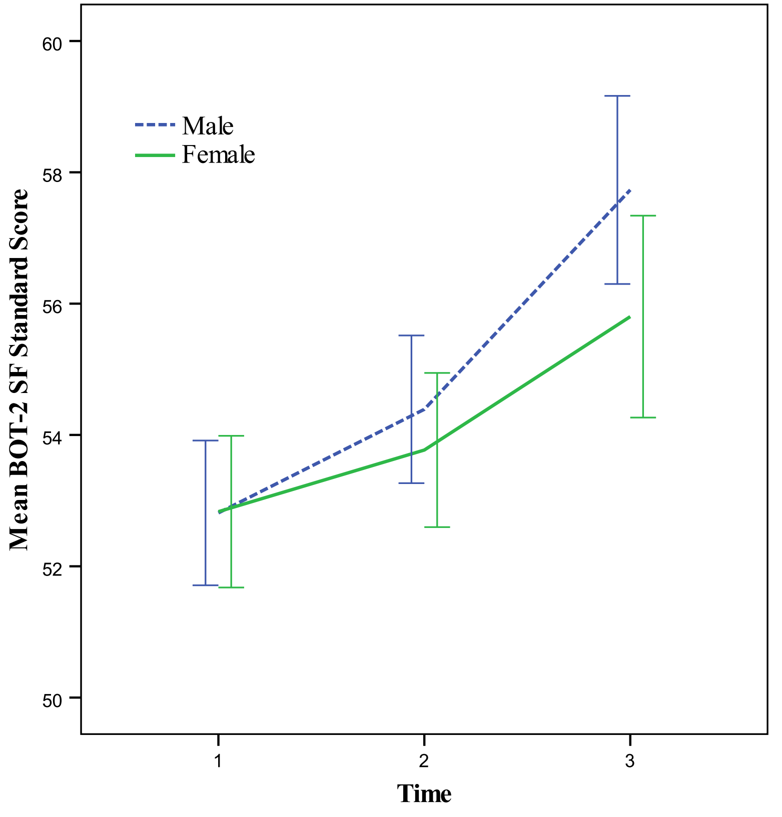

Fig. 3. Mean BOT-2SF standard scores at T1 (pretest), T2 (posttest), and T3 (follow-up) for females and males. Error bars, which represent 95% confidence intervals, are offset horizontally to make them visible.

factors such as gender stereotyping (Thomas & French), there is also neurological evidence identifying differences between boys and girls in brain structure in relation to motor related tracts (De Bellis et al., 2001; Liu et al., 2011). In the current study, the BOT-2SF was used to assess changes in motor performance. This is one of the few motor tests that uses sex specific norms for all ages of the test, and as standard scores were used in the current study, should control for any sex differences. As the Condition × Time × Sex interaction was not significant, the intervention did not impact differently on boys and girls. Furthermore, when looking at the whole sample (intervention and control conditions), girls did not significantly increase their motor performance over time. However, the boys' motor performance was significantly better in Year 1 at the follow-up testing compared with the pre-test scores. These results suggest that boys, but not girls, improve their motor proficiency during the transition stage to year 1. Although physical differences such as body proportions, body mass and fat mass between boys and girls have been investigated (Williams, Wood, & De Ste Croix, 2011), there has been very little research investigating differences in motor development in boys and girls, particularly for subtests of motor performance such as locomotion and manual control. Williams et al. suggest that the age of 6 years is where physical characteristics such as body, muscle and fat mass start to differentiate between boys and girls, and it is possible that this may be a factor contributing to differences in rates of motor development for boys and girls. This is an area in need of further research. It is also possible that this sex difference is a result of different levels of motor performance in Australian boys and girls, given that the BOT-2 is based on norms from children in the USA (and hence the need for Australian norms).

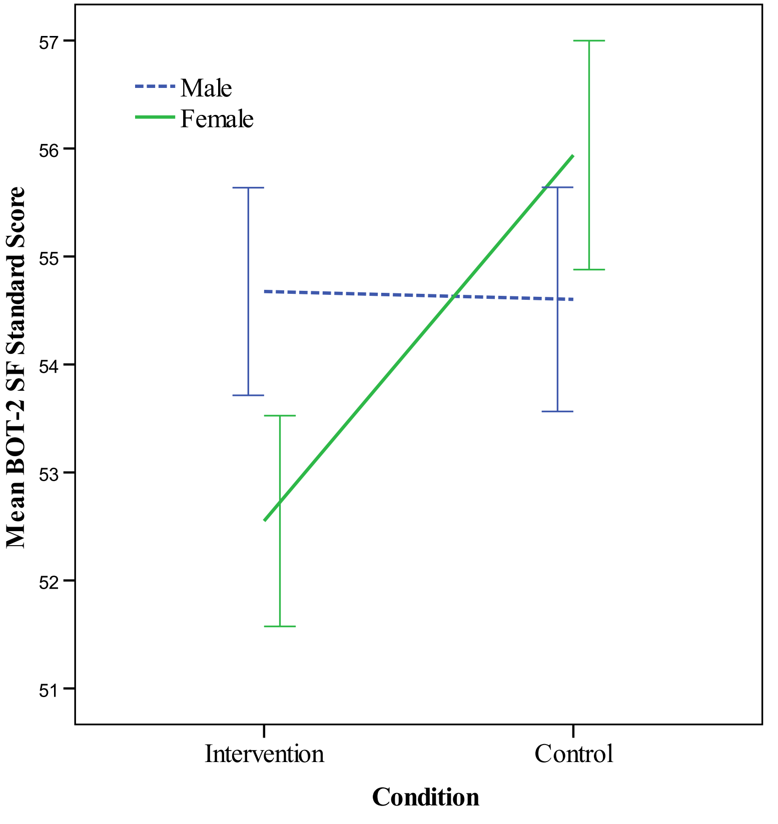

Fig. 4. Mean BOT-2SF standard scores for females and males in the intervention and control conditions. Error bars, which represent 95% confidence intervals, are offset horizontally to make them visible.

Further research is also required to investigate the transfer of the program to other activities, such as play in the playground or at home. Given that this program was designed to be like a game where the children imitate animals, it is possible that children practiced these skills out of classroom time. This would be an additional advantage of a program that focuses on fun rather than basic skill practice, and further research investigating this would be beneficial.

It should be noted that a limitation of the study which needs to be addressed in further research was that children in the intervention condition had poorer motor skills at pre-test than the control group, despite matching the control and intervention schools on key variables such as SES, school size and location. Also, the boys were poorer than the girls overall in the intervention group. However, none of the 3-way interactions were significant, suggesting that the intervention effect was not moderated by other variables such as sex or motor problems, indicating that this is a real effect.

5. Conclusions

The Animal Fun program (Piek et al., 2010) was found to significantly improve motor performance. However, given that the motor ability of the intervention group was significantly poorer than the control group at baseline despite being matched for SES, school location and school size, further investigation is needed to determine whether the program would lift performance above that of a control group which has been matched for initial motor ability. Despite this limitation, this randomized controlled trial of the Animal Fun program has provided promising initial findings that a universal movement program focusing on fun and embedded into the usual kindergarten or pre-primary/pre-school curriculum may be a useful approach to improving motor proficiency in children prior to commencing their formal years of schooling.

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