A combined movement and storytelling intervention enhances motor competence and language ability in pre-schoolers to a greater extent than movement or story-telling alone

Duncan, M, Cunningham, A & Eyre, E

Original citation & hyperlink:
Duncan, M, Cunningham, A & Eyre, E 2019, 'A combined movement and story-telling intervention enhances motor competence and language ability in pre-schoolers to a greater extent than movement or story-telling alone' *European Physical Education Review*, Vol 25, Issue 1, pp. 221-235.
http://dx.doi.org/10.1177/1356336X17715772

ISSN 1356-336X
ESSN 1741-2749

Publisher: Sage

This article is currently in press. Full citation details, including DOI, will be uploaded when available.

A combined movement and story-telling intervention enhances motor competence and language ability in pre-schoolers to a greater extent than movement or story-telling alone

Michael J. Duncan[1], Anna Cunningham[2], Emma L. J. Eyre[1]

[1]School of Life Sciences, Coventry University, UK

[2]Psychology, Behaviour and Achievement Research Centre, Coventry University, UK

Short Title: movement and storytelling intervention

Corresponding Author: Michael J Duncan, *School of Life Sciences,* Coventry University, Priory Street, Coventry, UK, CV1 5FB. Tel +44247666813. Email:michael.duncan@coventry.ac.uk

Abstract

This study examined the effect of a six week combined movement and story-telling intervention on motor competence and naming vocabulary in British pre-schoolers. Using a cluster randomised design, three pre-school classes were allocated to one of a combined movement and story-telling intervention (n = 22), or a movement only (n = 25) or story-telling only (n = 27) intervention. Motor competence and language ability were assessed pre, post and eight week post intervention. Results from repeated measures ANOVA indicated significantly greater improvement in both motor competence and language ability pre to post intervention for the combined movement and story-telling group compared to the movement only or story-telling only groups. However for the period post intervention to eight weeks post intervention the magnitude of change for motor competence and language ability was significant for all groups and similar in magnitude. The results of this study demonstrate the efficacy of combining movement and story-telling, over movement or story-telling alone, to benefit both motor competence and language ability in preschoolers. Combining both movement and story-telling appears to offer synergistic benefits in relation to physical and communication development which are critical for good development in the early years.

Keywords: Motor Development, Physical Literacy, Story-telling, Language, Early Years

Introduction

Increasing prevalence of sedentary behaviour and decreasing engagement in sufficient levels of health enhancing physical activity (PA) in children is considered a current public health concern (Herman et al., 2015). Low levels of motor competence and fundamental movement skills (FMS), e.g. catching, throwing, jumping, running, have been identified as a key barrier to development of a physically active lifestyle in children and adolescents aged 3-18 years (Lubans et al., 2010). Enhanced motor competency and mastery of FMS have also been identified as a key contributor to children's physical, cognitive and social development as well as providing the foundation for healthy weight throughout life (Lubans et al., 2010).

Children with better motor competence also have higher levels of academic achievement and PA (Jaakkola et al., 2015). Higher levels of motor competence may enable children to engage in higher levels of PA which, in turn, result in improved cognitive performance and academic achievement. The link between PA and academic achievement in children has recently been supported by Haapala et al. (2017). Haapala et al. (2017) noted that children, aged six-eight years old, with higher levels of PA and lower levels of sedentary time had higher scores for reading fluency and reading comprehension compared to children with either lower levels of PA or higher levels of sedentary time. This association also persisted across all the ages examined in their study leading Haapala et al. (2017) to conclude that promoting a physically active lifestyle may benefit the development of reading skills in children during their pre-school (i.e. the time before a child is old enough to go to school) years.

The purported link between motor development, PA and academic performance is not new, but only a few studies have examined this issue in young children. This may be due to the complexity in assessing these constructs in young

children; data collection is more time and labour intensive in this population relative to older children or adults. Most prior work has mainly focused on executive function (i.e. the cognitive ability to manage oneself and one's cognitive resources) and selfregulation (i.e. cognitive skills that help regulate thoughts, behaviour and responses) and the link between movement and language has received little attention. Recent work by Becker et al. (2014) has however reported that active play was not significantly associated with emergent literacy or mathematics scores in 50 preschoolers. Becker et al. (2014) also reported an indirect effect of active play on emergent literacy which was mediated by self-regulation. They suggested that increasing active play, led to growth in self-regulation which, in turn led to increased academic achievement and consequently postulated that PA during the pre-school period may have a positive effect on academic achievement (Becker et al., 2014). Likewise, research by Chang et al. (2013) reported a significant increase in response accuracy and reduction in response times on an Eriksen flanker task in preschoolers who undertook a 35 minute, twice weekly, low-moderate intensity coordinative exercise programme for eight weeks. Chang et al. (2013) suggested that exercise may preferentially benefit prefrontal lobe dependant tasks in preschoolers by increasing attentional resource allocation and enhancing efficiency of neurocognitive processing (i.e. the ability of the brain to perform a series of operations) in the immature brain.

The association between motor competence in the early years and academic achievement has specifically been acknowledged in the United Kingdom and the statutory framework for the early years foundation stage (EYFS) in particular. The EYFS places physical development as one of its three prime areas of learning alongside communication and language and personal, social and emotional development (Department for Education, 2014). Despite this, data suggest that both motor and language skills are poor in British children, particularly in the early years

(Sylva et al., 2014). The effective provision of pre-school education (EPPE) project has also identified a need to develop effective means of enhancing pre-school education in a way which is practical and manageable by pre-school staff (Sylva et al., 2014). Recent research by Schmitt et al (2015) reported that an eight-week, twice weekly (20-30 minutes per session) classroom based intervention enhanced behavioural self-regulation and cognitive flexibility in a group of 276 pre-schoolers randomised into intervention or control groups. Likewise, Diamond and Lee (2011) summarised interventions shown to aid executive function development in children aged four-12 years old. They reported that executive function can be enhanced in children via a diverse range of intervention with the strongest evidence for changes in executive function for children in the pre-school years resulting from curricula based interventions.

One potentially effective focus for intervention in the pre-school setting, which aligns with the EYFS, would be combining experiences to develop motor competence alongside other academic activity in a meaningful manner. There is good evidence that movement-based interventions lead to improved motor competence and overall PA in young children, including pre-schoolers (Donath et al., 2015). Likewise, there is also good evidence that engaging children in story-telling, as an academic activity, leads to benefits in language development in typical (Kory and Breazeal, 2014) and culturally diverse populations (Goodman, and Dent, 2016; Peterson, and Spencer, 2016), which may be a precursor to other aspects of academic performance in pre-schoolers. Interventions that enhance language skills in pre-schoolers have been shown to improve reading comprehension ability once children start school (Fricke et al., 2013). In turn, good reading comprehension has been associated with better academic outcomes (Oakhill et al., 2016). Studies suggest that engaging in story-telling results in positive effects in intellectual, social and emotional development

(Hasni-Mokhtar et al., 2011) because as children engage in story-telling they learn to listen to, participate in and understand narrative discourse creating a path to more sophisticated use of language, which is important in forming relationships with adults and other children (Brice 2004; Mallan 1992). The process of story-telling also involves memory and social skills (Glonek and King, 2014), both key in early years settings for future academic, social and emotional development. There is also potential for story-telling to employ physical as well as narrative aspects e.g. through 'acting out' a story. Practices in the early years setting which could employ both physical and story-telling aspects together might therefore be well placed to address the three prime areas of the EYFS, critical to later academic development (Department for Education, 2014).

Literature has suggested that movement and PA can improve cognitive processing, increase hippocampal volumes, enhance attention and blood flow to the brain (Donnelly et al., 2016; Voss et al., 2014) at least acutely post activity. However, most prior literature has focused on exercise of moderate to vigorous intensity (Donnelly et al., 2016; Voss et al., 2014). Maintaining such intensity of exercise with pre-schoolers may be unrealistic due to the nature of movement and activity patterns in this age range. Another suggestion for enhanced academic and cognitive performance in pre-schoolers may arise from embodied cognition (Wellsby and Pexman, 2014). Embodied cognition approaches suggest that sensorimotor experiences gained through bodily actions within the environment are important and useful for developing cognitive capabilities and cognitive processing (Engel et al., 2013). It is possible therefore that combining a movement intervention with a cognitive intervention that uses the frontal lobe (such as a language-focussed, storytelling intervention) may lead to additive benefits for both movement and cognitive performance (which could in turn lead to better academic outcomes) either as a consequence of embodied cognition via sensorimotor experience or enhanced blood

flow to the brain with higher intensities of exercise. Using a story-telling approach would seem well suited here in terms of its ability to enmesh with physical development, thereby meeting the aims of the EYFS as well as being easily accessible to pre-school aged children.

The aim of this study was therefore to pilot a combined movement and storytelling intervention, examining the effect of a combined movement and story-telling intervention, movement only intervention or story-telling only intervention on motor competence and naming vocabulary in British pre-schoolers. If such a link can be established, then this will lead to potential benefits in PA and academic achievement once the children reach school-age.

Methods

Participants

Following institutional ethics approval and parental informed consent, 74 preschoolers (39 boys; 35 girls aged three-four years) from three nurseries/pre-schools in central England participated in a cluster randomised intervention design study. The nurseries included were located in areas ranked as 60-80% least deprived in comparison to England as a whole using the Index of Multiple Deprivation (APHO 2008). Pre-schoolers from three nurseries were randomly allocated to one of three, 6 week interventions, 1) a combined movement and story-telling intervention, 2) a movement only intervention or 3) a story-telling only intervention. Children were only eligible to participate if they were free of neurological disease, attentional disorders or physical disabilities, and had normal or corrected-normal vision based on a minimal 20/20 standard. Participants were also only eligible to take part if they did not have a

recognised special educational need (e.g. dyslexia), behavioural problems or were classified as gifted and talented according to pre-school records.

Classes (n = three) were randomised into both a combined movement and story-telling intervention (n = 22), a movement only intervention (Control) (n = 25) or a story-telling only intervention (Control) (n =27). In this way we sought to examine the effect of the combined movement and story-telling intervention compared to receiving the individual components of the intervention in isolation. Following an orientation session, all participants undertook assessment of motor competence (process measures) and language ability (pre-test). This process was then repeated on completion of the six week intervention period (post-test) and then again eight weeks post intervention (delayed post-test). In the present study data was collected from all participants pre and post the intervention. However, for the eight week post intervention data collection period, the participants had all moved from their preschool/nursery setting into primary school. This made it logistically difficult to collect the eight week post intervention data on all the original participants, as the children had moved to multiple different schools and not all of the schools were amenable to participating in the follow up data collection period. As a consequence, 37 children provided data at the eight week follow up period. The results of the present study will therefore be presented in two parts. Firstly, the pre to post intervention data for all children will be presented followed by the post intervention to eight weeks follow period for those children where data were available. In this way we sought to indicate the acute (pre to post) and longer term (post intervention to eight weeks post) effects of the intervention.

Motor competence assessment

Process measurements of motor competence were employed in the present study. Process oriented motor competence assessments are concerned with how the skill is performed and indicate the quality of motor skill competence (Burton and Miller, 1998). In the current study four motor skills (run, jump, catch, overarm throw), were assessed using the Test of Gross Motor Development-2 (TGMD-2) (Ulrich 2000). The TGMD-2 assesses whether predefined components of each skill (four components for each skill) are performed or not performed to determine the mastery of each skill. Each skill was video-recorded (Sony video camera, Sony, UK) and subsequently edited into single film clips of individual skills on a computer using Quintic Biomechanics analysis software v21 (Quintic Consultancy Ltd., UK). The skills were then analysed using this software and a process oriented checklist, enabling the videos to be slowed down, magnified, replayed and scored. Scores from two trials were summed to obtain a raw score for each skill. The scores for all the skills were then summed to create a total score (0-32) reflecting overall motor competence following recommended guidelines of administration of the TGMD-2

(Ulrich 2000). Two researchers experienced in the assessment of children's

movement skills (having previously assessed movement skills in the context of another research study) analysed the FMS videos. Both raters had been trained in two separate two-three hour sessions by watching videoed skills of children's skill performances and rating these against a 'gold standard' rating. Congruent with prior research (Barnett et al., 2014), training was considered complete when each observer's scores for the two trials differed by no more than one unit from the instructor score for each skill (>80% agreement). Inter- and intra-rater reliability analysis was performed for all the FMS between the two researchers. Inter-rater reliability was 92.3% and intra-rater reliability was 97.6%, demonstrating good reliability (Jones et al., 2010).

Language ability

Language ability was assessed using the naming vocabulary subscale from the early years section of the British Ability Scales-3 (BAS3, Elliott and Smith, 2011). During the test, children were shown a series of coloured pictures and asked to name them. Guidelines were provided as to which responses were correct, incorrect, or required prompting. The Early Years British Ability Scales is a collection of standardised tests that are used to assess general thinking and reasoning skills, including language ability in children aged 2.6 to 5.0 years. In the current study the naming vocabulary subscale was utilised to provide a measure of language ability which reflects storage, search and retrieval processes within an information processing model of cognitive performance (Elliott and Smith, 2011). The subscale reflects general language

development and asks participants to cognitively match images to names/words requiring cognitive search strategies and word retrieval from long-term memory, rather than simply being a test of vocabulary. The naming vocabulary subscale is specifically designed for use in Early Years populations and
demonstrates good reliability and validity (See Hill, 2005 for a review).

The naming vocabulary subscale test was administered to children on an individual basis before and after the movement and story-telling intervention with researchers administering the tests being unaware of intervention group allocation. Both pre, post and eight weeks post intervention it was administered before the assessment of motor competence and in accordance with recommended guidelines for use of the BAS3 (Elliott and Smith, 2011). Scores are presented as raw ability scores for the purposes of the current study in order to capture absolute improvement in naming vocabulary between pre and post test.

Intervention components

For the three different interventions employed in the present study, sessions took place twice per week for six weeks and lasted 20-30 minutes per session. The movement interventions (either in isolation or combined with story-telling) used in the present study were specifically designed for pre-school aged children and were based on earlier reports on motor development for children of the ages involved in the study (Temple and O'Connor, 2005).

This design of the interventions was taken, congruent with studies examining efficacy of school based movement interventions (Bryant et al., 2016; Morgan et al.,

2013), in order to have little disturbance on other aspects of the curriculum, to create a design that could be realistically integrated into pre-school settings and to explore a design that would be more likely to be employed in the pre-school setting by preschool staff. The two movement interventions were also designed to be inexpensive and developmentally appropriate.

Components of the combined movement and story-telling intervention

The intervention undertaken by the combined movement and story-telling group was based around the popular children's book The Gruffalo (Donaldson and Scheffler, 2009). The movement related element of the intervention lasted approximately 20 minutes per session with five minutes before and five minutes afterwards focused on the story-telling element. The intervention was designed to enhance motor competence but in a way which added activities which would require the development of key aspects of communication such as facial expressions, body language and emotion.

For each session the children undertook activities relating to the following key FMS: Jump, leap, hop, slide, gallop, skip, throw, and catch. In each session the children focused on the role of one of the characters in the book and working on movement patterns that related to that character (e.g. a mouse, an owl). The full programme can be provided on request to the first author. In the final session of the intervention, the children integrated all the movements they had previously worked on using the narrative of The Gruffalo to 'tell' the story using movement. The movement demands of the programme were monitored by researchers during each session to ensure that the dose of activity per session was comparable for all children. Within each session the children were undertaking approximately 80-100 foot contacts of

locomotor activity with integrated object control activities classed as moderate intensity as recommended for children engaged in plyometric type activity (Chu and Myer, 2013).

Prior to each session, a researcher sat with the children and explained the character they were going to be working on that week and asked them to describe how that character might move. The researchers probed the children's answers by asking questions such as 'how' and 'why'. For example, in the case of the snake in the story children often responded that he would 'slither', 'slide' 'wriggle'. This was then followed by the researcher asking 'how would the snake slither/slide/wriggle?' with the researcher implicitly working on use of adjectives/descriptive language with the children, and then 'why would the snake move that way?' prompting the children to think about where that particular animal lives and specifically about how they move. There was a focus, per week, on four children (different children each week) providing the stem answers to the first question and then asking other children to then contribute. At the end of each session the researcher would also sit with the children and show them particular images from the book, and the particular page/animal in the book they were working on that week. The researcher asked the children to describe what they could see in the picture. This was followed by prompts to add descriptive words to the initial responses. Finally, the children were then asked to explain how they thought the animal/creature in each picture felt. As with the other elements of the story-telling aspect, the researcher prompted the children to ask 'why' they thought this. The researchers were conscious to ensure all the children in the group contributed verbally over the course of the six week programme.

Control interventions

The two other groups were employed as control groups. The two control interventions were designed, as best as possible to reflect either the same movement content or the same story-telling content experienced by the combined movement and story-telling group. The movement intervention only group undertook the same movement activity programme that was undertaken by the combined movement and story-telling intervention but without the beginning or end of session discussion element and with each session lasting approximately 20 minutes. The movement only intervention group undertook activities relating to the same FMS: Jump, leap, hop, slide, gallop, skip, throw, and catch that the combined movement and story-telling group also undertook. However, for this group, the sessions were not contextualised with the story of The Gruffalo. Instead the sessions were introduced with the particular skill/skills the children would be working on that session. Following this, the children engaged in FMS activities for a 20 minute period. In the movement only group, the same skills were performed in the same way as the combined movement and story-telling intervention but without the context of the story.

The story-telling only intervention group experienced the same story related input as the combined movement and story-telling group but without the movement aspect. In lieu of the movement session the children were read the story of The Gruffalo each session. The children in the story-telling only group were asked the same questions as those in the combined movement and story-telling group. The same probe questions were used and there was an emphasis on four children each week providing stem answers to the first question and then asking other children to contribute, in exactly the same way as occurred with the combined movement and story-telling group. Likewise, at the end of each session, the children in the storytelling only group were shown the same images from the book and were asked the same

questions as the children in the combined movement and story-telling group. In this case, each session in the story-telling only condition took approximately 10 minutes.

Statistical analysis

Recognising that there was a discrepancy in the number of participants who were able to provide eight week follow up data, compared to the number of participants who completed pre and post intervention assessment, two phases of statistical analysis were performed. In the first case, in order to examine any differences in FMS scores and language ability pre to post the intervention, two (one for FMS and one for language ability) repeated measures Analysis of Variance (ANOVA) were performed. Scores for FMS and language ability were included as within subjects factors and intervention (combined movement and story vs. movement only vs. story only) was included as the between subjects factor.

Secondly, in order to examine the effect of the intervention on FMS and language ability eight weeks post intervention, the statistical analysis was rerun using two, two (post, vs. eight weeks post) X three (intervention group) ways, repeated measures ANOVAs. This second analysis served to examine any changes in FMS and language ability from the end of the intervention to the eight week follow up period in the 37 children (story-telling only n = 14, movement only n = eight, movement and story-telling n = 15) who were available to complete the data collection during this phase. Where any significant differences were found post hoc pairwise comparisons (Bonferroni adjusted) were employed to examine where the differences lay. Partial η^2 was used as a measure of effect size. The Statistical Package for Social Sciences (SPSS, Version 20) was used for all analysis.

Results

FMS

Results from repeated measures ANOVA examining any changes pre to post the 6 week period indicated a significant group X Pre to post intervention interaction (F 1, 74 = 19.8, P = 0.001, Partial η^2 = .769, See Figure 1). Bonferroni adjusted post hoc pairwise comparisons indicated no significant difference between FMS scores for the three groups pre intervention (P = 0.406). Post intervention FMS scores were significantly higher for the combined movement and story-telling group compared to the story-telling only (P = 0.001) and movement only (P = 0.005) groups. There was no significant difference in FMS scores post intervention between story-telling only and movement only groups (P>0.05). Motor competence significantly increased pre to post for all the groups (all P = 0.001) with the magnitude of change being significantly greater for the combined movement and story-telling group (Δ=4.86) compared to the movement only (Δ=2.88) or story-telling only (Δ=1.77) groups.

Figure 1 about here

When data was analysed using the post intervention to eight weeks post data, there was a significant main effect for time (post intervention to eight weeks post (F 1, 34 = 8.014, P = 0.008, Partial η^2 = .191, See Figure 2). This indicated that, irrespective of group, FMS scores increased significantly post intervention to eight weeks post intervention. There was no significant time x group interaction (P = .762) with the magnitude of change for FMS being Δ=0.6, 0.9, and 0.7 for story-telling, movement and

combined movement and story-telling groups. Data were reanalysed using analysis of covariance, controlling for age. This did not change the findings of the original statistical analysis, nor was age significant as a covariate, so is not reported further.

***Figure 2 about here ***

Language ability

Like the results for motor competence, the results from repeated measures ANOVAs for language ability scores indicated significant group X time (pre to post) interactions ($F\ 1, 74 = 64.59$, $P = 0.001$, Partial $\eta^2 = .469$, See Figure 3). There was no significant difference in naming vocabulary scores pre intervention ($P = .267$). Post intervention naming vocabulary scores were however significantly different ($P = 0.001$). Post intervention naming vocabulary scores were significantly higher for the combined movement and story-telling group compared to the story-telling only ($P = 0.001$) and movement only ($P = 0.003$) groups. There was no significant difference in naming vocabulary scores post intervention between story-telling only and movement only groups ($P>0.05$). Naming vocabulary scores significantly increased pre to post for all the groups with the magnitude of change being significantly greater for the combined movement and story-telling group ($\Delta=13.6$, $P =- 0.001$) compared to the movement only ($\Delta=5$, $P = 0.001$) or story-telling only ($\Delta=3.4$, $P = 0.08$) groups.

Figure 3 about here

When data was analysed using the post intervention to eight weeks post data, there was a significant main effect for time (post intervention to eight weeks post (F

1, 34 = 10.03, P = 0.003, Partial η^2 = .233, See Figure 4). Irrespective of group, naming vocabulary scores increased significantly post intervention to eight weeks post intervention. There was no significant time x group interaction (P = .887) with the magnitude of change for naming vocabulary being Δ=4.8, 3.1 and 4.2 for storytelling, movement and combined movement and story-telling groups. Data for language ability were also reanalysed using analysis of covariance with age as a covariate. This did not change the findings of the original statistical analysis so is not reported further.

Figure 4 about here

Discussion

The results of this study demonstrate the efficacy of including a combined movement and story-telling intervention on both motor competence and language ability in preschoolers. The changes observed in the current study were superior when movement and story-telling were combined compared to those seen in children who undertook either a story-telling only or movement only intervention. The current study is the first to date that has investigated the potential of integrating movement and story-telling into an intervention in a way which is practically useable by pre-school teachers. As such the results of the current study are novel and extend the work of prior researchers that have demonstrated the importance of developing motor competence (Donath et al., 2015) or language ability (Fricke et al., 2013) through intervention in pre-schoolers. Importantly, the combined movement and story-telling intervention trialled in this study explicitly address the three prime areas of the EYFS (Department

for Education, 2014). We therefore suggest that this approach offers an innovative and useful means by which to improve physical and cognitive performance in children aged 3-4 years old.

The results of the current study in respect to both language ability (via BAS3 naming vocabulary scores) and motor competence (via total FMS scores) demonstrate a 'schooling effect' that is more commonly associated with the onset of formal school education rather than pre-school education. The schooling effect is commonly seen when children begin formal education and is associated with an acute increase in scores for cognition and academic ability due to the introduction of formal 'schooling' (Carlson et al., 2012). Thus, the present intervention may augment the improvements seen in cognitive and academic ability when children move into school by potentiating the effect in pre-school and thereby prompting a double schooling effect. This suggestion is however speculative and additional research would be needed to examine whether this double schooling effect would be present or whether the changes observed in the present study simply elicit the schooling effect earlier than expected. The data presented in the current study suggest the combined movement and story-telling intervention accelerates motor competence and language ability pre to post intervention but that once withdrawn motor competence and language ability reverted to an expected developmental pathway. The larger increases in FMS and language ability seen in the combined movement and story-telling group, compared to the story-telling only or movement only groups, resulted in higher FMS and language scores eight weeks post intervention, but the magnitude of change for both FMS and language ability were similar for all groups from completion of the intervention period to eight weeks post intervention.

Given the novel approach taken in this study it is somewhat difficult to make direct comparisons between the results presented here and the results of previous work. The results of the current study do however align with prior work which evidences that FMS can be enhanced via bespoke interventions based in pre-school settings (Donath et al., 2015; Adamo et al., 2016). The results of the present study also support claims made by Adamo et al. (2016) that brief interventions, based in pre-school settings, that target movement skills may be particularly effective.

The results from the present study are also difficult to compare to other interventions that have focused on language and language related ability (e.g. Fricke et al., 2013) and it is important to try to explain why the combined movement and story-telling intervention produced significantly more positive improvements in language ability than the story-telling intervention alone and why the combined group produced significantly greater change in FMS compared to the movement intervention alone. There is more than one potential mechanism for the changes seen in the current study. Firstly, acute bouts of exercise have been shown to promote transient changes in brain function, cognition and academic performance (Hillman et al., 2009). It has also been suggested that the period immediately post a 20 minute bout of PA may be one where academic performance can be enhanced if used in an interventional approach, as is the case with any intervention (Hillman et al., 2009). The main element of the language aspect, in the current intervention, occurred immediately following the movement element. This would correspond to the purported window of advantage, due to increased blood flow to the brain (Dietrich 2003), where potential for cognitive and academic performance can be augmented.

Secondly, integrating the story of The Gruffalo within the movement aspects of the intervention, where children 'acted' and moved like the various characters in the book, may have been more involving and attractive for the children to engage in, compared to the movement only or story-telling interventions. The children may therefore have invested more or engaged more with the combined intervention as a consequence resulting in enhanced language compared to the story-telling only group and enhanced FMS compared to the movement only group. Embedding a narrative with movement in the combined story-telling and movement group may have made the movement aspect more enjoyable, requiring greater use of imagination by the children. Both enjoyment and imagination that have been cited as developing through story-telling approaches (Hasni-Mokhtar et al., 2011). Language is also acquired more easily within the ages of the children participating in the present study (Hillman and Biggan, 2017). Thus, the results presented in the current study may be a consequence of the combined effects of using the proposed post activity window for enhanced cognitive and academic performance to embed language, alongside a more engaging movement intervention where story telling features within the motor development activities in the period where language is more easily acquired.

The intensity of the intervention was judged based on the number of foot contacts the children undertook and employed movements classified as being of low to moderate intensity (Chu and Meyer, 2013). No direct measure of the intensity of the movement intervention sessions was made. Using objective monitoring (e.g. heart rate monitors, accelerometers) to assess this aspect of the intervention was not feasible in terms of the time constraints before and after each intervention session to fit children with monitoring equipment. Nevertheless it would be useful for a more objective

measure of the dose of the exercise intervention to be made in future. As a consequence it may be equally likely that the changes reported in the present study arose due to embodied cognition. It has been argued that sensorimotor experiences in childhood are essential for learning and enable children to increase cognitive and physical capabilities as a result of their sensorimotor interactions with the environment (Wellsby and Pexmen, 2014). There is also evidence that sensorimotor experiences are beneficial for motor learning in infancy and language development and higher order cognition as children approach school age (Kontra et al., 2012). It is possible that the sensorimotor experiences provided as part of the movement intervention, coupled with the focus on story-telling in the combined movement and story-telling intervention served to augment the changes in language development and FMS for the combined group compared to the storytelling only or movement only groups.

These suggestions are however speculative as no assessment of brain function, motivation or readiness to engage was made. Undertaking such assessment with pre-schoolers would be challenging and, in regard to brain function such assessment cannot be made outside of laboratory environments. Future research which attempts to unpick the mechanisms of change for the motor competence and language ability changes reported in the current study would be welcome and useful in explaining the findings from the initial trial of this intervention.

Prior research by Becker et al. (2014) has also suggested that the effect of active play on mathematics and emergent writing ability in pre-schoolers was mediated by self-regulation. Changes in self-regulation may therefore also be one of the mechanisms driving the augmentation in language seen in the present study. It may be also be possible that the PA involved in each of the intervention sessions enhances

the connections between the neural systems involved in both motor and cognitive performance (Salmi, 2010) leading to increased performance in both motor and cognitive type performance.

The findings reported here are based on a relatively small sample of children from one geographical area of the UK. They are also limited to children within EYFS of the British curriculum. The present study was truly exploratory and sought to examine if combining story-telling with movement might be a useful approach to enhance movement and language in pre-schoolers. While the results of the current study are positive in this respect, it is possible that the intervention examined here could have also had positive impacts on other aspects of pre-schoolers' academic performance, such as verbal comprehension, spatial ability or non-verbal reasoning. Likewise, a restricted range of FMS were examined and the intervention might also have influenced motor skills other than the run, jump, throw and catch that were examined here. The time and labour demand of examining a wider range of outcome variables in pre-schoolers precluded their inclusion until the central hypothesis of this study had been established. Future research extending the work presented in this study is therefore needed which evaluates the effectiveness of this combined movement and story-telling intervention on a wider range of FMS and academic performance outcomes, in addition to other relevant secondary outcomes such as health indices and PA.

The results of this study suggest a six week combined movement and storytelling intervention enhances motor competence and language ability in preschoolers to a greater extent than a movement only or story-telling only intervention. The intervention is time and cost economical with ease of administration

for preschool staff and offers a positive opportunity for instilling good movement patterns in children alongside concurrent opportunities for academic development and in a way that addresses the three pillars of the EYFS for pre-school education.

Acknowledgement: This work was supported by a Small Research Grant from the British Academy.

Author Bio:

Michael Duncan is Professor of Exercise Science at Coventry University. His research interests centre on children's physical activity, exercise and motor competence for health.

Anna Cunningham is a Research Fellow at Coventry University with a focus on reading development and children's responses to early literacy instruction.

Emma Eyre is a Lecturer in Sport and Exercise Science at Coventry University with a particular interest in motor competence and physical activity in children.

References

Adamo KB, Wilson S, Harvey AL, Grattan KP, Naylor PJ, Temple VA and Goldfield GS (2016) Does intervening in childcare settings impact fundamental movement skill development? *Medicine and Science in Sports and Exercise* 48: 926-932.

APHO (2008) *Health Profile Nuneaton and Bedworth.* London: APHO and Department of Health.

Barnett LM, Minto C, Lander N and Hardy LL (2014) Interrater reliability assessment using the Test of Gross Motor Development-2. *Journal of Science and Medicine in Sport* 17: 667-670.

Becker DR, McClelland M, Loprizi P and Trost SG (2014) Physical activity, selfregulation, and early academic achievement in pre-school children. *Early Education and Development* 25: 56-70.

Brice RG (2004) Connecting Oral and Written Language through Applied Writing Strategies. *Intervention in School and Clinic* 40: 38-47.

Bryant ES, Duncan MJ, Birch SL and James RS (2016) Can fundamental movement skill mastery be increased via a six week physical activity intervention to have positive effects on physical activity and physical self perception? *Sports* 4: 10.

Burton AW and Miller DE. (1998) *Movement Skill Assessment.* Champaign, IL, Human Kinetics.

Carlson M, Dahl G and Rooth D-O (2012) *The effect of schooling on cognitive skills.* Cambridge: Massachusetts: National Bureau of Economic Skills.

Chang YK, Tsai YJ, Chen TT and Hung TM (2013) The impacts of coordinative exercise on executive function in kindergarten children: an ERP study. *Experimental Brain Research* 225: 187-196.

Chu D and Myer G (2013) *Plyometrics*. Champaign, Ill: Human Kinetics.

Department for Education (2014) *Statutory framework for the early years foundation stage*. London: Department for Education.

Diamond A and Lee K (2011) Interventions shown to aid executive function development in children 4 to 12 years old. *Science* 333: 959-964.

Dietrich A (2003) Functional neuroanatomy of altered states of consciousness: The transient hypofrontality hypothesis. *Consciousness and Cognition* 12: 231256.

Donaldson J and Scheffler A (2009) *The Gruffalo*. London: MacMillan Children's Books.

Donath L, Faude O, Hagman S, Roth R, Zahner L (2015) Fundamental movement skills in pre-schoolers: a randomized controlled trial targeting object control proficiency. *Child: Care, Health, Development* 41: 1179-1187.

Donnelly JE, Hillman CH and Castelli D (2016) Physical activity, fitness, cognitive function, and academic achievement in children. *Medicine and Science in Sport and Exercise* 48: 1197-1222.

Elliott CD and Smith P (2011) The British Ability Scales 3. *Technical Manual*. London: GL Assessment.

Engel AK, Maye A, Kurthen M and Konig P (2013) Where's the action? The pragmatic turn in cognitive science. *Trends in Cognitive Science* 17: 202–209.

Fricke S, Bowyer-Crane C, Haley AJ, Hulme C and Snowling MJ (2013) Efficacy of language intervention in the early years. *Journal of Child Psychology and Psychiatry* 54: 280-290.

Glonek K and King PE (2014) Listening to Narratives: An Experimental Examination of Story-telling in the Classroom. *International Journal of Listening* 28: 32-46.

Goodman G and Dent V (2016) One Story at a Time: Studying the Effectiveness of the Story-telling/Story-Acting (STSA) Play Intervention on Ugandan Preschoolers' Emergent Literacy, Oral Language, and Theory of Mind in Two Rural Ugandan

Community Libraries. *In: the 8th Qualitative and Quantitative Research Methods in Libraries Conference*. London, UK, May 24 – 27 2016.

Haapala EA, Väistö J, Lintu N, Westgate K, Ekelund U, Poikkeus AM, Brage S and Lakka TA (2017) Physical activity and sedentary time in relation to academic achievement in children. *Journal of Science and Medicine in Sport* 20: 583-583

Hasni-Mokhtar N, Halim MF and Kamarulzaman SZS (2011) The effectiveness of story-telling in enhancing communicative skills. *Procedia-Social and Behavioural Sciences* 18: 163-169.

Herman KM, Chaput J-P, Sabiston CM, Mathieu M-E, Tremblay A and Paradis G (2015) Combined physical activity/sedentary behaviour associations with indices of adiposity in 8-10 year old children. *Journal of Physical Activity and Health* 12: 20-29, 2015.

Hill V (2005) Through the Past Darkly: A Review of the British Ability Scales Second Edition. *Child and Adolescent Mental Health* 10: 87-98.

Hillman CH and Biggan JR (2017) A review of childhood physical activity, brain and cognition. *Pediatric Exercise Science* 29: 170-176.

Hillman CH, Pontifex MB, Raine LB, Castelli DM, Hall EE and Kramer AF (2009) The effect of acute treadmill walking on cognitive control and academic achievement in preadolescent children. *Neuroscience* 159: 1044-1054.

Jaakkola T, Hillman C, Kalaja S and Liukkonen J (2015) The associations among fundamental movement skills, self-reported physical activity and academic performance during junior high school in Finland. *Journal of Sports Science* 33: 1719-1729.

Jones RA, Okely AD, Caputi P and Cliff DP (2010) Perceived and Actual Competence among Overweight and Non-Overweight Children. *Journal of Science and Medicine in Sport* 13: 589-596.

Kory J and Breazeal C (2014) Story-telling with robots: Learning companions for preschool children's language development. In: *The 23rd IEEE International Symposium on Robot and Human interactive Communication*. Edinburgh, UK, 25-29 August 2014, pp. 643-648. New York: IEEE Publishing.

Lubans DR, Morgan PJ, Cliff DP, Barnett LM and Okely AD (2010) Fundamental movement skills in children and adolescents: review of associated health benefits. *Sports Medicine* 40: 1019-35.

Mallan K (1992) *Children as Storytellers.* Portsmouth: Heinemann Educational Books, Inc.

Morgan PJ, Barnett LM, Cliff DP, Okely AD, Scott HA, Cohen KE and Lubans DR. (2013) Fundamental movement skill interventions in youth: a systematic review and meta-analysis. *Pediatrics* 132: e1361-e1383.

Oakhill J, Cain K and Nesi B (2016) Understanding of idiomatic expressions in context in skilled and less-skilled comprehenders: online processing and interpretation. *Scientific Studies of Reading* 20: 124-139.

Peterson D and Spencer T (2016) Using Narrative Intervention to Accelerate Canonical Story Grammar and Complex Language Growth in Culturally Diverse Pre-schoolers. *Topics in Language Disorders* 36: 6-19.

Salmi J, Pallesen KJ, Neuvonen T, Brattico E, Korvenoja A, Salonen O and Carlson

SV (2010) Cognitive and motor loops of human cerebro-cerebellar system. *Journal of Cognitive Neuroscience* 22: 2663–2676.

Schmitt SA, McClelland MM, Tominey SL and Acock AC (2015) Strengthening school readiness for Head Start children: Evaluation of a self-regulation intervention. *Early Childhood Research Quarterly* 30: 20-31.

Sylva K, Melhuish E, Sammons P, Siraj-Blatchford I and Taggart B (2014) *The effective provision of pre-school education (EPPE) project. Findings from preschool to the end of key Stage 1*. London: Department for Education and Skills.

Temple V and O'Connor J (2005) *Healthy Opportunities for Pre-schoolers (HOP).* Vancouver: University of Victoria.

Ulrich DA (2000) *Test of Gross Motor Development, 2nd ed*., Austin, TX: Pro-Ed.

Voss MW, Carr LJ and Clark R (2014) Revenge of the still: Does lifestyle impact neuronal and cognitive health through distinct mechanisms associated with sedentary behaviour and physical activity? *Mental Health and Physical Activity* 7: 9-24.

Wellsby M and Pexmen PM (2014) Developing embodied cognition: insights from children's concepts and language processing. *Frontiers in Psychology* 5: 506.

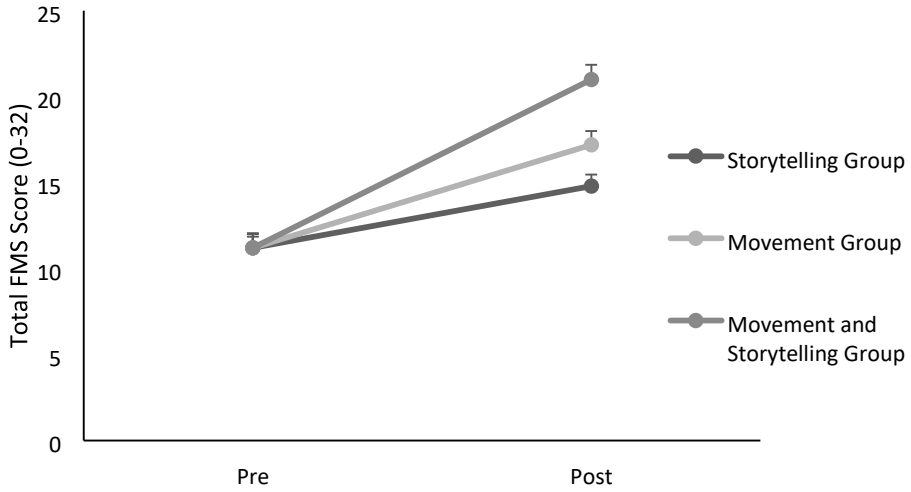

Figure 1. Mean ± SE of Total Fundamental Movement Skill (FMS) score (0-32) pre to post intervention for story-telling only, movement only and combined movement and story-telling groups.

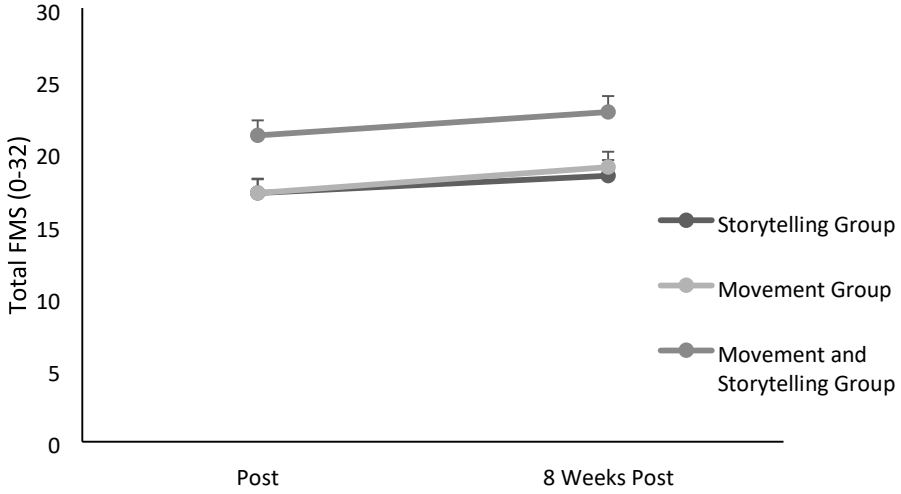

Figure 2. Mean ± SE of Total Fundamental Movement Skill (FMS) score (0-32) post intervention to eight weeks post for story-telling only, movement only and combined movement and story-telling groups.

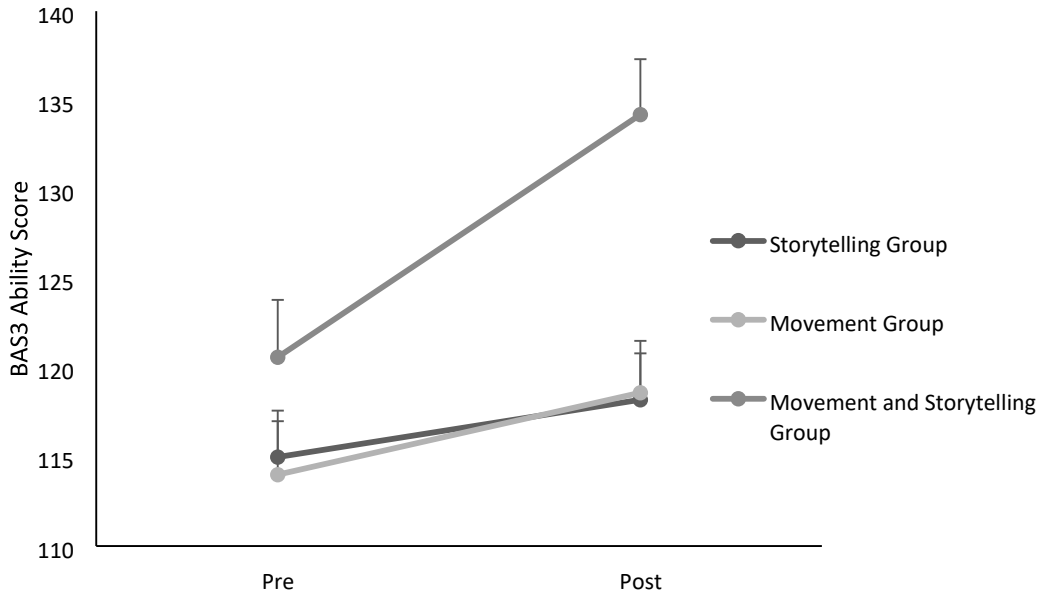

Figure 3. Mean ± SE of British Ability Scales 3 (BAS3) Ability Score for naming vocabulary pre to post intervention for story-telling only, movement only and combined movement and story-telling groups.

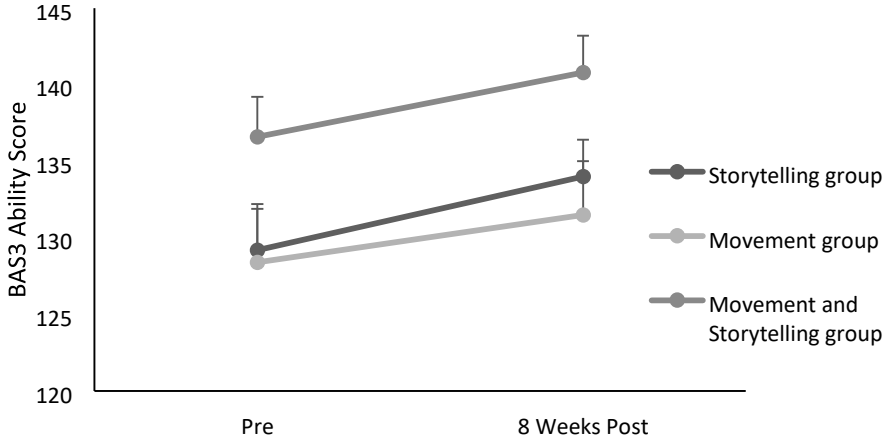

Figure 4. Mean ± SE of British Ability Scales 3 (BAS3) Ability Score for naming vocabulary post intervention to eight weeks post for story-telling only, movement only and combined movement and story-telling groups.