Article:
Chambers, ME and Sugden, DA (2016) Intervention for young children displaying coordination disorders. Journal of Early Childhood Research, 14 (2). pp. 115-131. ISSN 1476-718X

https://doi.org/10.1177/1476718X14548780

Intervention for young children displaying coordination disorders

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Keywords

Coordination disorders, early intervention, teachers, young children

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Abstract

Background

The years from three to six are a time when children develop fundamental movement skills that are the building blocks for the functional movements they use throughout their lives. By six years of age a typically developing child will have in place a full range of movement skills including, running, jumping, hopping, skipping, climbing, throwing, catching, kicking, striking, writing and drawing. These will not necessarily be performed in a competent manner but the rudiments are there to be developed through later refinement, combination, adaptation and exploration. However, some children on entry into school do not have a full range of these fundamental skills and this lack of competence in motor skills often affects their academic work and activities of daily living.

Methods

This study concentrates on the years three to six and aims to examine the efficacy of graded intervention programmes for children identified with coordination difficulties and involved working with nurseries, schools and parents. A total of 35 children with coordination difficulties were identified and individual profiles mapped out. The study lasted for 2 years, including assessment and periods of intervention and no intervention. The children were assessed regularly throughout the project using the Early Years Movement Skills Checklist together with diaries and comments from teachers and parents.

Results

The children as a group made significant improvement in their motor skills giving cautious optimism to a graded intervention approach. At the end of the study, 32 children had improved their motor skills and, although, the remaining three children improved their coordination skills, their test sores remained below the 5^{t}h percentile of the Early Years Movement Sills Checklist. Profiles of individual children illustrate the different progression children made.

Conclusion

This study has shown that graded intervention programmes for children identified with coordination difficulties have been found to be effective.

1. Introduction

The years from three to six are a time when children develop fundamental movement skills that are the building blocks for the functional movements they use throughout their lives. By six years of age a typically developing child will have in place a full range of fundamental movement skills including running, jumping, hopping, skipping, climbing, throwing, catching, kicking, striking, manipulating, writing and drawing (Gabbard, 2008; Gallahue & Ozmun, 1995; Haywood & Getchell, 2008). These skills are not necessarily performed in a competent manner but the rudiments are there to be developed through refinement, combination, adaptation and exploration (Keogh & Sugden, 1985). However, some children on entry into school do not have a full range of these fundamental skills and this lack of competence in motor skills often affects their academic work and their normal activities of daily living (APA, DSM-IV, 1994; DSM-IV-TR, 2000). In addition, there is evidence that poor motor development is linked with other areas of school activity including underachievement at school, lack of concentration, behaviour problems, low self-esteem, emotional and social isolation and lack of physical hobbies (Cantell, Smyth & Ahonen, 2003; Cermak et al., 2002; Knight et al., 1992; Losse et al., 1991; Missiuna et al., 2007; Rivard et al., 2011; Rodger & Mandich, 2005; Skinner & Piek, 2001; Wilson 2005).

There are a number of studies to show that intervention in children with Developmental Coordination Disorder (DCD) can be effective although few, if any, are in the developmental period of three to six years of age (Green, Chambers & Sugden, 2008; Laszlo, Bairstow & Batrip, 1988; Pless, 2001; Pless & Carlsson, 2000; Polatajko, Mandich & Miller, 2001; Polatajko et al., 2001; Sugden & Chambers, 1998, 2003). The primary objective of all methods of intervention for children with DCD is to improve their motor skills and their ability to function in everyday life. However, individuals concerned with intervention approaches have approached this objective in different ways. Intervention approaches vary but can generally be grouped into two broad categories of *process* and *task* oriented approaches (Polatajko & Cantin, 2007; Sugden & Chambers, 1998, 2005; Sugden & Wright, 1998). In addition, there are also other approaches, often eclectic in nature, which incorporate

features of both process and task oriented approaches. Additionally, intervention has historically been undertaken in the UK by occupational therapists or physiotherapists and has generally taken place in clinics or Child Development Centres. However, more recently it has been found that school and home-based approaches have been successful with the majority of children (Sugden & Chambers, 2003, 2005, 2007; Wright & Sugden, 1997, 1998), although there have been few studies which have systematically identified children in the pre school age followed by a period of intervention.

Early intervention in a range of developmental disabilities has been shown to result in the child needing fewer special educational and other support services later in life and, in some cases, being indistinguishable from typically developing children years after intervention (Brown, 1991; Chandler et al., 2002; Guralnick, 1989, 1997, 2011; Mitchell & Brown, 1991; Sénéchal & LeFevre, 2002; Ulrich et al., 2001). The importance of early intervention is widely recognised (Guralnick, 2011; Fieldman, 2004; Paige-Smith & Rix, 2006) and can been evidenced through the creation and implementation of a variety of programmes developed to support children with learning difficulties and disabilities. The term Early Intervention is usually used to refer to infants and young children; however, Fieldman (2004) notes that conceptually, early intervention can be offered at any age before or in the early stages of a developmental disability.

Typically, children receiving early intervention are at risk for developmental, emotional, social, behavioural and cognitive difficulties because of biological and/or environmental factors. In addition, 'Removing Barriers to Achievement' (DfES, 2004) recognises the importance of early intervention and notes that it " . . . is the Cornerstone of Our Strategy" (p.9). This document is part of a generalised reform of children's services as set out in the Green Paper 'Every Child Matters' (DfES, 2003) and it is widely believed that investing early in the life of a child can have greater benefits in the long term. Further, the National Service Framework (NSF) Disabled Child Standard (Standard 8) states the importance of early intervention:

“Delaying early intervention can result in irretrievable loss of function or ability or the intervention being less effective. … Early intervention has a positive effect both in terms of promoting development and minimising decline or regression among children with developmental disabilities” (http://www.dh.gov.uk).

In the case of intervening with young children displaying coordination difficulties, the likelihood is that they have not experienced the associated difficulties that are so often present in older children with DCD allowing the intervention to be focused on motor skill development with no need to address any associated difficulties (Chambers & Sugden, 2002). Therefore, it can be argued that intervening before any associated difficulties have developed is important and in order to address this, this study aimed to explore the effectiveness of Early Intervention for children between the ages of three and six years of age.

This study proposed to:

- Examine the use of an assessment instrument, Early Years Movement Skills Checklist (Chambers & Sugden,, 2006) designed to identify and assess movement difficulties in the age range three to six years
- Examine the efficacy of graded intervention programmes for children identified with coordination difficulties

2. Methodology

This section details the assessment instruments that were used to identify and assess the motor skills of the participants; it gives an overview of the content of each and reports on their reliability and validity. It then provides a detailed explanation of how the children were selected to participate in the study and, finally, it details how the study was carried out including a section which explains the low level, graded intervention strategy that was used.

2.1 Assessment Instruments

*Early Years Movement Skills Checklist (*Chambers & Sugden, *2002)*

The Early Years Movement Skills Checklist was used as it has been specifically developed for use with young children and contains functional, every day skills that can be observed in daily situations and can also inform intervention programmes. It is an observational screening instrument as well as a means for planning intervention programmes. It is divided into four sections, Self Help Skills, Desk Skills, General Classroom Skills and Recreational/Playground Skills with each section having a number of different movement skills. It has been constructed to assess functional, everyday skills of three to six year old children and, as such, contains activities which are easily observed by teachers and parents as part of everyday activities. It is scored on an ordinal scale of 1 to 4 for each skill so that the total score will range from 23 to 92 with increased difficulty associated with the higher scores.

The reliability and validity of the EYMSC is reported in some depth (Chambers & Sugden, 2002, 2006). Both interrater and test-retest reliability have been established as 0.96 and 0.95 respectively. The validity of the EYMSC was calculated through a comparison with the Movement ABC Test (Henderson & Sugden, 1992) with a coefficient value 0.76. The sensitivity index of the EYMSC has been calculated as 1.00 and the specificity index has been calculated as 0.64 (Chambers, 2000; Chambers & Sugden, 2002). Cut off scores have been established as follows:
15th percentile: 44 (3 year olds), 36 (4 year olds) and 31 (5 year olds)
5th percentile: 56 (3 year olds), 42 (4 year olds) and 40 (5 year olds).

Movement Assessment Battery for Children (Henderson & Sugden, 1992)
The test component of the Movement ABC is a normative referenced test and has been chosen as, in addition to a total score, it gives qualitative information about a child's performance on each part of the test. It provides norms for children aged 4 to 12 years in four age related item sets. Each age band consists of 8 items measuring manual dexterity (3), ball skills (2) and balance (3). Children can score between 0 and 5 on each item, so that the total score will range from 0 to 40 with increased difficulty associated with the higher scores.

The reliability of the Movement ABC Test is reported in some depth in the Movement ABC Manual (Henderson & Sugden, 1992). Both test-retest and interrater reliability have been established, and yielded good results. A test-retest investigation over a two-week period revealed 0.97 agreement for age 5, 0.91 for age 7 and 0.73 for age 9. Interrater reliability measures are also reported where a minimum value of 0.70 interrater reliability on total scores is reported, with a minimum of 0.75 agreement and maximum of 0.98 agreement on item scores from one tester to another. The overall reliability of the Movement ABC Test is considered to be good (Henderson & Sugden, 1992). The validity of the Movement ABC Test has been assessed in several ways (such as construct and concurrent validity) and a considerable amount of data are available from the manual to confirm that the Movement ABC Test does in fact measure what it is intended to measure.

2.2 Participants

The children were selected for the project through a staged process. As this research was funded by a medical/health based charity, it was considered and approved by the NHS Local Research Ethics Committee. After permission had been obtained from a Local Education Authority, initial contact was made with a randomly selected sample of eleven primary (elementary) schools to discuss the project with head teachers, special educational needs coordinators (SENCOs) and class teachers. Following the initial assessment, parents of all the children assessed with the Early Years Movement Skills Checklist (Chambers & Sugden, 2006) were contacted; they were given an information booklet which detailed the project and a consent form to sign on behalf of their child. The children who took part in the intervention study were those for whom the parents had agreed to their participation.

The Class teachers were asked to complete the Early Years Movement Skills Checklist (EYMSC) (Chambers & Sugden, 2006) with a randomly selected group of children, according to computer generated numbers. The number of checklists sent out to schools was 340; of these, 319 (93.8%) were returned and 314 (92.3%) were completed correctly and included in the study. Of

these 314 checklists, 96 children (30.5%) were assessed at or below the 15th percentile indicating a possible coordination difficulty. These children formed the selected sample. A further 28 children, whose scores on the EYMSC (Chambers & Sugden, 2006) indicated the absence of a coordination difficulty, were identified to form a control sample of typically developing children; this group of children all scored above the 15th percentile. Consent to participate in the research was granted from a total of 54 parents; 35 parents from the group displaying possible coordination difficulties (selected sample) and 19 parents from the control sample (typically developing children). In accordance with DSM IV TR (APA, 2000), all the children identified by the EYMSC (Chambers & Sugden, 2006) had coordination difficulties that interfered with academic achievement and/or activities of daily living and no child had a generic learning difficulty or a medical condition such as cerebral palsy. All children aged four years and over (23 children from the selected sample and 19 children from the control sample) were also tested on the Movement ABC Test (Henderson & Sugden, 1992).

From an original random sample of three hundred and fourteen children (169 boys and 145 girls), 54 children aged from 3 to 6 years of age took part in the study. The mean age of the children at the date of first testing was 4.25 years, the range was 3.04 years to 6.11 years and the standard deviation was 0.86 years.

Children were then assigned to one of three groups (total n=54): Group 1 (Selected sample 1) (SS1) (17 children) and Group 2 (Selected sample 2) (SS2) (18 children) consisted of children who scores on the EYMSC indicated that they had a coordination difficulty and Group 3 (Control sample) (CS) (19 children) consisted of children who did not have a coordination difficulty. Table 1 gives details of each group's mean age at the date of first testing followed by the range and standard deviation.

Insert Table 1 about here

Group 1 (SS1) consisted of 17 children whose scores on the EYMSC (Chambers & Sugden, 2006) were below the 15th percentile (mean EYMSC score 51.11, range 33 to 72 and mean Movement ABC Test score 18.25, range 11.5 to 26). There were 18 children in Group 2 (SS2) whose scores on the EYMSC were also below the 15th percentile (mean EYMSC score 44.22, range 34 to 69 and mean Movement ABC Test score 18.73, range 12 to 36.5). Group 3 (CS) consisted of the 19 children whose scores on the EYMSC were above 15th percentile (mean EYMSC score of 34.63, range 23 to 54 and mean Movement ABC Test score was 3.57, range 0 to 9).

The EYMSC (Chambers & Sugden, 2006) scores increase with severity of difficulty and a score of 44 (3 year olds), 36 (4 year olds) and 31 (5 year olds) is within the lowest 15% of the population whilst a score of 56 (3 year olds), 42 (4 year olds) and 40 (5 year olds) is at the 5th percentile. On the Movement ABC Test (Henderson & Sugden, 1992) scores also increase with severity of difficulty and a score of 10 and above is within the lowest 15% of the population, and a score of above 13 is at the 5th percentile. Seven of the children from the selected sample scored between 10 and 13 with 16 children at 13.5 or above. For a child with a score below the 5th percentile, intervention is recommended while borderline children who score from the 5th to the 15th percentile, close monitoring is recommended (Henderson & Sugden, 1992). Normally, we would look to intervene with only those at the 5th percentile or below, in this case 16 children. However, seven children scored within the borderline and, as teachers were looking for help for them and had the support of parents, it was decided that it would be unethical not to include them in the project. In addition, all three year old children identified by the EYMSC (Chambers & Sugden, 2006) as displaying movement difficulties were also included in the project. Table 2 gives details of each group's scores on the EYMSC and the Movement ABC Test at the original testing

Insert Table 2 about here

2.3 Procedures

2.3.1 Sequence of events

Following the first assessment, individual profiles detailing strengths and weaknesses were developed for each child in Groups 1 and 2. Using the information gathered through the assessment, teachers and parents assisted in identifying priority areas for intervention. Every three weeks, class teachers were given guidelines for working with the children; these guidelines were developed from the assessment profiles and priorities of each child and prepared by the Project Team for each individual child. The guidelines contained abilities to work on, activities to include and suggestions for manner of teaching. Each child received three to four sessions a week of intervention activities lasting approximately for 20 minutes each session. Most of the principles underlying the guidelines came from the "Cognitive motor approach to intervention" (Henderson & Sugden, 1992) and later elaborated in Ecological Intervention (Henderson & Sugden, 2007).

The children in Group 1 (SS1) initially worked with their class teachers for a total of ten weeks with a one week mid-term break, while Group 2 (SS2) received no intervention during this period. At the end of the ten weeks, the children in all three groups were assessed again by their class teachers with the EYMSC (Chambers & Sugden, 2006). Following on from this, children in Group 2 (SS2) worked with their class teachers for a total of ten weeks with a one week mid-term break, while Group 1 (SS1) received no intervention during this period. At the end of this period all the children were assessed again with the EYMSC (Chambers & Sugden, 2006). A final assessment using the Movement ABC Test (Henderson & Sugden, 1992) took place a short while following the end of the intervention period.

The design of the study, involving periods of intervention and no intervention was employed to isolate the effects of the intervention provided by the teacher against possible developmental/maturational effects. Overall, the children were involved in the project for 34 weeks; ten of which involved intervention by teachers, 10 weeks with no intervention and approximately 14 weeks of assessment. The schedule of assessments and intervention periods are illustrated in Table 3.

Insert Table 3 about here

The intervention used in this project was a preventative intervention carried out by class teachers involving the three graded components of exposure, experience and targeted practice. This intervention was based on a class approach such that the individual child with difficulties was not specifically identifiable to the rest of the class or visitors. For each child, the intervention took all of the fundamental motor skills that are deemed necessary for activities of daily life and academic performance and taught them in such a manner that each child had the opportunity to learn them. If a child had difficulty learning the skills, the teachers were given specific methods to help the child, such as task analysis, the use of context for motivation, paired learning and modified equipment such as different shaped writing implements. For the intervention activities, the project team drew upon work with older children in a previous study (Sugden & Chambers, 2003) but scaled appropriately for the younger age group. Class teachers were provided with full support and guidance during the intervention phase.

2.3.2 Teacher information

At all stages during the project, there was regular contact with class teachers. This took a number of forms: Firstly, every three weeks the guidelines were distributed and any queries answered. Secondly, informal contact was made to ensure that progress was satisfactory and to respond to comments and questions. Mid way through the intervention periods, a short questionnaire was sent to class teachers asking for feedback concerning the amount of time spent on the activities each week, the appropriateness of the activities for each child and whether the activities were beneficial to the child. They were also asked to keep a record of when and for how long they worked with each child; this was in order to gain a record of how convenient it was to work through the programme in an early years classroom. The guidelines were not a rigid structure but allowed the class teachers to work flexibly within the

classroom parameters. The idea behind this flexible approach is supported by the literature that states that the activities in the movement skill domain have been organised into a framework so that a class of activities can be identified (Schmidt, 1991) with intervention aimed at that class and can be used flexibly by teachers. This means, that a class teacher is free to choose an activity from a particular class of activities, one which may fit particularly well with the general activities of the classroom; thus ensuring that the child in the intervention study is not singled out and is not identifiable to any visitor to the classroom.

3. Results and Analysis

The results are presented in two sections; firstly group data are examined followed by an analysis of individual profiles.

3.1 Group Data

3.1.1 Examining the use of the Early Years Movement Skills Checklist to identify and assess children with coordination difficulties

At the beginning of the study, all 35 of the children from Groups 1(SS1) and 2 (SS2) scored below the 15th percentile on the EYMSC (Chambers & Sugden, 2006) with 17 scoring below the 5th percentile and 18 children scoring between the 5th and 15th percentile. By the end of the project only three of the children remained below the 5th percentile and four remained between the 5th and 15th percentile. Table 4 illustrates these results.

Insert Table 4 about here

All statistical analyses were computed using the statistical software SPSS Version 17 (2009).

3.1.2 Examining the efficacy of graded intervention programmes for children with coordination difficulties

After the first intervention phase, an analysis of the raw interval data were performed and a 3 (Group) x 3 (Test) Repeated Measures ANOVA, (F (2, 11.035) = 1298. 979, $p<0.005$) confirmed that children in Group 1 (SS1) displayed improvement between Test 1 and Test 2 (the intervention phase) and this improvement was maintained to Test 3 during the period of no intervention for Group 1 (SS1).

No improvement took place between Tests 1 and 2 for Group 2 (SS2) when there was no intervention but improvement did take place between Tests 2 and 3 during the intervention phase (F (1, 833.284) = 74891.130 $p<0.005$).

Additionally, at the start of the study there was a significant difference between the scores for Group 3 (CS) and Groups 1 (SS1) and 2 (SS2); a significant difference was found between mean scores for all three group; 3 (Group) x 1 (Test) (F (2, 11.769) = 582.522 $p<0.005$). At Test 2, after Group 1 (SS1) had received intervention, there was no difference between the scores for Group 1 (SS1) and Group 3 (CS), but the significant difference remained between Group 2 (SS2) (who had not received intervention) and Group 3 (CS). At Test 3 (when both Group 1 (SS1) and Group 2 (SS2) had received intervention) there were no significant differences between the scores of any of the groups; showing that the children in Group 1(SS1) and Group 2 (SS2) had improved their coordination skills. These results are illustrated in Table 5.

Insert Table 5 about here

3.1.3. Movement ABC Test

These EYMSC results were validated by assessing all children in the study on the Movement ABC Test (Henderson & Sugden, 1992). At the start of the project (Test 1) all children of 4 years of age and above were assessed on the

Movement ABC. Children in Group 1 (SS1) had a mean score of 18.25, children in Group 2 (SS2) had a mean score of 18.73 and children in Group 3 (CS) had a mean score of 3.5. At the end of the intervention phase (Test 2) when both Group 1 (SS1) and 2 (SS2) had completed 10 weeks of intervention, the mean scores on the Movement ABC Test were as follows: Group 1(SS1): 8.5, Group 2 (SS2): 6.0 and Group 3 (CS): 2.18. An analysis of the raw interval data were performed and a 3 (Group) x 2 (Test) ANOVA, ($F(2, 1006.550) = 36.222$ $p<0.005$) confirmed that there were significant differences between mean scores at Test 1 between Group 1 (SS1) and Group 3 (CS) and Group 2 (SS2) and Group 3 (CS), but no significant differences found between any of the groups at Test 2.

Table 6 shows the significance levels for mean scores for each group on the Movement ABC Test (Henderson & Sugden, 1992) at the start of the study (Test 1) and the end of the study (Test 2)

Inset Table 6 about here

3.1.3.Teacher Data

The opinions of the teachers corresponded well with the test results. A number of teachers and parents commented that the children had increased their confidence and self esteem which, in turn, had improved their motivation and ultimately their motor skills. Class teachers also commented that the activities were enjoyable for the children to do.

The majority of class teachers commented that the activities for the children were fairly easy to fit into the normal routine of the day often because a classroom assistant was present in the classes for younger children and class teachers felt able to give attention to the child in the project for a few minutes each day. The number of sessions each week ranged from two a week to five times.

3.2 Individual Data

Individual profiles placed the children from Group 1 (SS1) and Group 2 (SS2) in categories according to the amount of intervention they received and the amount of improvement they have displayed. Category 1 consists of 30 children who received a moderate amount of intervention or more (at least four times a week) and who showed improvement; Category 2 consists of two children who received only a small amount of intervention (three times a week or less) and yet showed improvement; Category 3 consists of three children who, despite receiving moderate or more intervention, showed improvement but their scores remain below the 5th percentile on the EYMSC (Chambers & Sugden, 2006). All the children who received intervention displayed improvement in their coordination skills with the majority of them displaying significant improvement and just three children who, despite improving, remain below the 5th percentile. Individual results are interesting and useful because they show the idiosyncrasies of progress and are signposts to individual provision and management. As such, three profiles are presented here to illustrate different progressions.

3.2.1 Child 175

Child 175 is a boy from Category 1 and he was in Group 1 (SS1) for the intervention phase. At the start of the programme he was 3.05 years of age and his initial score on the EYMSC (Chambers & Sugden, 2006) was 53, placing him between the 5th and 15th percentile. At the start of the study, he was not assessed on the Movement ABC Test (Henderson & Sugden,1992) as he was below the age of four years. His initial assessment revealed particular difficulties in all four sections; Self Help skills, Desk Skills, General Classroom skills and Recreational/Playground skills.

Difficulties observed by the class teacher included poor fine motor and manual dexterity skills and poor judgement of force for aiming, catching and throwing and difficulties with balancing skills and large movements. The class teacher noted that the child's movement problems were made worse when speed was involved and also if he was put under pressure. Additionally, the class teacher noted that he was a bright child, he was cooperative, he enjoyed

small group work and he was a popular member of the class. Priority areas for intervention were identified as fine motor skills and handwriting, manipulative skills and balancing skills.

Child 175 scored poorly on all four sections of the EYMSC (Chambers & Sugden, 2006) at Test 1 but as can be observed from the result for Tests 2 and 3 these improved during the study. During the 10 week phase of intervention, he received five sessions a week and improved his score by 24 points, which placed him above the 15th percentile. During the ten weeks when he received no intervention, his score on the EYMSC improved by a further three points, giving him a final total score of 26 on the EYMSC. Figure 1 shows the scores for Child 175 on the EYMSC at each testing point (before and following intervention).

Insert Figure 1 about here

The Movement ABC Test (Henderson & Sugden, 1992) score at the end of the project confirmed his improvement and he scored a final total score of 3; a score well above the 15th percentile.

His class teacher commented on the general overall improvement that Child 175 displayed, and also his increased confidence as well as specific skills targeted as priority areas. The class teacher commented that it had been fairly easy to incorporate the activities into the normal routine of the day and she also commented that Child 175 had worked hard at all the activities, he appeared to enjoy doing them and he had done some of the activities with a partner.

3.2.2. Child 300

Child 300 is a girl from Category 2 who was in Group 2 (SS2) for the intervention phase. At the start of the programme she was 4.02 years of age and her initial score on the EYMSC (Chambers & Sugden, 2006) was 49,

placing her below the 5th percentile. Although Child 300 is over four years of age, she does not have a score for the Movement ABC Test as she refused to complete any of the tasks. Her initial assessment on the EYMSC revealed particular difficulties in all four sections; Self Help skills, Desk Skills, General Classroom skills and Recreational/Playground skills.

Movement difficulties observed by the class teacher included poor fine motor and manipulative skills, poor ball skills and difficulties with large movements. The class teacher noted that the child's attention was poor and she displayed little confidence. Also, her movement problems were made worse when speed was involved and also if she was put under pressure. Additionally, the class teacher noted that she tried hard in class, she was eager to please and she was a fairly popular member of the class but was frequently absent from school. Priority areas for intervention were identified as fine motor skills and handwriting, manipulative skills and ball skills.

Child 300 scored poorly on all sections of the EYMSC (Chambers & Sugden, 2006) at Test 1 (total score of 49) but the results for Test 3 (total score of 25) following intervention show improvement in these skills. During the 10 week phase when she received no intervention, her score on the EYMSC improved by 2 points. During the 10 week phase of intervention she received two sessions a week and, despite receiving only a small amount of intervention, she improved her score by a further 22 points, giving her a final total score of 25 on the EYMSC which placed her above the 15th percentile. Figure 2 shows the scores for Child 300 on the EYMSC at each testing point (before and following intervention).

Insert Figure 2 about here

The Movement ABC Test score at the end of the project confirmed her improvement and she scored a final total score of 0.5; a score well above the 15th percentile.

Her class teacher commented on the general overall improvement that Child 300 displayed, also noting her increased attention and confidence, as well as specific skills targeted as priority areas. The class teacher commented that it had been fairly easy to incorporate the activities into the normal routine of the day and she also commented that Child 300 had worked hard at all the activities, she appeared to enjoy doing them and she had done some of the activities with a friend.

3.2.3. Child 44

Child 44 is a girl from Category 3 who was in Group 1 (SS1) for the intervention phase. At the start of the programme she was 5.00 years of age and her initial score on the EYMSC (Chambers & Sugden, 2006) was 39, placing her between the 5th and 15th percentile. Her Movement ABC Test (Henderson & Sugden, 1992) score was 26 which placed her below the 5th percentile. Her initial assessment on the EYMSC revealed particular difficulties in three of the four sections; Self Help skills, General Classroom skills and Recreational/Playground skills.

Movement difficulties observed by the class teacher included general clumsiness, poor fine motor and manipulation skills and poor PE skills, specifically aiming and catching and balancing skills. The class teacher noted that the child's movement problems were made worse when speed was involved and also if she was put under pressure. Despite her difficulties, the class teacher noted that she expressed herself well and achieved a fairly good standard of work. Priority areas for intervention were identified as increasing confidence in PE (hopping, skipping and ball skills), handwriting and general presentation skills.

Child 45 scored poorly on three of the four sections at Test 1 but as can be observed from the result for Tests 2 and 3 these only improved very slightly during the study. During the10 week phase of intervention, she received four sessions a week and improved her score by 4 points and she remained between 5th and 15th percentile. During the ten weeks when she received no intervention, her score on the EYMSC improved by a further one point, giving

her a final total score of 34 on the EYMSC. Her total improvement over the study was 5 points. Figure 3 shows the scores for Child 45 on the EYMSC at each testing point (before and following intervention).

Insert Figure 3 about here

The Movement ABC Test score of 23 at the end of the project showed an improvement of 3 points and remained below the 5th percentile.

Her class teacher commented on the slight overall improvement that Child 44 displayed, there was a small improvement in schoolwork as well as specific skills targeted as priority areas. The class teacher commented that it had been fairly easy to incorporate the activities into the normal routine of the day, but PE skills had been slightly more difficult. The class teacher also commented that Child 44 had worked fairly hard at all the activities and appeared to enjoy doing them.

4. Discussion

This research study has focused on the accurate identification and assessment of coordination difficulties in children aged three to six years and an examination of the efficacy of graded intervention programmes for children identified with difficulties.

The first main aim of the study was to examine the use of an assessment instrument, Early Years Movement Skills Checklist (Chambers & Sugden, 2006) which is designed to identify and assess movement difficulties in the age range three to six years. The instrument was based on the developmental progression of children, the interaction with the task to be completed and the context in which it is being performed (Keogh & Sugden, 1985; Newell, 1986). The activities within the movement skill domain have been organised into a

framework so that a class of activities can be identified (Schmidt, 1991) with intervention aimed at that class and can be used flexibly by teachers and parents/carers as part of everyday activities and not within an artificially created testing situation.

The EYMSC was constructed using functional, everyday skills appropriate for 3 to 6 year old children and focusing on specific areas of functional, everyday activities. In this way, it is possible to identify specific environments in which a child experiences difficulties and enables a child's difficulties to be assessed appropriately. Additionally, it is possible to use the EYMSC to inform intervention and, as can be seen from the individual profiles detailed above, very often the difficulties identified by the teachers were those picked up by the EYMSC.

It was shown in the study that the EYMSC is able to differentiate between children with and without coordination difficulties. The children identified as displaying coordination difficulties were found to be a significantly different group from their well coordinated peers. In a similar way, the EYMSC was also able to identify children who improved their coordination following a period of intervention. It was seen that all the children in Group 1 (SS1) and Group 2 (SS2) improved their coordination skills following intervention and this was reflected in their EYMSC scores at Test 2 and Test 3. At Test 3, no statistically significant differences were found between the scores of any of the groups; showing that the children in Groups 1 and 2 had improved their coordination skills. The results of the EYMSC were, again, confirmed by the Movement ABC Test (Henderson & Sugden, 1992).

The second main aim of the study was to examine the efficacy of graded intervention programmes for children identified with coordination difficulties. Graded intervention programmes consist of three stages; exposure, experience and targeted practice. The initial phase of the intervention is based around *exposure*; this is based on a class approach such that the individual child with difficulties is not specifically identifiable to the rest of the class or visitors. Activities, appropriate to the child's age, are provided and it is

important that these complement the activities of the classroom and gives the child exposure in a wide range of tasks. The next stage of the intervention is *experience*; this phase takes the fundamental motor skills that are deemed necessary for activities of daily life and academic performance and ensures the child actually experiences them. This stage is only used if the child shows no improvement in the preceding exposure stage. The third and final stage is *targeted practice*; in this stage, specific methods such as task analysis, the use of context for motivation, paired learning and modified equipment such as different shaped writing implements are used to teach the child skills which will enable them to function effectively in the classroom and home context.

The results confirmed that the use of graded intervention was effective for improving the coordination skills of young children with the majority of the children improving during the period of intervention; graded intervention has been shown to be effective in other areas of the school curriculum, such as reading intervention (Marchand-Martella, Ruby & Martella, 2007). More specifically, out of the 17 children who were below the 5th percentile at the beginning of the project, only three remained there at the end of the study. In addition, the improvement shown took place during the period of intervention and no gain was evident during the short periods of no intervention at the beginning and end of the project. Of the 18 children who scored between the 5th and the 15th percentile at the beginning of the study, only four children remained in this category at the end of the study.

The children in this study have not been identified as specifically having DCD; rather, they are described as displaying coordination difficulties as recommended by the Leeds Consensus Statement (Sugden, 2006). The case for early intervention was discussed above and it has been shown that early intervention in a range of difficulties has been effective in preventing or reducing the incidence of later problems. It is, however, difficult to predict whether the children involved in this study would have eventually displayed characteristics of DCD; however, at the beginning of the study they displayed various difficulties which prevented them from functioning effectively in the classroom and in activities of daily living. For older children, there is good

evidence to show that without intervention children with DCD continue with their difficulties into later life (Cantell et al., 2003; Cermak et al. 2002; Losse et al., 1991; Missiuna et al. 2007; Rivard et al, 2011; Rodger & Mandich, 2005; Skinner & Piek, 2001; Wilson 2005).

In a general manner, there was an attempt to link the amount of instruction received to the improvement shown. This was done by establishing three broad categories into which the children were placed according to their results and the amount of intervention received. Most of the children fell into the first category which contained 30 children who received adequate intervention and who improved substantially. A second category containing two children is more difficult to explain; these children who, despite receiving little intervention, made significant progress. They did receive some help, usually two or three times a week, and this may have triggered a development that had been delayed. A third category contained three children who received adequate intervention and displayed improvement but their scores remain below 5th percentile on both the EYMSC (Chambers & Sugden, 2006) and the Movement ABC Test (Henderson & Sugden, 1992) and little or no improvement by the end of the study. An explanation for this is that these children have difficulties that are of a more complex type and would require specialist therapy in order to meet their needs or they may need a longer period of intervention.

It has been noted by various researchers that children with DCD do not form a homogeneous group. Differences between children with and without DCD has long been an investigating priority and more recently researchers have examined intra group characteristics (Green & Baird, Sugden & Chambers, 2005; Vaivre-Douret et al., 2011; Wilson, 2005). These studies, while not showing agreed stable sub groups, do show the children to have different profiles. It is possible that, just as characteristics are showing differences across clusters of children, differences are evident in the manner to which children respond to intervention. This has been shown by Sugden and Chambers (2003, 2007) who, although working with older children, concluded that some children may require varying amounts of exposure to activities with

the amount being the influential factor, whereas with others, most notably those children who made little or no improvement following intervention, a qualitatively different type of approach may be required.

An important factor in any intervention study is the maintenance of improvement made and, in relation to this, a follow up study will be developed to investigate whether this group of children will maintain the improvement in motor skills that they have made during this study. Furthermore, it is possible that this group of children, as they all came from the same geographical area of the UK (an area of significant social and economic challenge) have shown a different profile of progression from children in other geographical areas and further study will be developed to examine the effect of early intervention in different areas of the UK.

The main limitation of this study was the number of participants involved; initially the number of children identified as displaying coordination difficulties was 96 (30.5%); whilst this is much higher than numbers shown in older age groups, it is, perhaps, indicative of the geographical area in which the study took place. Nevertheless, of the 96 children identified as displaying coordination difficulties, consent to allow their children to take part was received from only 35 parents. Whilst a range of profiles (response to intervention) was evident in this cohort, a larger number of participants would allow for a possible wider range of profiles to be examined and allow for further insight into coordination disorders in young children.

In conclusion, this study has shown that graded intervention programmes for children identified with coordination difficulties have been found to be effective and the majority of children who received intervention programmes have shown significant improvement in their coordination skills. As such, it shows that young children in this age range can be helped; this allows them to fully participate in school life and activities of daily living, both of which are important factors in a young child's development. Furthermore, the research team are cautiously optimistic that, as children in the age range of 3 to 5/6 years of age can be helped in the development of their motor skills, this can

help prevent more severe pervasive later difficulties. This study has application for early years settings; the EYMSC (Chambers & Sugden, 2006) has been shown to be an effective, easily administered checklist for children in the age range of 3 to 5/6 years and it provides detail that informs the individual intervention programmes for young children. These intervention programmes involve functional activities which are graded so that a child participating in an intervention activity is unidentifiable to any visitor to the classroom.

Key Messages

1. The Early Years Movement Skills Checklist has been shown to be effective in identifying movement difficulties in children between the ages of 3 and 6 yes of age
2. The Early Years Movement Skills Checklist has been shown to be effective in informing intervention
3. Graded intervention programmes have been found to be effective for young children with coordination difficulties
4. The research team are cautiously optimistic that children in the age range 3 to 5/6 years of age can be helped in the development of their motor skills and help prevent more severe pervasive later difficulties.

Acknowledgements

This research study was supported by Action Medical Research. The authors wish to thank the head teachers, teachers, the children and their parents for their time and assistance which they generously contributed to this study.

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TABLES

	Mean Age and Range (Years and months)	Standard Deviation (Months)
Group 1 (SS1) n=17	4.05 (3.04 to 5.11)	0.85
Group 2(SS2) n=18	4.10 (3.06 to 6.11)	0.9
Group 3 (CS) n=19	4.07 (3.05 to 5.10)	0.64

Table 1 Mean ages, range and standard deviations for each group

	EYMSC Test 1	Movement ABC Test 1
Group 1 (SS1) n=17	51.11 (33-72)	18.25 (11.5-23.5)
Group 2 (SS2) n=18	44.22 (34-69)	18.73 (12-36.5)
Group 3 (SC) n=19	34.63 (23-54)	3.5 (0-9)

Table 2 Mean total scores and range of scores for each group on the EYMSC and the Movement ABC Test at the beginning of the study

Stage 1: Assessment of total group with the Early Years Movement Skills Checklist and Movement ABC Test (for all 4 to 6 year olds)
Stage 2: Group 1 Teacher Intervention for 10 weeks
Group 2 No intervention
Stage 3: Assessment of total Group with the Early Years Movement Skills Checklist
Stage 4: Group 2 Teacher Intervention for 10 weeks
Group 1 No intervention
Stage 5: Assessment of total Group with the Early Years Movement Skills Checklist and Movement ABC Test for all children

Table 3 Sequence of Assessments and Intervention

	EYMSC 1	EYMSC 2	EYMSC 3
Below 5%ile	17	8	3
5 – 15%ile	18	13	4
N	35	35	35

Table 4 Frequencies of Impairment for Group 1 (SS1) and Group 2 (SS2)

	EYMSC 1	EYMSC 2	EYMSC 3
Group 1	51.11 (33-72)*	38.23 (23-57)*	30.58 (23-46)
Group 2	42.22 (34-69)*	40.77 (28-63)**	29.7 (23-42)*
Group 3	34.63 (23-54)*	27.73 (23-35)**	25 (23-33)

*Significant at the .005 level

**Significant at the .005 level

Table 5 Total mean scores and significance levels for each group at each testing occasion on the EYMSC

	Movement ABC Test 1	Movement ABC Test 2
Group 1	18.25 (11.5-23.5)*	18.25 (11.5-23.5)*
Group 2	18.73 (12-36.5)*	6.0 (0-14)*
Group 3	3.5 (0-9)*	2.18 (0-9.5)

*Significant at the .005 level

Table 6 Total mean scores and significance levels for each group on the Movement ABC Test at the beginning and end of the study

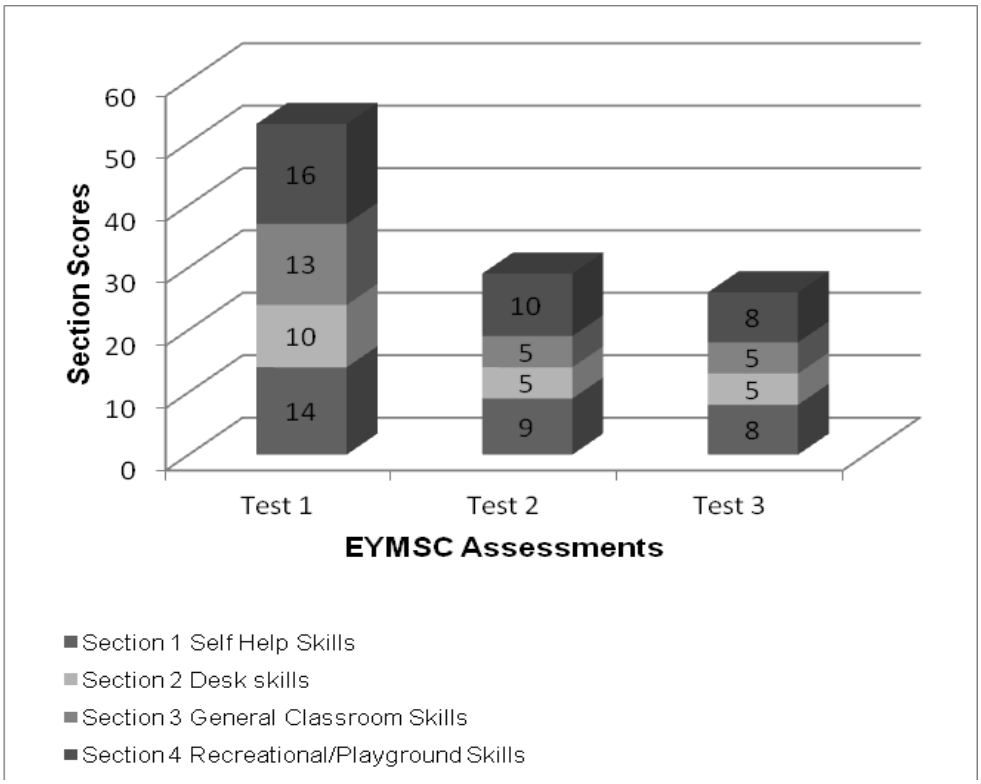

Figure 1 Profile for Child 175 displaying scores on the EYMSC (higher scores indicate poorer coordination skills)

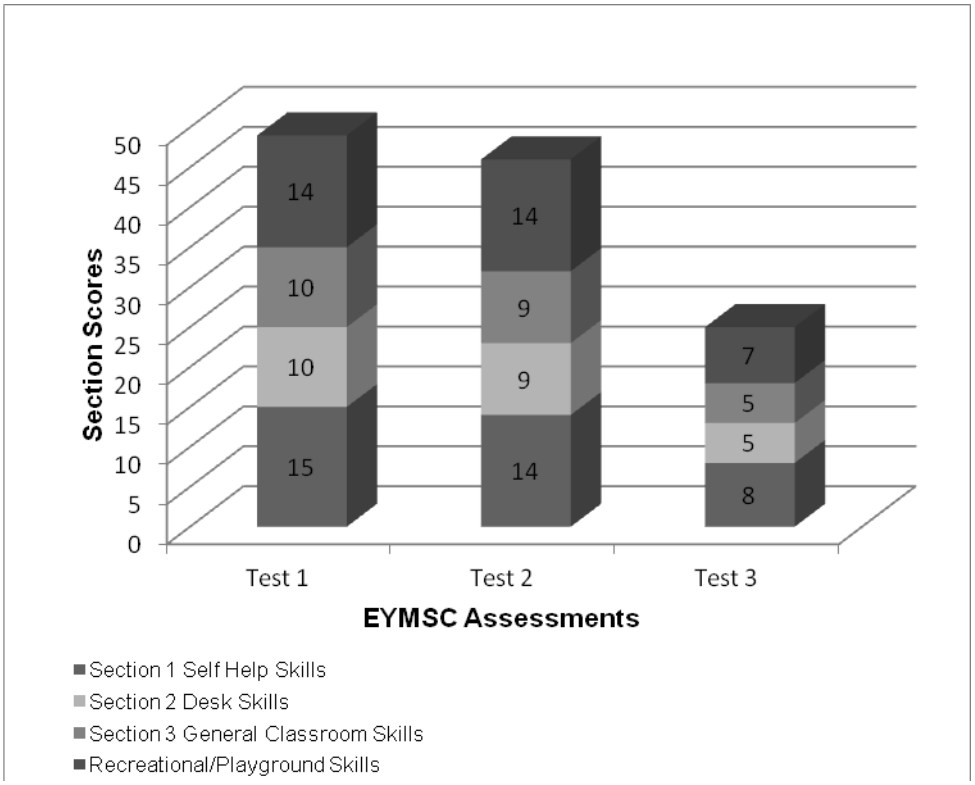

Figure 2 Profile for Child 300 displaying scores on the EYMSC (higher scores indicate poorer coordination skills)

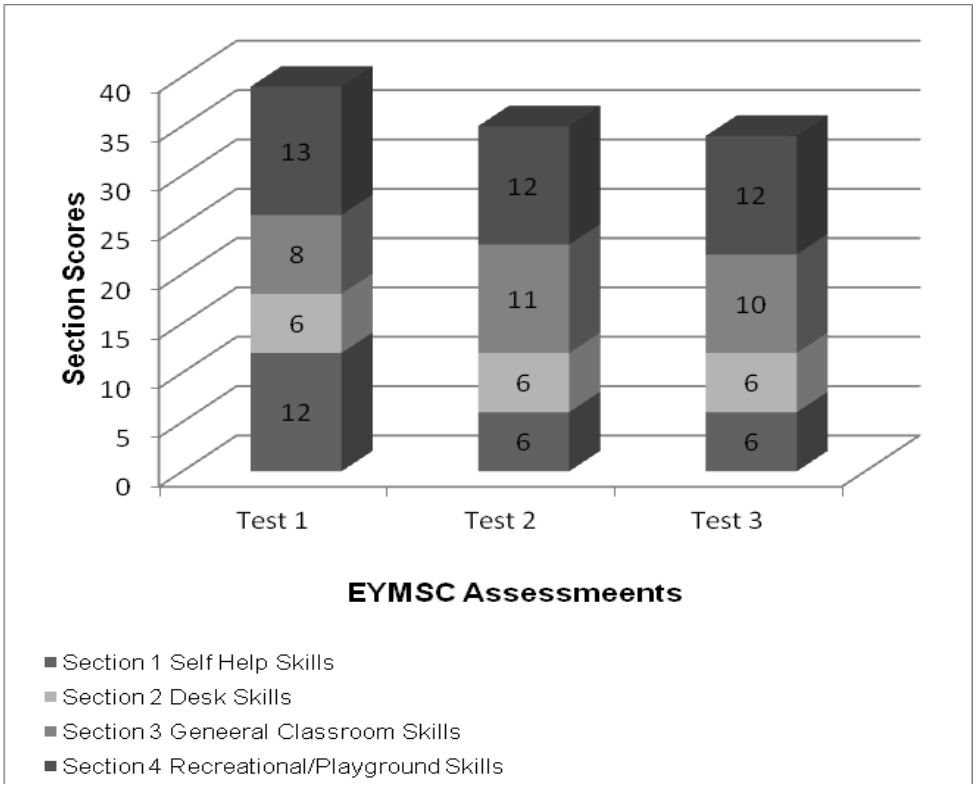

Figure 3 Profile for Child 44 displaying scores on the EYMSC (higher scores indicate poorer coordination skills)