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The effects of the Primary Movement programme on the academic performance of children attending ordinary primary school

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The present study investigated the prevalence of a primary reflex (the Asymmetrical Tonic Neck Reflex) in children attending ordinary primary school and how this related to attainments in a number of academic areas. The effectiveness of a specific movement intervention programme in reducing primary reflex persistence and improving academic attainment was also evaluated.

A comparative study of the progress of 683 children over a two-year period from Years 3 and 5, who completed an intervention programme known as Primary Movement, was carried out using the relative attainments of children at the same schools and standardised scores as baseline and follow-up measures. A second, quasi-experimental study followed the progress of four parallel groups in each of two large schools with the experimental side completing the movement intervention programme while the other side acted as the control.

It was found that ATNR persistence was significantly associated with level of attainments in reading, spelling and mathematics and that boys were more at risk than girls for ATNR persistence. In both studies, it was found that the movement intervention programme had a very significant impact on reducing the levels of ATNR persistence in children and that this was associated with very significant improvements in reading and mathematics, in particular.

This research provides further evidence of a link between the attainment of core educational skills and the interference that may result from an underlying developmental deficit. The effectiveness of the intervention programme in reducing ATNR persistence and in increasing academic attainments suggests that this programme could be used to complement other strategies that have been shown to have a positive effect on children's learning.

Introduction

This study evaluates the effects of a movement programme, known as Primary Movement, on the development of core educational skills (reading, spelling, mathematics) in children (6–11 years old) attending ordinary primary school.

Primary reflexes

Primary reflexes emerge *in utero* and play an important role in the early survival of the newborn (e.g., rooting and suck reflexes). More than 70 primary reflexes have been identified (Illingworth, 1987) and they are readily elicited in the first six months after birth (Capute, Shapiro, Palmer, Accardo & Wachtel, 1981). They are, however, inhibited or transformed during the first year of post-natal life and a secondary (postural) reflex system emerges to provide the reflexive support for movement and balance as the child moves to the upright world of the toddler.

Abnormalities of the primary reflex system either in the degree or rate of disappearance (persistence) may lead to significant problems in the development of motor functioning (e.g., Holt, 1991). There are very close links between the inhibition of primary reflexes and the attainment of gross-motor milestones (Capute, Accardo, Vining, Rubenstein & Harryman, 1978; Milani-Comparetti & Gidoni, 1967). The assessment of motor milestones has been used as a diagnostic procedure for the early detection of severe learning difficulties and cerebral palsy, and significant delays in motor development have been shown to index the incidence and the extent of severe learning difficulties (Donoghue, Kirman, Bullmore, Laban & Abbas, 1970). Milder persistence is associated with less severe disorders including reading difficulties (Morrison, 1985).

Some movement interventions have included the inhibition of persistent primary reflexes as a core element in addressing the underlying functional deficits that children with various difficulties have shown. The remediation approaches of David McGlown (Developmental Reflexive Rehabilitation, BIRD) and Peter Blythe (Neuro-developmental Therapy, INPP.), both from Chester, England, have focused almost exclusively on the inhibition of persistent primary (or primitive) reflexes and the stimulation of secondary or postural reflexes. They suggested that the failure to integrate the primary reflex system through inhibition, modification or transformation into voluntary behaviour in the first year of life was at the root of a range of learning difficulties (Blythe & McGlown, 1978).

From this perspective, the actual movements used are not intended to 'pattern' appropriate developmental movement or to train particular adaptive movement but to inhibit, integrate or transform persistent, aberrant reflexes. This is achieved through the imitation of actual reflex patterns. The sequence of movement used is based on the normal sequential emergence of the primary reflexes during development (McGlown, 1990).

Unfortunately, there is no peer-reviewed published research on the effectiveness of either of these interventions with children or adults with learning difficulties and a recent evaluation of the I.N.P.P. programme for primary school children showed minimal impact in a school context (Fylan & Grunfeld, 2004). The lack of evaluative research, in general, has allowed critics of movement interventions to conclude that the 'treatment of children with developmental disabilities has been plagued throughout its history by a variety of unproven and irrational treatment approaches' (Starrett, 1991, p. 219).

There are few studies in the area of movement intervention that fulfil the basic requirements of scientific evaluative research and this is all the more regrettable when many of the interventions are extremely expensive and involve a considerable commitment on the part of the child and, usually, the parents. In recent years, huge controversy arose with the publication of an evaluative study (Reynolds, Nicolson & Hambly, 2003), on a process-oriented approach known as the 'DDAT' or 'Dore' programme, that was compromised by a number of serious methodological flaws (e.g., Rack, 2003; Richards, Moores, Witton, Reddy, Rippon, Rochelle & Talcott, 2003; Snowling & Hulme, 2003; Stein, 2003).

The Primary Movement programme

The Primary Movement programme was devised by Martin McPhillips (Queen's University, Belfast) who began using movement in the school classroom with children with moderate learning difficulties in 1982. The approach was initially based on the work of Raymond Dart (1893–1988) who was Professor of Anatomy at Witwaterstrand University, Johannesburg from 1922. Although Dart is best known for his work in physical anthropology, he pioneered the establishment of training for physical and occupational therapists in South Africa in the 1920s and went on to develop a movement programme (the Dart Procedures) for children with movement difficulties. This involved a progressive sequence of movement including, for the first time, the replication of fœtal movement (Dart, 1946).

The Primary Movement programme involves the daily repetition of a short sequence of movement that mimics the early reflex movement of the fœtus and includes specific exercises to stimulate the major motor centres in the brain including the cerebellum. Five fœtal movements are used including one developed from the 'fœtal posture' movement of Raymond Dart (1946) and another from the 'fœtal movement' used at the Institute for Neuro-Physiological Psychology, Chester (McPhillips, 2001). A large part of the programme is presented in a child-friendly format using action songs and rhythms.

Aims of the research study

The main aim of the present study is to evaluate the effectiveness of the Primary Movement programme in a school setting over a two-year period. McPhillips, Hepper and Mulhern (2000) in a randomised, double-blind, controlled study found that the Primary Movement programme had a very significant impact relative to controls on the reading ability of children (8–11-year-olds) when the programme was undertaken at home. The present study is concerned with the added value of including this programme as part of the curriculum in ordinary primary school.

It was decided to investigate the impact of the programme on the whole class as it has been shown in a school-based study involving a cross-sectional sample of 9-year-olds that some children without obvious learning difficulties experience a degree of primary reflex persistence. McPhilllips and Sheehy (2004) found that the persistence of the Asymmetrical Tonic Neck reflex (ATNR) was significantly associated with reading difficulties but that there was some evidence of low levels of ATNR persistence in children who were reading well beyond their chronological age.

As the movement programme does not involve direct instruction in any specific academic area it was decided to look at the impact of the programme on mathematical reasoning, in addition to standard literacy measures such as reading and spelling.

Methods

Sample and design

Irene Knox and Stanton Sloane of the SEELB selected 13 schools from the South Eastern Education and Library Board (SEELB) area in Northern Ireland as representative of the total district. The schools ranged from large to small and reflected the urban and rural catchment area of the SEELB. A large, comparative, longitudinal study included all children attending all of the 13 schools in Years 3, 5 and 7 (7-, 9- and 11-year-olds, respectively). To provide baseline measures and standardised comparisons, 1136 children were initially assessed at the outset (including 391 Year 7 (11-year-olds)). At reassessment of the Year 3 and 5 children after two years (who were now Year 5 and Year 7, respectively), it was possible to reassess 683 children (from 735 initially). Over the course of the study, 52 children had moved to different schools or out of the area.

A second, quasi-experimental study followed the progress of two parallel groups of children from Year 3 to Year 5 (n = 82) and two parallel groups from Year 5 to Year 7 (n = 97) in two of the larger schools where one group of children completed the intervention programme (experimental group) and the other parallel group continued with normal class work (control group) in each year group.

Parental consent was obtained for all the children who participated in the study. Two children were withdrawn by parental request before the initial assessments.

Procedure

At the end of the school year (spring and summer 2002), all of the children in Years 3, 5 and 7 attending the 13 selected schools were tested individually on a range of measures including standardised tests of reading, spelling and mathematics and a clinical diagnostic test for the Asymmetrical Tonic Neck reflex (ATNR). The Year 3 and Year 5 children were also tested in class groups for verbal IQ. (Year 7 children were too old for this test). These assessments provided the baseline measures for both the longitudinal study and the quasi-experimental study.

The children in the larger, longitudinal study and the experimental group of the second quasi-experimental study began the Primary Movement intervention at the start of their subsequent academic year. The movement programme was repeated on a daily basis in class groups for 10 minutes per day until the end of that academic year. The children were not reassessed at the end of the intervention year but reassessment of all of the children (with the exception of those who had left the participating schools) was completed at the end of the next academic year (spring and summer 2004).

This provided a longitudinal dimension to both studies and helped to minimize attention or novelty of intervention effects that might occur during an intervention period. It also allowed an evaluation of the added value of including a movement intervention relative to the past achievement levels of the sample schools.

All of the individual assessments were carried out by the author with the assistance of a small group of testers from a ‘bank’ of experienced testers used by the School of Psychology in applied educational projects. A teacher from each school completed a short training course in Primary Movement (supervised by Martin McPhillips, School of Psychology, QUB) so that they could undertake the movement intervention with the children in their schools.

Measures

Wechsler Objective Reading Dimensions. The Wechsler Objective Reading Dimensions (WORD) is an individually administered test designed for the assessment of children aged 6 to 16 years. The two WORD sub-tests used in this study were Basic Reading and Spelling. These two lines of assessment offer the opportunity to view a child’s progress in acquiring fundamental literacy skills (Rust, Golombok & Trickey, 1993).

Wechsler Objective Numerical Dimensions. The Wechsler Objective Numerical Dimensions (WOND) is also an individually administered test designed for the assessment of children aged 6 to 16 years. Mathematics Reasoning is a sub-component of WOND and offers the opportunity to view a child’s progress in acquiring fundamental numeracy skills (Rust, 1996).

Non-Reading Intelligence Tests (Levels 1 and 3). The Non-Reading Intelligence Tests (NRIT) incorporates the original Non-Readers Intelligence Test (now Level 1) and the Oral Verbal Intelligence Test (as NRIT Level 3) (Young, 1989). In this study, Level 1 was administered to Year 3 children and Level 3 was administered to Year 5 children.

Asymmetrical Tonic Neck reflex (ATNR). The Schilder Test was used to score the ATNR (see Appendix 1).

Analysis

A multiple regression analysis was conducted to evaluate the significant predictors of reading, spelling and mathematics for the Year 3 and 5 children using the five predictor variables available in this study: verbal IQ, ATNR persistence, sex of the child, month of birth and free school meal entitlement.

One-way ANOVAs were used to analyse the performance of the Year 5 children in 2004 (post intervention) relative to the Year 5 children of 2002 and the Year 7 children in 2004 (post intervention) relative to the Year 7 children of 2002. Effect sizes for the impact of the movement intervention were calculated for reading, spelling and mathematics.

The data for the quasi-experimental study were analysed by means of a 2 × 2 split-plot ANOVA with group (experimental) as a between participant factor and time (before and after intervention) as a within participant factor. One-way ANOVAs were used to analyse the differential performance of the experimental and control groups.

Results

Baseline measures

The distribution of the reading, spelling and mathematical reasoning scores for the total sample are shown in Figure 1.

The boxplot reveals that although reading and spelling scores generally improve between Years 3 and 5, there is a small decline between Years 5 and 7. However, mathematics scores generally improve as the children come up through the school and the mathematics scores of the Year 7 children are markedly high on this standardised comparison.

A comparison of male and female attainment levels in reading, spelling and mathematics is shown in Figure 2. The boxplot reveals that females have higher attainments in reading and spelling while males and females have similar attainments in mathematics.

The Non-Reading Intelligence Test (NRIT) revealed that the year groups (3 and 5) had very similar verbal IQ scores

Figure 1: A boxplot of the baseline standardised reading, spelling and mathematics scores for the three-year groups

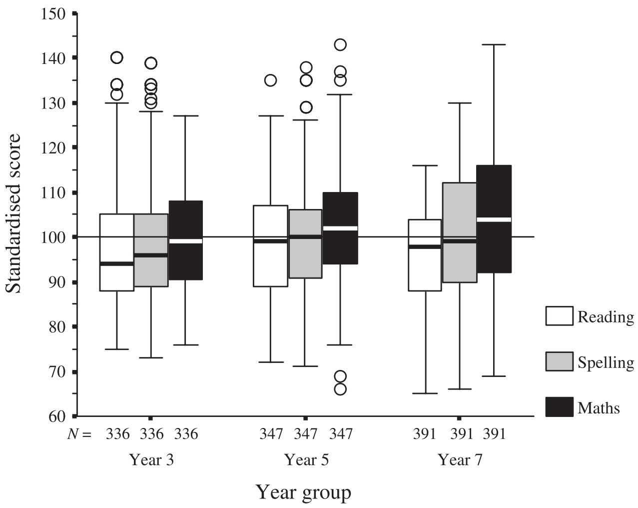


Figure 3: Boxplot of NRIT scores (verbal IQ) for Years 3 and 5

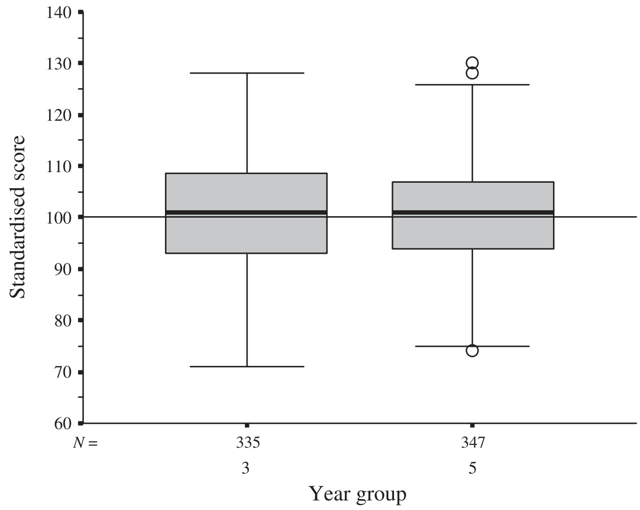
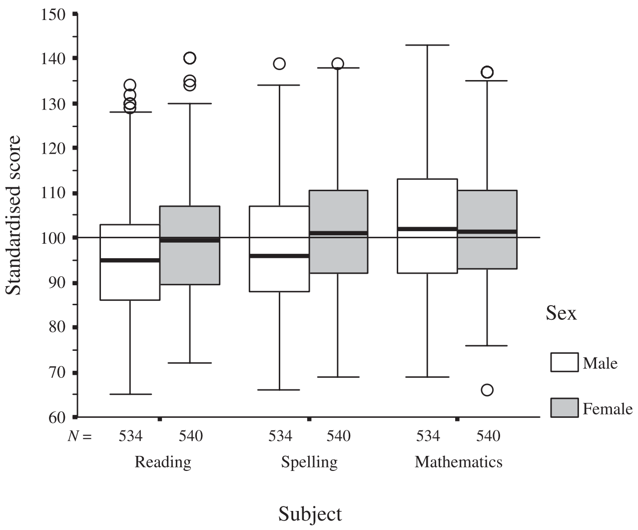


Figure 2: A boxplot of male and female attainment levels for reading, spelling and mathematics



of 101.0 and 100.7, respectively, and that the scores were distributed normally with standard deviations of 11.6 and 10.5, respectively (see Figure 3).

This test could not be used with the Year 7 children because they were at the age limit of the test. However, the NRIT scores obtained for the Year 3 and 5 children suggest that the sample schools were representative of the wider population of children attending ordinary primary school in Northern Ireland and that the year groups were comparable in underlying ability.

Furthermore, the proportion of children receiving free school meals in the final study sample of 1074 children was 24%. The proportion of children entitled to free school meals in Northern Ireland was 22% (Department of Education, Northern Ireland, 2003).

Table 1: Partial correlations between each predictor and attainments in reading, spelling and mathematics controlling for all other predictors

Predictors	Reading	Spelling	Mathematics
Verbal IQ (NRIT)	0.42***	0.37***	0.46***
ATNR	–0.35***	–0.33***	–0.25***
Month of birth	0.23***	0.23***	0.28***
Free school meal	–0.12***	–0.09*	–0.13***
Sex of the child	0.05	0.06	0.15***

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

The multiple regression equations with all five predictor variables included were significantly related to the outcome measures used in this study: reading, spelling and mathematics. $R = 0.67$, $R^2 = 0.45$, adjusted $R^2 = 0.44$, $F(5,677) = 109.5$; $p < 0.001$ for reading; $R = 0.63$, $R^2 = 0.40$, adjusted $R^2 = 0.40$, $F(5,677) = 109.5$; $p < 0.001$ for spelling and $R = 0.67$, $R^2 = 0.45$, adjusted $R^2 = 0.44$, $F(5,677) = 109.7$; $p < 0.001$ for mathematics. The relative strength of the individual predictors for each outcome measure is summarised in Table 1.

It is apparent from the regression analyses and partial correlations that verbal IQ is the strongest predictor of attainments in reading, spelling and mathematics. The persistence of the ATNR is also very predictive of attainments in these three core areas and this is illustrated in Figure 4 which shows a direct relationship between ATNR persistence and reading level for the three year groups assessed. Month of birth and entitlement to free school meals were also predictive at lower levels.

Although it was found that the sex of the child was only predictive of mathematics attainments at Year 7, the regression model is based on a principle of parsimony and

Figure 4: The relationship between ATNR persistence and reading attainment

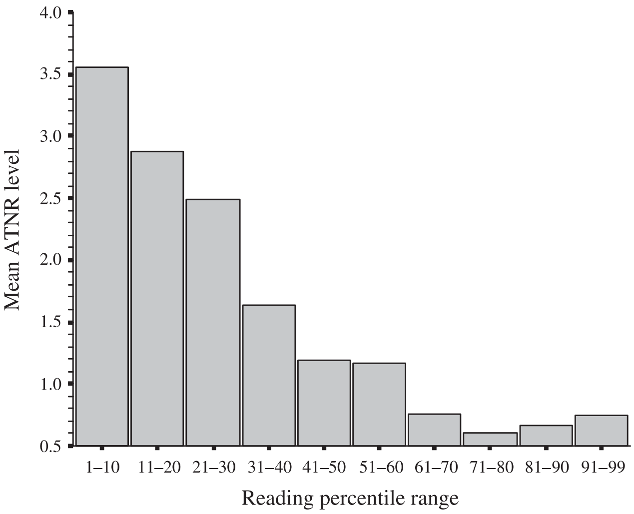
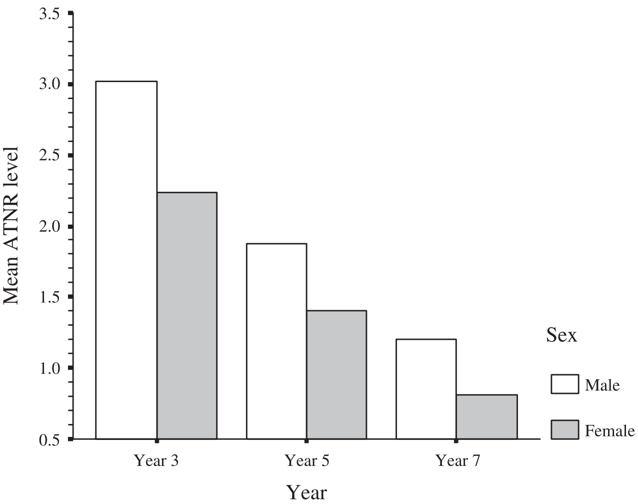


Figure 5: The relationship between ATNR persistence and the sex of the child



the predictive power of the sex of the child may be subsumed within other more powerful predictors. Indeed, there are very clear differences between males and females in the levels of persistent ATNR at the three age levels used in this study, see Figure 5. This shows how ATNR persistence is significantly higher ($F(1,1073) = 18.0$; $p < 0.001$) for boys than girls in all three year groups. An effect size of 0.26 between mean levels of ATNR persistence for boys and girls suggests that the sex of the child has a moderately small effect on ATNR persistence.

Outcomes

ATNR

For ATNR levels, a comparison of the Year 5 children in 2002 with the Year 5 children in 2004 revealed that there was significantly less ATNR reflex in the 2004 (post-intervention) group ($F(1,670) = 200.6$; $p < 0.001$). A comparison of the Year 7 children in 2002 with the Year 7 children in 2004 also revealed that there was significantly less ATNR reflex in the 2004 (post-intervention) group ($F(1,692) = 123.3$; $p < 0.001$). The mean differences in ATNR levels for the year groups are shown in Table 2. Effect sizes of 0.6 and 0.5 for the differences in mean reflex levels of the Year 5 and 7 groups, respectively, indicates that the intervention programme had a relatively strong effect in reducing ATNR persistence for both year groups.

Table 2: Mean levels (standard deviation) of ATNR for each year group at baseline and post-intervention

	Year 3	Year 5	Year7
2002 (baseline)	2.7 (2.3) n = 336	1.6 (2.1) n = 347	1.0 (1.8) n = 391
2004 (post-intervention)		0.6 (1.3) n = 336	0.3 (0.8) n = 347

Table 3: Mean levels (standard deviation) for reading for each year group at baseline and post-intervention

	Year 3	Year 5	Year 7
2002 (baseline)	97.7 (13.2) n = 336	98.2 (12.5) n = 347	95.9 (10.8) n = 391
2004 (post-intervention)		106.0 (13.6) n = 336	103.8 (11.5) n = 347

Reading

For reading, a comparison of the Year 5 children in 2002 with the Year 5 children in 2004 revealed that the 2004 (post-intervention) group had significantly higher reading attainment levels ($F(1,670) = 63.8$; $p < 0.001$). A comparison of the Year 7 children in 2002 with the Year 7 children in 2004 also revealed that the 2004 (post-intervention) group had significantly higher reading attainment levels ($F(1,692) = 37.4$; $p < 0.001$). The mean differences in reading for the year groups are shown in Table 3. Effect sizes of 0.6 and 0.5 for the differences in mean reading levels of the Year 5 and 7 groups, respectively, indicates that the intervention programme had a relatively strong effect in improving reading skills for both year groups.

Spelling

For spelling, a comparison of the Year 5 children in 2002 with the Year 5 children in 2004 revealed that the 2004 (post-intervention) group had significantly higher spelling attainment levels ($F(1,670) = 9.3$; $p = 0.002$). A comparison of the Year 7 children in 2002 with the Year 7 children in 2004 also revealed that the 2004 (post-intervention) group had significantly higher spelling attainment levels ($F(1,692) = 6.4$; $p = 0.012$). The mean differences in spelling for the year groups are shown in Table 4. An effect size of 0.2 for the differences in mean spelling levels of both the Year 5 and 7 groups indicates that the intervention programme had a small effect in improving spelling levels for both year groups.

Table 4: Mean levels (standard deviation) for spelling for each year group at baseline and post-intervention

	Year 3	Year 5	Year7
2002 (baseline)	98.1 (12.7) n = 336	99.5 (12.1) n = 347	99.8 (14.4) n = 391
2004 (post-intervention)		100.9 (12.0) n = 336	102.0 (14.0) n = 347

Table 5: Mean levels (standard deviation) for mathematics for each year group at baseline and post-intervention

	Year 3	Year 5	Year 7
2002 (baseline)	99.6 (11.3) n = 336	102.8 (11.9) n = 347	104.4 (15.2) n = 391
2004 (post-intervention)		109.1 (13.1) n = 336	115.4 (16.8) n = 347

Mathematics
For mathematics a comparison of the Year 5 children in 2002 with the Year 5 children in 2004 revealed that the 2004 (post-intervention) group had significantly higher mathematics attainment levels ($F(1,670) = 102.9$; $p < 0.001$). A comparison of the Year 7 children in 2002 with the Year 7 children in 2004 also revealed that the 2004 (post-intervention) group had significantly higher mathematics attainment levels ($F(1,692) = 131.7$; $p < 0.001$). The mean differences in mathematics attainment levels for the year groups are shown in Table 5. Effect sizes of 0.8 and 0.9 for the differences in mean mathematics levels of the Year 5 and 7 groups, respectively, indicates that the intervention programme had a very strong effect in improving mathematics reasoning skills for both year groups.

A boxplot of the comparative changes in reading, spelling and mathematics for the Year 5 group (post-intervention 2004) relative to their Year 3 score (baseline 2002) is shown in Figure 6. This figure also includes the baseline measures for the Year 5 children of 2002 as a further comparison.

A boxplot of the comparative changes in reading, spelling and mathematics for the Year 7 group (post-intervention 2004) relative to their Year 5 score (baseline 2002) is shown in Figure 7. This figure also includes the baseline measures for the Year 7 children of 2002 as a further comparison.

In order to examine the impact of the movement intervention on children who were attaining at average and below average standardised score levels (including children in the lowest 15% of the population (below a standard score of 86)), histograms of the changes in frequency distributions over the course of the study were drawn up for the combined Year 5 and Year 7 (2004) groups. Figures 8 and 9 reveal how the frequency distributions for reading have moved to the right at post-intervention and Figures 10

Figure 6: A boxplot of comparisons in attainments for reading, spelling and mathematics for Year 5 children (post-intervention) relative to their baseline measures and a previous Year 5 group

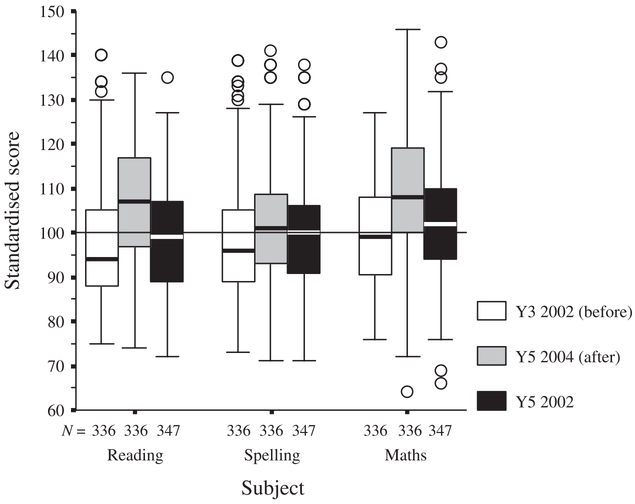
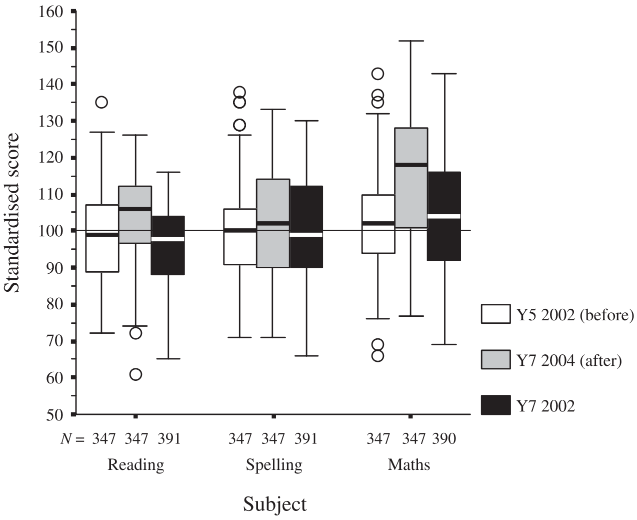


Figure 7: A boxplot of comparisons in attainments for reading, spelling and mathematics for Year 7 children (post-intervention) relative to their baseline measures and a previous Year 7 group



and 11 show the same pattern for mathematics attainments over the same period. In reading, for example, 13% and 18% of the Year 3 and Year 5 children, respectively, were attaining in the bottom 15% in 2002 but this had fallen to 7% and 8%, respectively, for the same two groups of children in 2004.

Quasi-experimental study
The mean scores for the experimental and control groups in reading, spelling and mathematics at the outset in 2002 and at follow up in 2004 are shown in Tables 6 and 7.

For reading there were very significant (group by time) interactions for both year groups ($F(1,80) = 24.9$; $p < 0.001$ for Year 5 and $F(1,95) = 35.7$; $p < 0.001$ for Year 7).

Figure 8: A histogram of the frequency distribution at baseline of the standardised reading scores below 116

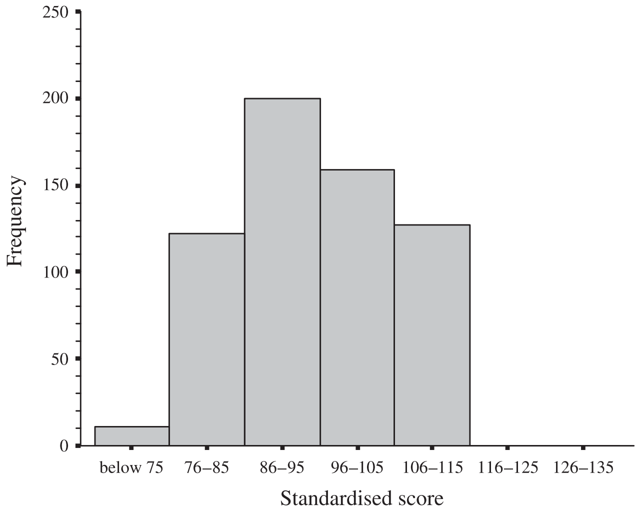


Figure 9: A histogram at post-intervention of the standardised reading scores that were below 116 at baseline

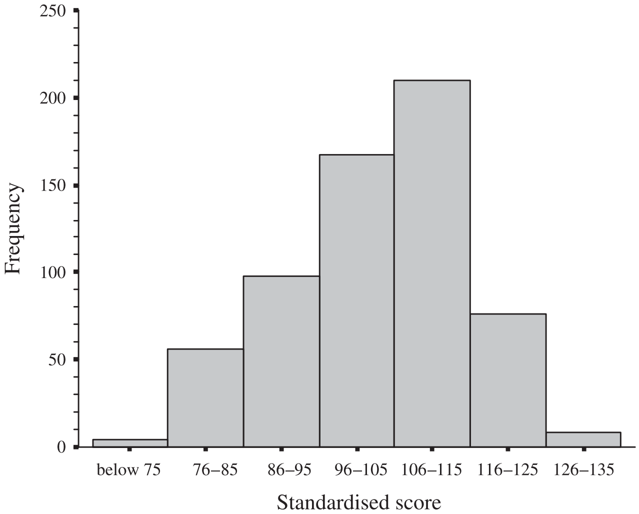


Table 6: Means and standard deviations for reading, spelling and mathematics attainments for experimental and control groups, Year 3 to Year 5

	Experimental		Control	
	2002 n = 42	2004 n = 42	2002 n = 40	2004 n = 40
Reading	85.8 (9.0)	102.1 (13.2)	93.3 (12.8)	98.8 (14.5)
Spelling	96.2 (9.8)	96.9 (10.5)	99.8 (11.7)	97.9 (13.7)
Mathematics	95.2 (15.5)	108.0 (11.8)	99.6 (18.1)	104.9 (14.0)

Figure 10: A histogram of the frequency distribution at baseline of the standardised mathematics scores below 116

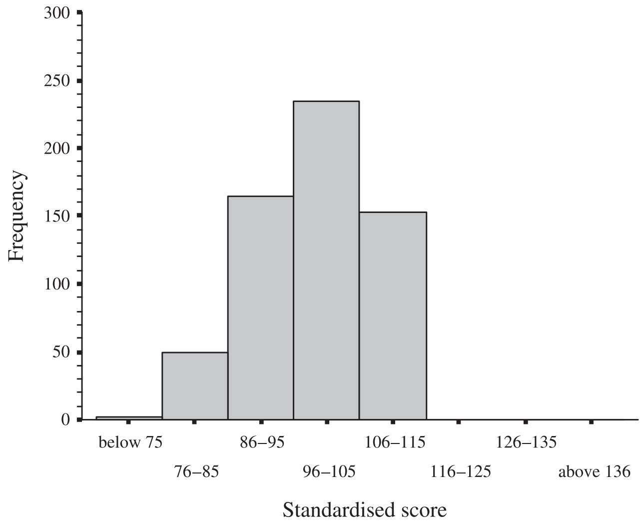


Figure 11: A histogram at post-intervention of the standardised mathematics scores that were below 116 at baseline

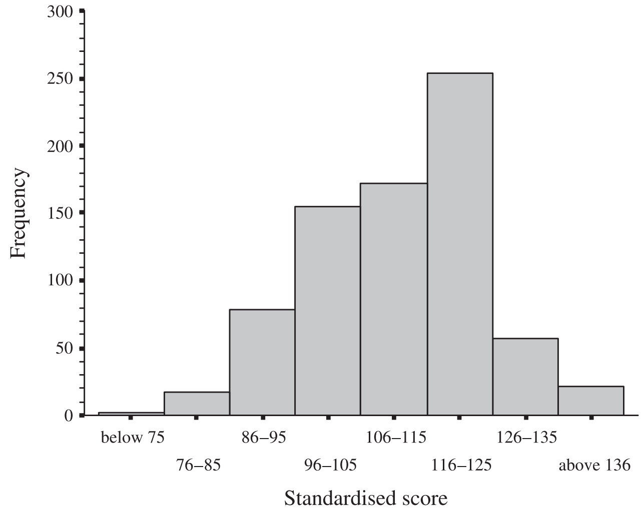


Table 7: Means and standard deviations for reading, spelling and mathematics attainments for experimental and control groups, Year 5 to Year 7

	Experimental		Control	
	2002 n = 50	2004 n = 50	2002 n = 47	2004 n = 47
Reading	96.7 (11.5)	103.1 (12.1)	99.3 (10.5)	97.2 (10.0)
Spelling	100.4 (10.9)	96.9 (12.8)	104.3 (11.5)	101.2 (14.1)
Mathematics	100.9 (14.6)	111.0 (17.3)	108.6 (12.8)	107.7 (13.9)

Figure 12: A boxplot of changes in reading attainment for experimental and control groups, Year 3 to Year 5

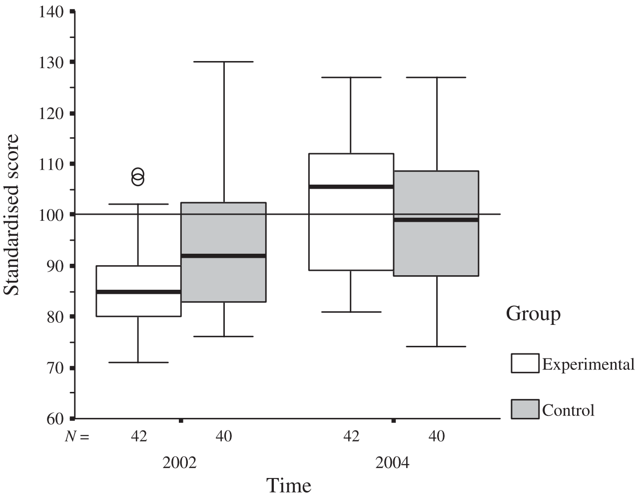
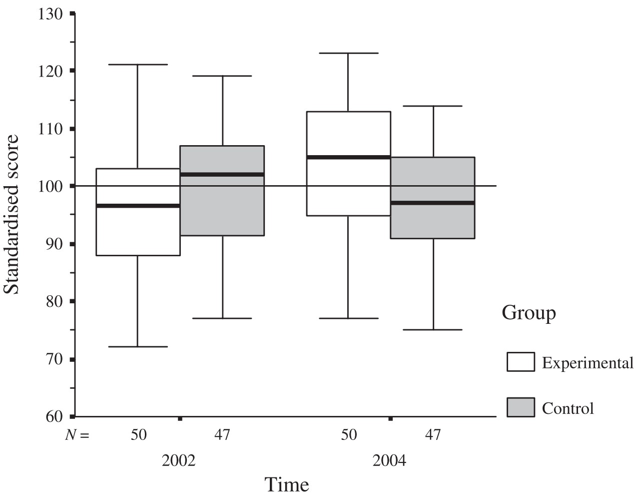


Figure 13: A boxplot of changes in reading attainment for experimental and control groups, Year 5 to Year 7



However, the experimental groups in both years made significantly greater progress ($p < 0.001$) than the control groups. This is illustrated in Figures 12 and 13.

For spelling there were no significant (group by time) interactions for either year group ($F(1,80) = 1.5$; NS for Year 5 and $F(1,95) = 0.03$; NS for Year 7).

For mathematics there were very significant (group by time) interactions for both year groups ($F(1,80) = 11.1$; $p < 0.01$ for Year 5 and $F(1,95) = 29.3$; $p < 0.001$ for Year 7). However, the experimental groups in both year groups made significantly greater ($p < 0.001$) progress than the control groups. This is further illustrated in Figures 14 and 15.

Discussion

The present study provides evidence of a strong relationship between reading, spelling and mathematics

Figure 14: A boxplot of changes in mathematics attainment for experimental and control groups, Year 3 to Year 5

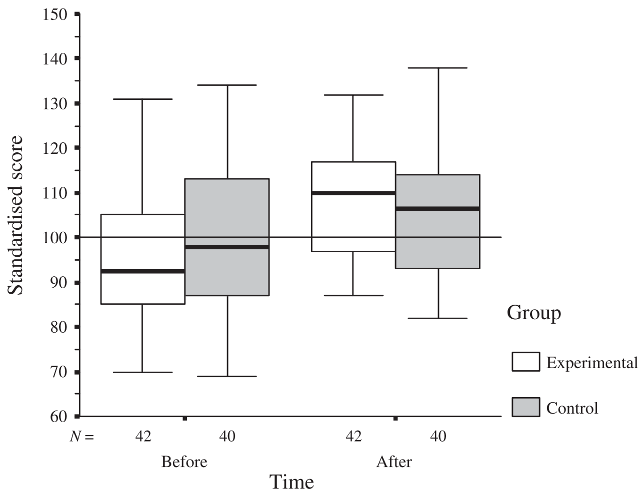
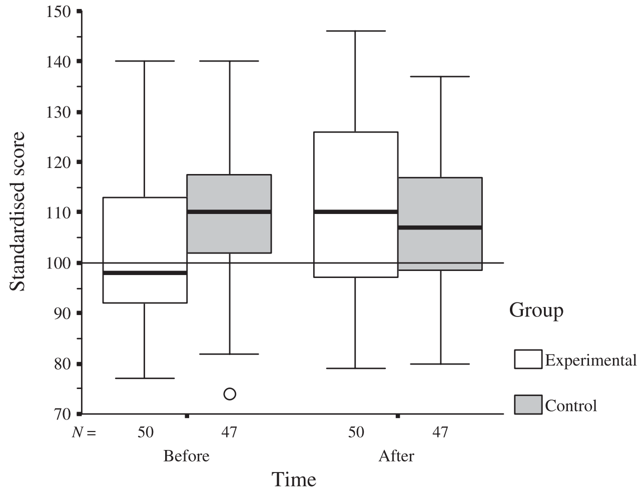


Figure 15: A boxplot of changes in mathematics attainment for experimental and control groups, Year 5 to Year 7



attainments and verbal IQ. Furthermore, it is apparent that the persistence of the Asymmetrical Tonic Neck reflex (ATNR) is also very predictive of attainments in these core skills. This concurs with previous work (McPhillips & Sheehy, 2004) where it was found that verbal IQ was very predictive of reading performance in 9-year-olds and that the persistence of the ATNR played a significant role in delaying the reading progress of children attending ordinary primary schools.

The baseline data in the present study also provides evidence of a significant sex difference in performance on standardised tests for both reading and spelling but not for mathematics across the three age groups assessed and that ATNR persistence occurs at a significantly higher level in boys than girls for all three year groups. This does not mean that ATNR persistence can wholly explain the differences in performance of boys and girls on standardised tests but it does suggest that the higher levels of persistence of the ATNR in boys may place them at risk of potential difficulties relative to girls. The persistence of the ATNR may be used as a clinical indicator of developmental delay (e.g., Morrison, 1985) and there is considerable evidence that boys are more 'at risk' than girls for a range of developmental problems such as dyslexia and autism (e.g., Frith, 2003).

Effects of intervention

The follow-up results suggest that the Primary Movement programme has a significant effect on reducing the persistence of the ATNR and on improving the academic performance of primary school-aged children. The effects of the movement programme were particularly marked for reading and mathematics with spelling showing a smaller effect. The improvement in reading may have been anticipated from previous work (McPhillips et al., 2000) but the improvement in mathematics scores suggests that the effects of ATNR persistence may extend into a range of cognitive areas.

Learning difficulties are known to be very difficult to remediate and the consistency of the baseline scores in 2002 across the three year groups for children with learning difficulties illustrates the intractable nature of this problem. The results, however, show that there is a marked decrease in the number of children with low scores in reading and mathematics (the bottom 15%) in 2004 following the intervention. For example, the numbers of children in Years 3 and 5 scoring in the bottom 15% in reading in 2002 were 13% and 18%, respectively. But in 2004, following the intervention, these had dropped to 7% and 8%, respectively, for the same groups of children. In other words, the intervention programme would seem to help children who experience significant difficulties in achieving fundamental reading and mathematics skills. Children who were attaining at average and above-average levels in these core areas would seem to benefit from the intervention as well.

Standardised scores were used as the benchmark for monitoring the attainments of the children in this study and the data was collected on an individual basis, independently of the schools. The use of restricted tests (not available for school use) ensured that there was little likelihood of practice effects or 'teaching to the tests'. The time-scale of the study (two years) minimised the effect of novelty that inevitably occurs with any new intervention and reduced the possible impact of particular teachers. Evaluations of interventions have often been conducted over relatively small time frames where there is considerable risk of placebo effects and little room for post-intervention 'slippage' or 'wash-out' effects.

Furthermore, standardised or norm-referenced scores are known to be particularly resistant to change over time. A number of studies have shown that standardised scores in reading and mathematics have not shown the increases that have been reported in Key Stage test results following the introduction of the national literacy and numeracy strategies in the late nineties (Brown, Askew, Millett & Rhodes, 2003; Hopkins & Davis, 2004 [cited in the *Times Educational Supplement*, 2003]). These studies suggest that the improved performance of children on Key Stage tests does not transfer into improved performance on standardised tests or tests that are not specifically curriculum-based. The relative importance of the curriculum in determining attainment has been demonstrated in other international comparative studies (e.g., Burstein, 1992).

The results from the quasi-experimental study, however, are particularly important in establishing whether the changes in standardised scores found in the larger study are a result of the effects of the movement intervention or if they occurred as a result of some other factor or factors that coincided with the period of the study.

Quasi-experimental study

The results for the quasi-experimental study provide further evidence of the specific effects of the movement intervention programme. The progress of the experimental group is significantly greater than the control in reading and mathematics but there is no significant effect for spelling. It should be noted, however, that the experimental group were further behind the control group at the outset and it is difficult to know if this was advantageous in their response to intervention.

The static nature of standardised scores, however, is further emphasised when the attainments of the control group over the course of the study are considered. These mirror the original trends of the baseline data with the exception of mathematics where attainment between Years 5 and 7 goes down.

Although the intervention has a small effect on spelling when the total sample of children is considered, there is no significant effect when the experimental and control groups are compared. In the latter study, the groups may not have been large enough to detect the relatively small effect on spelling that is apparent in the larger study. This suggests that spelling may be an area of learning that is very dependent on teaching as there are particular difficulties presented by the orthography of the English language. (English is an 'opaque' language that does not have the sound-letter correspondences of other more regular languages such as Finnish or Italian (e.g., Elley, 1992)). Furthermore, McPhillips (2001) stresses that while the movement programme may increase the child's 'readiness' to learn by reducing ATNR levels, the programme should not be seen as an alternative to appropriate direct instruction.

In conclusion, the results of the present study suggest that the use of a specific movement intervention programme (Primary Movement) may have a very significant effect on the academic progress of primary school children, particularly with regard to reading and mathematics. Most importantly, the impact of the programme is evident across a wide range of children including those with very significant learning difficulties.

It should, however, be noted that there are children with learning difficulties who do not experience ATNR persistence and it is apparent from the individual scores that these children were the least responsive to the intervention. The Primary Movement programme, therefore, is not a panacea for the remediation of learning difficulties in school but it may be of considerable help for those children at risk of ATNR or primary reflex persistence. For example, the results suggest that 44% of children in the bottom 10% of readers experience significantly high levels of ATNR persistence. Furthermore, there are other children with much milder levels of ATNR persistence across the spectrum of academic attainment that may benefit also from this intervention.

The implementation of the intervention in a school setting would seem to have a number of advantages as it takes relatively little time to complete (10–15 minutes per day) and can be used with whole classes. The programme is predominantly movement-based (with singing accompaniment for some movements) and it does not involve any special equipment. It may be used as a change of activity in the classroom or as a complementary aspect of physical education. It does, however, require considerable teacher expertise as the movements have to be demonstrated (with singing accompaniment where appropriate) and children with learning difficulties, in particular, need close supervision and monitoring.

It was beyond the scope of the present study to detail the impact of the Primary Movement intervention on other non-academic aspects of the child's school experience following intervention and reports of, for example, improved self-esteem, better engagement with sports or more positive behaviours remain anecdotal. However, all schools were enthusiastic about the programme and this is confirmed by the absence of withdrawals from the study despite the extra demands that were inevitably placed on the teaching staff of the participating schools. It is unusual for intervention studies of this size to retain all participants. Furthermore, all of the schools have continued to use the movement programme after the completion of the study.

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Appendix 1

The Asymmetrical Tonic Neck Reflex (Schilder test)

The test position and procedure are demonstrated. The child then stands upright with feet together and arms held straight out in front at shoulder level but with the wrists relaxed ('hands floppy'). The tester stands behind the child and gives the instruction: 'In a moment, you will close your eyes and I will turn your head slowly first to one side and then the other, all you have to do is to keep your arms in exactly the same position as they are now; only your head moves'. The tester then slowly turns the child's head to one side (70–80 degrees or until the chin is over the shoulder), pauses for 5 seconds and then slowly turns the head to the other side. After another pause for 5 seconds the whole sequence is repeated once more.

Positive indicators of this reflex include movement of the extended arms in the same direction as the head turn, dropping of the arms or swaying and loss of balance.

Scoring:

0 no response (the arms remain straight out in front);
2 slight movement of the arms (up to 20 degrees) to the same side as the head is turned (or slight dropping of the arms);
3 movement of the arms (up to 45 degrees) as the head is turned (or marked dropping of the arms);
4 arm movement greater than 45 degrees either to the side or down, swaying or loss of balance.

Each side is scored separately and a total is obtained for both repetitions of the test with a maximum score of 12.