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Releasing Educational Potential Through Movement: A Summary of Individual Studies Carried Out Using the INPP Test Battery and Developmental Exercise Programme for use in Schools with Children with Special Needs

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This paper provides a summary of findings from a series of independent studies that have been undertaken separately. The studies used a specific developmental test battery—the Institute for Neuro-Physiological Psychology (INPP) Developmental Test Battery for use in schools with children with special educational needs—with a total of 810 children, the object being to assess whether neurological dysfunction was a significant factor underlying academic achievement. All children were tested using the INPP Developmental Test Battery together with additional standard educational measures to assess drawing and reading at the beginning and end of the programme. The progress of 339 children aged four to five years of age was tracked through the school year to see whether children with higher scores on the INPP Developmental Test Battery (indications of neurological dysfunction) performed less well academically at the end of the school year. A smaller number of children in mainstream classes (235 children) aged 8–10 years undertook a specific programme of developmental exercises (The INPP Schools' Developmental Exercise Programme) for 10 minutes a day under teacher supervision over the course of one academic year. Two hundred and five children aged 8–10 years also underwent the INPP Tests but did not take part in the Developmental Exercise Programme. The third group acted as a control group. No pre-selection was made among these groups at the beginning of the study. One study included a fourth group of 31 children who were given non-specific exercises for the same

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time period each day as the experimental group (INPP exercises) to see whether general daily exercises were more or less effective than the specific INPP exercises. Children in this study were seven to nine years of age. The results showed that the children who participated in the daily INPP exercises made significantly greater improvement on measures for neurological dysfunction, balance and coordination. Children who had scores of more than 25% on tests for neurological dysfunction and whose reading age was less than their chronological age at the outset also showed small but significantly greater progress in reading than children who did not take part in the programme.

Introduction

It is a generally accepted medical fact that primitive and postural reflexes (sometimes referred to as primitive and postural *reactions*) at key stages in development provide reliable diagnostic signposts of maturity in the functioning of the central nervous system (Capute, 1986; Peiper, 1963).

Primitive reflexes emerge *in utero*, should be present in the full-term neonate and are gradually inhibited by the developing brain in the first 6–12 months of postnatal life. Examples of primitive reflexes include the infant rooting, suck, palmar grasp and tonic neck reflexes.

Postural reflexes emerge in the first weeks after birth, and continue to develop up to 3.5 years of age. Examples of postural reflexes include the head-righting reflexes and segmental rolling reflexes.

During the first year of life, as connections to higher centres in the brain are established, the increased involvement of higher brain centres is reflected in the transformation of primitive reflexes to postural reflexes. The transition from primitive to postural reflex marks successful passage through basic postural abilities and motor skills in the early years, which underpin later automatic control of balance, posture, coordination and centres involved in the control of eye movements. It also reflects increased maturity in the functioning of the central nervous system.

The term neurological dysfunction describes the continued active presence of primitive reflexes beyond 6–12 months of age and underdevelopment of postural reflexes in a child beyond 3.5 years of age.

While retained primitive reflexes are accepted signs of pathology in conditions such as cerebral palsy, persistent primitive reflex activity in the absence of identified pathology has been a grey area for many years, with some experts denying that it can persist in the general population. For many years the prevailing medical view has been that retained primitive reflexes were an indication of pathology and as such would not respond to remedial intervention.

There is now an increasing body of evidence to support the theory that abnormal primitive and postural reflex activity can exist within the general population (Bender, 1976; Blythe & McGlown, 1981; Goddard Blythe, 2001; Gustafsson, 1971; McPhillips & Sheehy, 2004; Rider, 1972; Wilkinson, 1994) and that in many cases abnormal reflexes do respond to specific types of remedial intervention (Bender, 1976; O'Dell & Cook, 1996; McPhillips, Hepper, & Mulhern, 2000[1]).

The Institute for Neuro-Physiological Psychology (INPP) in Chester was established by Dr Peter Blythe in 1975 to research the effects of central nervous system dysfunction in children with specific learning difficulties and in adults suffering from agoraphobia and panic disorder, and to develop effective programmes of remediation.

Since 1975, the INPP has worked with thousands of children, assessing gross muscle coordination and balance, cerebellar involvement, dysdiadochokinesia, abnormal primitive and postural reflexes, laterality, oculo-motor functioning and visual–perceptual performance. Individual remedial programmes using physical exercises designed to stimulate and inhibit specific reflexes are given on the basis of the child's individual reflex profile. The exercises are carried out at home daily under parental supervision for approximately one year. The child's progress is monitored at eight-weekly reviews through the course of the year and the exercise programme adjusted accordingly.

One of the problems with the method has been that only a relatively small number of children can access such detailed evaluation and individual supervision. It was in answer to this problem that the INPP Test Battery and Developmental Exercise Programme for Children in Schools was compiled (Goddard Blythe, 1996).

Programme under Investigation

Training was provided for teachers and other professionals by the INPP in the administration of a short battery of tests to assess three reflexes:

- The asymmetrical tonic neck reflex (ATNR).
- The symmetrical tonic neck reflex (STNR).
- The tonic labyrinthine reflex (TLR).

These reflexes have been selected because they are connected to the functioning of the vestibular system and associated pathways (the vestibular–spinal system, the vestibular–ocular system and the vestibular–cerebellar loop) (Eliot, 1999; Sherrill, 1998). Retention of tonic neck and labyrinthine reflexes can result in a "mismatching" of signals passing between the vestibular–ocular–proprioceptive pathways (DeQuiros & Schrager, 1978) affecting balance, posture, coordination and perceptual stability. Each reflex has been identified as playing a part in specific learning difficulties.

The ATNR, for example, can interfere with hand–eye coordination, particularly left–right integration (DeMyer, 1980; Holt, 1991), control of the hand when writing (Blythe & McGlown, 1979), ability to cross the vertical midline and the visual skills necessary for reading such as visual tracking (Bein-Wierzbinski, 2001; Goddard, 1995).

The STNR affects the integration of postural control and coordination between the upper and lower portions of the body (horizontal midline). This can manifest itself as poor posture, particularly when sitting, difficulty sitting still, predominance of flexor muscle tone and slow re-adjustment of visual focusing between different distances. If the STNR is retained in the school-age child, it can affect coordination and attention (O'Dell & Cook, 1996), copying (Blythe & McGlown, 1979) and speed of refocusing between different visual distances (Goddard, 1995). The child may also have difficulty learning to swim, catching a ball and doing forward rolls.

The TLR affects both vestibular and proprioceptive functioning, because movement of the head forwards or backwards through the mid-plane induces flexion or extension of muscle groups throughout the body. If the TLR remains, it can interfere with the development of full head-righting reflexes, which are essential for the maintenance of proper head alignment in relation to the environment, upright head and body posture and control of eye movements (DeQuiros & Schrager, 1978; Kohen-Raz, 1986).

Additional tests are included in the INPP Test Battery to identify soft signs of neurological dysfunction (tandem and fog walks), visual tracking, visual integration (Valett, 1980), visual discrimination (Tansley standard figures; Tansley, 1967) and visual–motor integration (visual motor Gestalt test; Bender, 1938).

Teachers were encouraged to carry out additional measures of educational attainment on basic skills such as reading, spelling, writing and drawing, including the Draw a Person Test (Harris, 1963), at the beginning and the end of the programme.

The intervention comprises a series of developmental movements based on movements normally made by the infant in the first 12 months of postnatal life. Children carry out four developmental movements for 10 minutes a day, every day during the school year under teacher supervision. The movements are changed approximately every six weeks according the progress of the class. It takes approximately eight to nine months for children to pass through all movement stages in preparation for crawling on hands and knees. One of the major differences between the INPP programme and other motor training programmes is the time spent in developing postural abilities in the prone, supine, sitting and four-point kneeling positions *prior* to training balance in the upright position.

Participants

Pilot studies have been carried out in a number of schools in the United Kingdom and Germany over the past five years. Each study cited in this paper was conducted as an independent piece of research. For this reason there is some variation between studies in the baseline criteria used for selection of participants, matching of experimental and control groups and independent educational measures. The numbers of participants in the first two studies (Mellor School and Prince Albert School) are relatively small.

Table 1 Participants

School	Age range	Experimental	General	Control	Total
Mellor School	8–10 years	11	0	7	18
Prince Albert School	7–8 years	24	0	10	34
Swanwick School	7–9 years	32	31	32	95
NEELB schools	5–6 years (P2)	339	N/A	N/A	339
	8–9 years (P5)	168		156	324
Total		235	31	205	810

The North Eastern Education Library Board Study (NEELB) in Northern Ireland carried out two pieces of research:

1. Testing of 339 children aged five to six years (P2s) using the INPP Developmental Test Battery for children aged three to six years, to identify signs of neurological dysfunction and additional baseline educational assessments. These children were reassessed on all measures at the end of the academic year to investigate whether children with higher scores on the INPP Developmental Test Battery (indications of neurological dysfunction) had lower scores on the baseline educational assessment at the end of the school year.
2. Testing of 324 children aged eight to nine years (P5s) using the INPP Developmental Test Battery, to identify signs of neurological dysfunction and additional educational measures. The children were divided into two groups:
   a. 168 children carried out the INPP Developmental Exercises in School each day for one academic year; and
   b. 156 children did not participate in the INPP Exercise Programme.

Criteria for Selection of Participants

In the cases of Mellor School and Prince Albert School, children in both the experimental and control groups were selected on the basis of having a reading age of one year or more below their chronological age.

For the NEELB Study and Swanwick School, no pre-selection was made.

Ethical Considerations

Each study was independently financed and the design of each study was the responsibility of the teacher or head of department involved in overseeing the study. The INPP was granted permission to disseminate a summary of results from all studies.

Consent was obtained in the form of a letter sent out to all parents explaining what the study would involve and asking for their written permission for their child to participate.

Aims of the Studies

Each study set out to answer the following questions:

- Is neurological dysfunction a significant factor in children who are under-achieving at school?
- Does neurological dysfunction respond to a specific programme of developmental exercises carried out at school every day for one academic year? (The INPP School Programme).
- Is there a cross-over from change in neurological status to improvement in academic measures (reading, reading comprehension and drawing)?

Methods

The INPP provided training in the use of the test battery, the INPP exercises and feedback via video on test scoring to ensure inter-test reliability, but had no further involvement once the intervention began.

All participants were assessed using the neurological tests from the INPP Test Battery and specific educational measures at the beginning of the programme. Children were assigned to experimental or comparison group(s).

In all schools, the experimental groups carried out the INPP exercises at school each day under teacher supervision for periods of between eight and 14 months. The comparison groups did not undertake the INPP exercises. Swanwick School introduced a third class, which carried out non-specific exercises for the same time period each day as the experimental group (this group is referred to as the General Exercise group).

All groups were re-assessed at the end of the programme using the neurological tests and specific educational measures.

The criteria for selection and additional educational assessments varied between schools. For this reason, individual differences are listed in the results sections.

The neurological tests[2] are presented in Table 2 and the scoring for neurological tests is presented in Table 3. Individual neurological scores were obtained as a fraction of the total number of tests times the maximum possible score of 4 on each test.

Table 2 Neurological Tests

Function	Test
Balance and coordination	Tandem and fog walks
Abnormal reflex activity	Quadruped test for the ATNR (Ayres, 1993)
	Hoff–Schilder erect test for the ATNR (Hoff & Schilder, 1927)
	Quadruped test for the STNR
	Erect test for the TLR
Visual tracking	Valett test
Visual integration	Valett test
Visual discrimination	Tansley figures and Bender visual
Visual–motor integration	Motor Gestalt figures
Spatial	Tansley and Bender visual–Gestalt figures

Table 3 Scoring for Neurological Tests

Score	Measure
0	No abnormality detected
1	Reflex present to 25% or 25% dysfunction in carrying out task successfully
2	Reflex present to 50% or 50% dysfunction in carrying out task successfully
3	Reflex present to 75% or 75% dysfunction in carrying out task successfully
4	Reflex retained (100%) or unable to carry out the task successfully

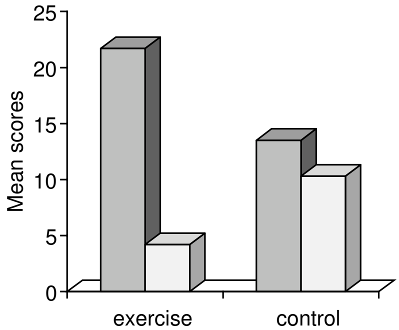
Analysis

Results from all studies were sent for independent statistical analysis (F. Fylan, Brainbox Research Ltd).

Results of Individual Schools

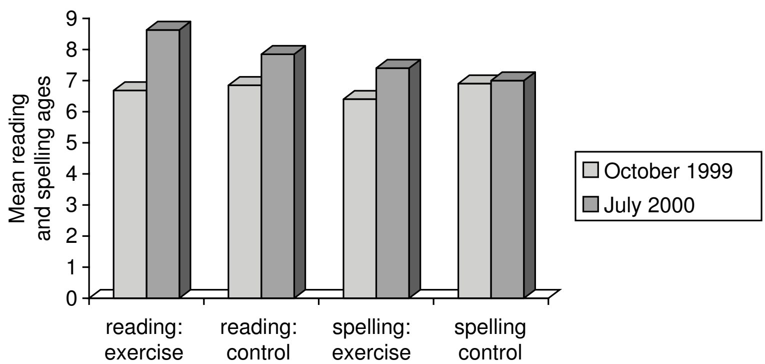
Mellor Primary School, Leicester

Children in this study were all aged 8–10 years and were selected on the basis of having a reading age more than one year below their chronological age. Mean neurological scores are shown in Figure 1.



Neurological Scores	Exercise Mean (SD)	Control Mean (SD)
Pre-programme neurological score	21.7 (6.2)	13.5 (7.5)
Post-programme neurological score	4.2 (3.6)	10.3 (4.9)

Figure 1 Change in Neurological Scores from October 1999 to July 2000 (High Score Indicates Evidence of Neurological Dysfunction), Mellor Primary School, Leicester.



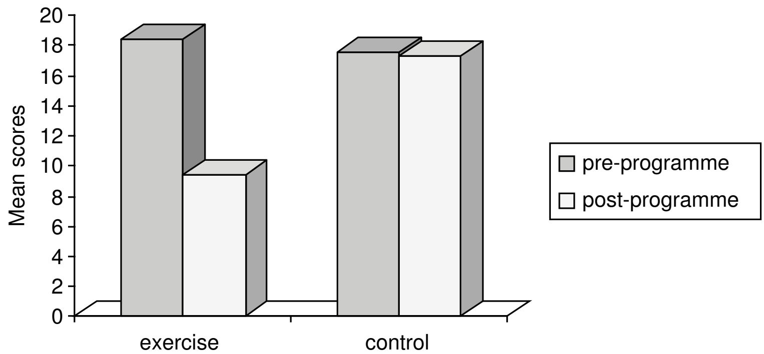
Gains in Reading Scores (in years)	
Experimental	+1.95
Control	+1.00
Spelling Scores	
Experimental	+ 10 months
Control	+ 1 month

Figure 2 Change in Reading and Spelling, Mellor Primary School, Leicester.

Analysis of the results, using analysis of variance (ANOVA), showed a significant interaction effect between time and exercise ($F = 14.20$, $p = 0.001$): children on the exercise programme showed a significantly greater decrease in neurological scores than did children who did not complete the programme.

Prince Albert School, Birmingham (Bertram, 2002)

Analysis of the results, using ANOVA, of the neurological scores showed a significant interaction effect between time and group ($F = 5.90$, $p = 0.018$): children on the exercise programme showed a significantly larger decrease in neurological scores than did children in the control group (Figure 3).



Participants:

Total	34
Experimental	24
Control	10

Neurological Scores	Exercise Mean (SD)	Control Mean (SD)
Pre-programme neurological score	18.4 (7.5)	17.5 (7.5)
Post-programme neurological score	9.4 (4.7)	17.3 (8.4)

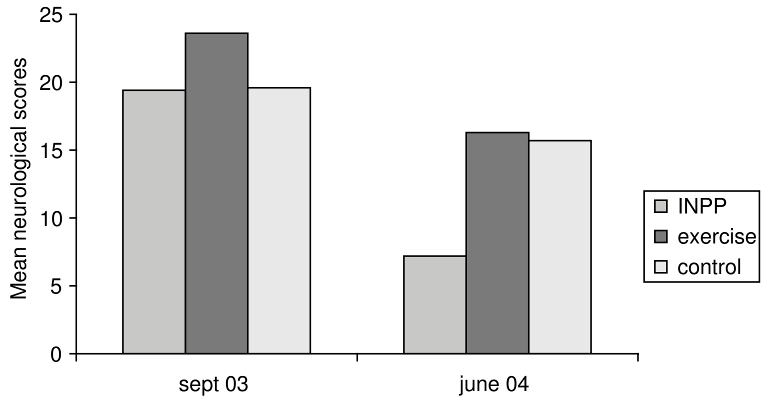
Figure 3 Neurological Scores, Prince Albert School.

Swanwick Primary School, Derbyshire

Participants were assigned to three groups (Table 4). Neurological scores decreased significantly for all children. This decrease was significantly larger in the INPP group (Figure 4).

Table 4 Group Assignment for Swanwick Primary School

Numbers	Experimental (INPP)	General exercises	Control group
All	32	31	30
Year 3	13	15	12
Year 4	19	16	18



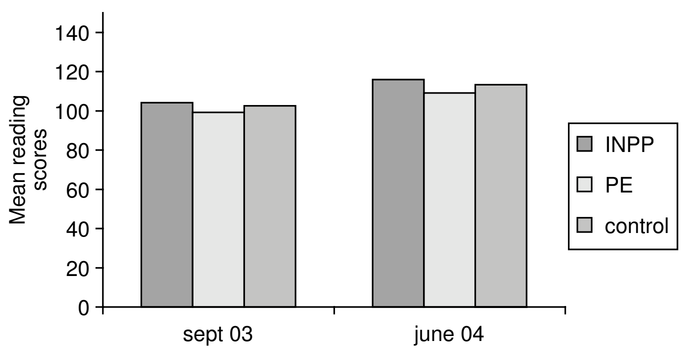
Participants: 93
Time Period: 9 months

Neurological Scores	Exercise Mean (SD)	PE Mean (SD)	Control Mean (SD)
Pre-programme neurological score	19.4 (8.6)	23.6 (14.1)	19.6 (11.3)
Post-programme neurological score	7.2 (3.0)	16.3 (8.3)	15.7 (11.0)

Figure 4 Change in Neurological Scores, Swanwick School.

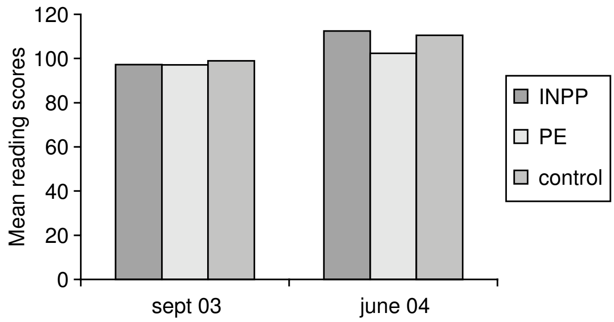
Analysis of the results, using ANOVA, showed a significant interaction effect between time and group ($F = 5.90$, $p = 0.018$): children on the INPP exercise programme showed a significantly larger decrease in neurological scores than did children in the PE group or the control group.

Reading scores increased for all children, as shown in Figure 5. Analysis of the results, using ANOVA, showed that there was no significant difference in the progress in reading made by children in the different groups ($F = 1.08$, $p = 0.345$). However, when



Reading Scores	Exercise Mean (SD)	PE Mean (SD)	Control Mean (SD)
Pre-programme reading score	104.5 (10.7)	99.2 (12.7)	102.5 (10.7)
Post-programme reading score	116.2 (10.8)	109.1 (12.9)	113.4 (11.0)

Figure 5 Change in Reading Scores (All Children—No Pre-selection), Swanwick School.



Participants:
INPP exercises 14
General exercises 19
Control group 20

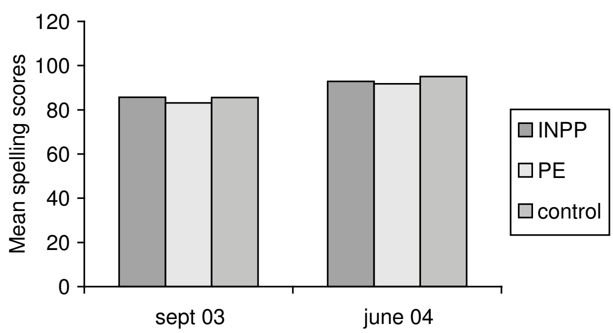
Reading Scores	Exercise Mean (SD)	PE Mean (SD)	Control Mean (SD)
Pre-programme reading score	97.2 (8.5)	92.1 (9.1)	98.9 (10.9)
Post-programme reading score	112.5 (12.0)	102.3 (10.8)	110.5 (11.9)

Figure 6 Lower Achieving Children in Reading, Swanwick School.

results from a smaller group of children were compared on the basis of having a reading age below their chronological age, children in the INPP group made more progress.

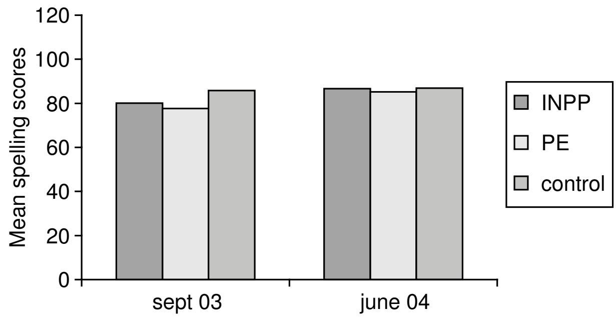
Analysis of the results, using ANOVA, for lower achieving children in reading showed that the groups differed in terms of their reading progress ($F = 4.32$, $p = 0.019$). The children in the PE group (non-specific exercises) made less progress than the other two groups (Figure 6).

Spelling scores increased for all the groups, as shown in Figure 7. Analysis of the results, using ANOVA, showed that there was no significant difference between the groups in their spelling progress ($F = 0.897$, $p = 0.411$).



Spelling Scores	Exercise Mean (SD)	PE Mean (SD)	Control Mean (SD)
Pre-programme spelling score	85.7 (12.0)	83.1 (11.1)	87.5 (10.9)
Post-programme spelling score	92.9 (13.1)	91.8 (12.9)	95.1 (11.3)

Figure 7 Change in Spelling Scores (All Children—No Pre-selection), Swanwick School.



Participants:
INPP exercises 14
General exercises 19
Control group 20

Spelling Scores	Exercise Mean (SD)	PE Mean (SD)	Control Mean (SD)
Pre-programme spelling score	80.1 (9.8)	77.6 (7.2)	85.8 (11.2)
Post-programme spelling score	86.6 (10.5)	85.2 (8.3)	86.6 (10.7)

Figure 8 Change in Spelling Scores (Lower Achieving Children), Swanwick School.

Children's spelling scores were also analysed on the basis of *lower* achievement (Figure 8). In this group there was significantly less improvement in spelling scores in the control group. Analysis of the results, using ANOVA, showed that the groups differed in terms of their spelling progress ($F = 4.32$, $p = 0.019$). The children in the control group made less progress than the other two groups.

NEELB Study

The final report of results from this study remains the property of the NEELB. The INPP has been granted permission to issue the following summary:

Executive Summary

The programme was evaluated for children who have high levels of retained reflexes and who are underachieving educationally (the criteria for which the programme was designed), and also for all children, regardless of their reflex or educational scores.

Measures of retained reflexes, balance, educational ability and concentration/coordination were made in a controlled study of P5 children (8–9 year olds) in seven Northern Ireland primary schools at the start (September 2003) and end (June 2004) of the school year. In each school one P5 class undertook the exercises and the other did not.

Two P2 (5–6 year olds) classes in each school also participated in the research. The INPP Test Battery was amended to include only developmentally appropriate tests for this age group. The tests used for P2 children are listed in Appendix 1.

None of the P2 classes undertook the exercises, and the extent to which the presence of retained reflexes at the start of the school year can predict educational progress at the end of the year was assessed. A total of 663 P2 and P5 children participated in the research. The following conclusions were drawn.

- 35% of P5 children and 48% of P2 children showed elevated levels of retained reflexes at the first assessment
- 15% (49) of P5 children had a reading age below their chronological age. Of these, 28 also had elevated levels of retained reflexes
- Elevated levels of retained reflexes are correlated with poor educational achievement at baseline
- Children who undertook the exercise programme showed a statistically significant greater decrease in retained reflexes than children who did not undertake the exercises
- Children who undertook the exercise programme showed a highly significant improvement in balance and coordination, and a small but statistically significant increase in a measure of cognitive development over children who did not undertake the exercises. No difference was found in reading, handwriting or spelling *in children who were already achieving at or near their chronological age, but for children with high levels of retained reflexes* <u>*and*</u> *a reading age below their chronological age, those who undertook the exercise programme made greater progress.*
- Retained reflexes are correlated with poor cognitive development, poor balance and teacher assessment of poor concentration/coordination in P2 children. Neurological scores and teacher assessment at baseline predicted poorer reading and literacy scores at the end of the study.

Discussion

The findings suggest that developmental immaturity and neurological dysfunction are significant factors in some children identified as underachieving (Pettman, 2000) and that neurological dysfunction does respond to a specific programme of daily exercises used at school over the course of one academic year.

In the case of Mellor Primary School, the two groups were not well matched. One of the problems in carrying out controlled studies within education is that class teachers want to provide maximum help for pupils with the greatest problems. In this case, the teacher assigned children with the more severe reading problems to the experimental group. However, this small study does suggest that neurological problems were greatest for the children with the more severe reading problems. This is of interest, because these are the children who traditionally respond less well to standard remedial intervention. Children in the experimental group who had the highest scores on the tests for neurological dysfunction showed a statistically significant greater improvement in neurological dysfunction than the comparison group.

While the difference in reading and spelling between the two groups at Mellor Primary School following the INPP programme did not reach statistical significance, the general trend was for greater improvement in reading and spelling in the experimental group compared with the control group. A difference of 9+ months in improvement in reading and spelling between the two groups has implications for educational performance in the future.

Prince Albert School, Birmingham is located in an Education Action Zone where up to 80% of the pupils come from homes where English is spoken as a second language. As this could act as a confounding variable, measures of literacy attainment were not evaluated in this study. Changes in neurological status *were* significant, with the experimental group showing a significant decrease in measures of neurological dysfunction compared to the control group.

In schools where children were not selected on the basis of underachievement (Micklethwaite, 2004; NEELB, 2004) a degree of neurological dysfunction was also found to be present in some children who had not previously been identified as under-achieving. In these schools, children who undertook the INPP Programme showed significantly greater improvement on the neurological and balance tests than children who did not take part in the programme, irrespective of the degree of dysfunction at the time of the first neurological assessment.

At Swanwick School, where a "General PE" group was included in the study, children in the General Exercise group made almost twice as much progress on the INPP Developmental Test Battery as children in the control group, but only *one-half* as much as children in the experimental group (INPP exercises). There were no significant differences in reading progress when the groups were compared on the basis of mixed reading ability, but when the results were compared on the basis of reading age below chronological age, children in the non specific exercise (General PE group) performed less well than children in the control group. The INPP exercise group showed the greatest improvement but the difference was not enough to reach statistical significance. Spelling scores were also compared on the basis of mixed ability—no significant differences between the three groups, and reading age below chronological age—children in the control group performed less well than children in either the general exercise group or the experimental group. Although the numbers were relatively small, the results suggest a trend whereby children who undertook the INPP exercises made the greatest progress on all measures. General PE exercises carried out on a daily basis appear to improve balance and coordination but do not necessarily transfer across to educational improvement. Further studies involving larger numbers of participants would need to be carried out to confirm this observation.

Children who had a reading age equivalent to or above their chronological age at the outset of the NEELB study did not make significant educational gains compared with the comparison group, despite improvement in balance, coordination and reflexes. However, many of these children also had relatively low scores on the neurological tests (less than 25%) at the time of the first assessment.

In the NEELB study, a smaller group of children was selected from the general group on the basis of elevated reflex scores (greater than 25%) *and* reading age below their chronological age. A trend emerged in which children who undertook the INPP exercises showed greater improvement in reading than the comparison group.

When an additional group were selected on the basis of reflex scores greater than 25% and reading age *six months below* their chronological age, the improvements in both neurological and educational measures were marked. "Whilst there were too few children for the results to be statistically significant, the children in the exercise group show clear advantages in every educational measure, and in the Tandem and Fog Walks" (Fylan, 2004).

The NEELB results suggest that the INPP programme is most effective when aimed specifically at the children for whom it was originally designed—children who fit the criteria of underachieving educationally (reading age below their chronological age) and having elevated reflex scores (greater than 25%).

Reflex scores of less than 25% did not appear to have a significant impact on educational achievement. Although children in the experimental group showed greater reduction in reflexes and improvement in balance after following the INPP programme, the relatively small change in neurological status did not have a significant effect on educational attainment. This suggests that the *degree* of neurological dysfunction is an important determinant in the effect on cognitive performance with scores of greater than 25% having an impact on academic performance.

All studies have shown a general trend in which children who took part in the INPP movement programme showed not only significant improvement in measures of balance, coordination, reflexes and drawing (Draw a Person Test), but also greater improvement in measures of educational performance such as reading and spelling. Although the improvements in reading and spelling did not reach statistical significance in all of the studies, this might be because re-assessment of educational measures was carried out too early in the programme. That is, if balance, coordination and motor skills provide a stable platform on which higher skills are built, it may be necessary for the platform to be securely in place *before* other educational skills start to catch up. It is suggested that future studies continue to track participants for a minimum of one year *after* the developmental programme has been used to see if educational performance continues to improve after the neurological changes have taken place. One study carried out in Germany (Jändling, 2003) showed that children who had participated in the developmental programme had maintained the gains they had made as a result of the INPP programme, and continued to make educational gains commensurate with improvement two years after completing the INPP programme.

Conclusion

Although there was considerable variation in research design between each of the independent studies, each study indicates the following:

1. Neurological dysfunction (reflex scores greater than 25%) was a significant factor in educational underachievement (reading age below their chronological age).
2. Neurological dysfunction did respond to the INPP Developmental Exercise Programme for use in schools with children with special needs, with children in the experimental groups showing significantly greater improvement in reflex scores and tests for balance and coordination than the control or comparison groups.
3. There was a general trend whereby children who did fit the criteria for using the INPP programme (reflex scores greater 25% and reading age below their chronological age) showed greater improvement in educational measures after using the INPP programme than comparison groups who did not take part in the programme.

The findings suggest that within the general population there exists a group of children for whom neurological dysfunction is a significant factor, and that neurological dysfunction is linked to educational performance.

The INPP programme was effective in reducing signs of neurological dysfunction in the experimental groups compared with the control groups. Balance, coordination and drawing also showed greater improvement in the experimental groups irrespective of the children's level of educational attainment at the beginning of the programme.

The results have also indicated which specific group of children are likely to benefit both developmentally *and* educationally from the INPP programme—children who fit the criteria of having reflex scores greater than 25% and a reading age below their chronological age.

More extensive use of tests for neurological dysfunction within the school system could help to identify those children who are underachieving as a direct result of underlying neurological dysfunction so that their developmental problems can be corrected enabling them to perform to a higher level.

The results from the P2 children in the NEELB study suggest that a number of children are developmentally immature in terms of physical skills connected to balance, coordination and reflexes at the time they enter school at four to five years of age. This lack of developmental maturity does appear to have an affect upon performance in the classroom.

Further longitudinal studies need to be carried out to assess the long-term effects of change in neuro-developmental status upon academic achievement. It is also recommended that any future controlled studies employing the INPP Developmental Exercise Programme should be designed as two-year projects, to enable the control groups to be offered the same intervention as the experimental group during the second year.

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Notes

[1] McPhillips *et al*. (2000) used exercises based on movements originally devised by Peter Blythe at the INPP, Chester.

[2] Details of all reflex tests listed may be found in Goddard (2001).

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Appendix 1: Tests used with P2 Children in the NEELB Study

Table A1 Neurological Tests (1st Assessment Only)

Function	Test
Balance	Romberg Test
Balance	One Leg Stand
Coordination	Crawling on hands and knees
Coordination (midline)	Passing ball from hand to hand
Coordination (midline)	Touching the opposite hand and foot
Dysdiadochokinesia	Finger and thumb opposition test
Reflexes	Quadruped test for the ATNR (Ayres)
	Hoff & Schilder erect test for the ATNR
	Quadruped Test for the STNR
	Erect test for the TLR
Visual–Motor Integration	Tansley Standard Figures (first 4 figures only)

Table A2 Educational Assessments (2nd Assessment Only)

Function	Test
Drawing	Draw a person test (Harris)
Reading	Salford sentence test
Literacy Indicators	Literacy Indicators