Neuro-motor Maturity as an Indicator of Developmental Readiness for Education.

Report on the use of a Neuro-Motor Test Battery and Developmental Movement Programme in Schools in Northumberland and Berkshire

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Neuro-motor Maturity as an Indicator of Developmental Readiness for Education.

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Abstract

Two independent projects were undertaken with 64 children in schools in Northumberland and Berkshire to investigate whether neuro-motor immaturity, defined by the continued presence of three primitive reflexes, was present in children in mainstream primary schools in the United Kingdom. Children were also assessed for performance in reading, writing, spelling, maths and drawing using SATS results or the Salford Sentence Reading Test.

In Northumberland, 52 children age 7 – 8 years were divided into two intervention groups: One group took part in a daily programme of developmental movements (The INPP Programme); the other group participated in a less specific programme of daily physical exercises (The Activate Programme) for one academic year.

In Berkshire, 12 children who had been identified as under-performing in reading, spelling or handwriting were assessed using the Salford Sentence Reading Test. Six children participated in The INPP Programme at school every day for one academic year. The results of both groups on the Salford Reading Test were compared at the end of the year.

The results indicated that neuro-motor immaturity was present in 88.5% of children age 7–8 years and 40 % of children age 4-6 years in the Northumberland sample. There was a correlation between higher scores on tests for retained primitive reflexes and lower performance on the Draw a Person test. Children in the INPP group in the Northumberland study showed a significantly greater decrease in scores for abnormal reflexes (an indication of *increased* maturity in neuro-motor skills) than children in the Activate group following intervention. There was no significant difference between the INPP and Activate groups on SATS scores for reading, writing, spelling and maths.

Six children who followed The INPP Programme for one academic year in Berkshire showed significant improvements on the Salford Sentence Reading Test at the end of the year compared to six children who did not take part in The INPP Programme.

Introduction

Readiness for school requires much more than a child simply reaching the chronological age required for school entry. To perform well in an educational environment, a child needs to be able to: sit still; pay attention; use a writing instrument, and to control a series of eye movements, which are necessary to follow a line of print without the eyes "jumping" or losing their place on the page. These are physical abilities, which are linked to the development and maturation of motor skills and postural control. Growth and physical development are as important to education as they are to the field of developmental medicine but have been largely overlooked by the educational system since the phasing out of routine developmental tests for all children which used to be carried out by the school doctor at rising 5 years of age.

The disappearance of developmental testing of all children was the result of two changes in the administration of the whole area of special needs in education in the United Kingdom: Firstly, in the 1980's responsibility for special needs was handed over from the Department of Health to the Department of Education transferring from the domain of Medicine to the Educational Psychologist and teachers trained in special educational needs. This meant that although the testing of children's cognitive abilities was secure, testing of children's physical developmental status was no longer carried out as a matter of routine. Secondly, in the words of a retired paediatrician, "in the 1980's we entered an era of evidence based medicine when it became necessary to provide a proven remedy for any problems that were detected as a result of routine testing – at that time we did not have the resources or a standard method to offer - and the routine developmental testing of every child was phased out" (Paynter A, 2004).

One of the outcomes of these changes has been that children who are delayed in specific aspects of their physical development but who do not present with a medical problem simply "slip through the net" of services which should be in place to identify problems and provide appropriate remedial intervention or educational support. In view of the increasing number of children who appear to fall into this category, it was decided to monitor the introduction of a developmental test battery and physical remediation programmes in several schools.

Rationale and Literature Review

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 (Peiper A, 1963, Capute, 1986).

Primitive reflexes are normal stereotyped reactions to specific stimuli, which emerge during life in the womb, should be present in the full-term neonate and are gradually inhibited and transformed by the developing brain in the first 6 - 12 months of postnatal life into more mature reactions. Examples of primitive reflexes include the infant rooting, suck, palmar grasp and tonic neck reflexes.

Postural reflexes are reflexes which appear in the first weeks after birth, and continue to develop up to 3½ years of age. Examples of postural reflexes include the Head-Righting, Amphibian and Segmental Rolling Reflexes. Postural reflexes support control of balance and coordination at a sub-conscious level, freeing "higher" centres in the brain from conscious involvement in the direction of non-purposeful movements.

During the first year of life, as connections to higher centres in the brain develop, the increased involvement of higher brain centres is reflected in this transformation of primitive to postural reflexes. Postural and motor skills at key stages in development provide markers of maturation and integration in the functioning of the Central Nervous System (CNS) of the developing child.

The term Neurological Dysfunction (ND) describes the continued active presence of a cluster of primitive reflexes beyond 6 – 12 months of age and under-development of postural reflexes in a child above the age of 3 ½ years.

Whilst 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 residual primitive reflexes persist in the absence of pathology. However, in recent years there has been a growing body of evidence to support the theory that immature primitive and postural reflexes can persist in the general school population and are linked to educational under-achievement (McPhillips et al.2000, Goddard Blythe 2001, McPhillips and Sheehy 2004, Taylor et al. 2004, Goddard Blythe 2005).

There is also evidence to support the theory that persistent abnormal reflexes in the absence of identified pathology respond to specific programmes of remedial intervention (Bender 1976, O'Dell and Cook 1996, McPhillips et al.2000[1], The North Eastern Education and Library Board Report 2004, Goddard Blythe 2005).

The Institute for Neuro-Physiological Psychology (INPP) in Chester was established by Dr Peter Blythe in 1975 to research the effects of CNS dysfunction in children with specific learning difficulties and adults suffering from Agoraphobia and Panic Disorder, and to develop reliable systems of assessment and effective remedial programmes.

Since 1975, INPP has worked with thousands of children, carrying out assessments which include tests for: 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 movements designed to stimulate, integrate and inhibit specific reflexes are prescribed on the basis of the child's individual reflex profile. The developmental movements are carried out at home every day under parental supervision for approximately one year. The child's progress is monitored at 8 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

[1] McPhillips used exercises based on movements originally devised by Peter Blythe at The Institute for Neuro-Physiological Psychology (INPP) in this study.

this problem, that the INPP Test Battery and Developmental Exercise Programme for Children in Schools was compiled (Goddard Blythe 1996).

The INPP Test Battery for Schools

The INPP Test Battery for Schools comprises a shortened battery of tests to assess balance, coordination and the retention of 3 primitive reflexes:

- The Asymmetrical Tonic Neck Reflex (ATNR)
- Symmetrical Tonic Neck Reflex (STNR)
- Tonic Labyrinthine Reflex (TLR)

Reflexes are evaluated using a 5 point rating scale for each reflex test:
0 = no abnormality detected
1 = primitive reflex evident to 25%
2 = primitive reflex residually present to 50%
3 = primitive reflex virtually retained – 75%
4 = primitive reflex retained – 100%

These three reflexes were selected because they are connected to the functioning of the vestibular system and associated pathways:

1. The vestibular-spinal system, which is involved in balance, proprioception and coordination (Sherrill 1998, Eliot, 1999).
2. The vestibular-ocular-reflex, which is involved in stabilising the visual image on the retina and is essential for the control of eye movements and co-ordination of vision with balance.
3. The vestibular-cerebellar loop, which is involved in the fine-tuning of coordination, the automisation of certain motor skills (Nicolson et al. 1993) and a number of cognitive skills (Leiner et al. 1986, Leiner et al. 1993).

Retention of Tonic Neck and Labyrinthine Reflexes in the older child can result in a disagreement or "mismatch" of signals passing between the three vestibular loops (De Quiros & Schrager 1978), affecting balance, posture, coordination, control of eye movements and visual perception. Each reflex has been identified as playing a part in specific aspects of learning and behaviour (Goddard 1996, Goddard Blythe 2008).

The Asymmetrical Tonic Neck Reflex (ATNR) for example, is activated by rotation of the head to either side resulting in extension of the arm, hand and leg on the side to which is the head is turned and flexion of the occipital limbs. If present in a school-aged child, this can interfere with control of balance, 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 (Goddard 1995, Bein-Wierzbinski 2001).

The Symmetrical Tonic Neck Reflex (STNR) affects coordination of the upper and lower sections of the body depending on the position of the head. Flexion of the head elicits bending of the arms and extension of the legs: conversely, extension of the head results in extension of the arms and bending of the legs. If this is present in the school-aged child it can affect posture when sitting or standing, the ability to sit still, and the muscle tone and

coordination needed for activities such as learning to swim and do forward rolls. Other researchers have found a link between retention of the STNR and Attention Deficit Hyperactivity Disorder (ADHD) (O'Dell and Cook 1996) and problems with speed and accuracy of copying (Blythe and McGlown 1979).

The Tonic Labyrinthine Reflex (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 head-righting reflexes, which are essential for the maintenance of proper head alignment in relation to body position, upright head and body posture and control of eye movements (De Quiros and Schrager 1978, Kohen-Raz 1986).

Previous studies have indicated that a total score of >25% on tests for the ATNR, STNR and TLR are linked to educational under-achievement (North Eastern Education and Library Board Report 2004, Goddard Blythe 2005).[2]

Teachers were encouraged to carry out additional measures of educational attainment on basic skills such as reading, writing, spelling and maths (SATS) and use of the Draw a Person Test (Aston Index) at the beginning and the end of the programme.

Programmes under Investigation:

1. The INPP Developmental Exercise Programme for use in Schools

The INPP Developmental Exercise Programme 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 4 developmental movements for 10 minutes a day, every day during the school year under the supervision of a teacher who has undergone training in the administration of the programme. The movements follow a developmental sequence taking 8 – 9 months to pass through the different developmental stages which prepare the child 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 early postural abilities in prone, supine, sitting and four point kneeling positions *prior* to introducing crawling and creeping exercises, cross-pattern movements or training balance in the upright position. Exercises are changed approximately every 6 weeks according to the progress of the group or class. The programme can be implemented as a whole class activity or used with smaller groups of selected children who have been identified as having residual primitive reflexes.

2. The Activate Programme

[2] 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) and visual-motor integration (Bender Visual Motor Gestalt Test, 1938). These tests were not included in data submitted for statistical analysis. A list of these tests ma be found in Appendix 1.

Activate in the Classroom is a general movement programme designed to be age specific and uses progressively staged, repeated patterns of movement with music (Sabin V, 2004). The patterns of movement-to-music programmes take a whole class of pupils through 3-dimensional repetitive movement activities within their personal stand-up space. Each exercise is carried out to music which enables the tempo and rhythm in the movements of the pupils to be varied through changes in the music.
The Activate programme is designed for daily use at the beginning of the school day, after registration, for about 10 minutes and for 5 minutes immediately after lunch at the start of the afternoon.

Activate movements are used for 2 weeks, then moved up in a step by step sequence through a progressive and developmental 36 week structure. The extra activity extensions provided can be introduced at a speed to suit the class. Every 9th week there is provision for the pupils to create their own programme from their favourites or their own original movement ideas.

Two independent projects were undertaken:

1. The Northumberland project involved four primary schools. No pre-selection of participants was made in this study.
2. A small study at St John's Primary School in Berkshire with 12 children whose reading age was identified as being lower than their chronological age

I. The Northumberland Project

Aims

The pilot project undertaken in 4 schools in Northumberland was carried out to investigate:

1. Is there evidence of persistent primitive reflexes in children in mainstream schools in this sample?
2. Is there a relationship between immature reflexes and lower performance on the "Draw a Person" Test? (The Draw a Person Test provides an indication of non-verbal cognitive performance)
3. Is the INPP Programme for Schools effective in reducing the incidence of abnormal reflexes?
4. Is there a cross-over from improvement in reflex status to improvements in drawing, reading and SATS results?

Ethics

Parents of all participants were contacted by letter explaining the aims of the project and requesting permission for their child to be included in the project. The project was supervised in all schools by Ruth Marlee, Behaviour Support Service Schools and Family Support Division, Children's Services Directorate Northumberland County Council, Hepscott Park, Morpeth, Northumberland.

The Activate programme was included because teachers were unwilling to withhold intervention from a control group, who might potentially have benefited from a daily

intervention programme. For this reason, two intervention groups were included in the study and there was no control group.

Method

Training was provided for teachers by an approved INPP trainer in the administration of the INPP test battery and programme. Inter-test reliability was checked by Ruth Marlee who had received additional training from INPP. INPP was not involved at any time in the assessment or supervision of the programme. Results following the final assessment of all participants were passed to INPP and sent on for independent statistical analysis.

The INPP training course instructs teachers how to:

1. Administer a simple test battery to assess developmental maturity of:

- Balance
- Coordination
- 3 primitive reflexes

(A list of all tests included in the INPP test batteries for schools may be found in Appendix 1)

2. Supervise a daily programme of exercises (10 minutes per day) with individual groups or whole classes of children over the course of one academic year.

Participants

187 children from 4 schools took part in the INPP exercise programme over the course of one academic year. Of these:

- 25 children aged 4– 6 years were assessed using the INPP test battery for younger children at the beginning and end of the year. This group participated in the INPP Programme.
- 52 children age 7 – 8 years were assessed using the INPP test battery for children from 7 years at the beginning and end of the programme. Of these,
- 21 children participated in the INPP Developmental Programme every day under teacher supervision for one academic year
- 21 children participated in a general programme (Activate) of daily exercises for one academic year.
- All pupils following the 7+ programme were in parallel classed in the same school. They followed the same curriculum in every aspect other than the exercise programmes. Five pupils had Statements of Special Educational Need and were referred to the Behaviour Support Service before the first assessment using The INPP Test Battery. All five pupils followed the INPP programme

Data was recorded for the following tests prior to implementing the exercise programmes and at the conclusion of the programmes:

- Asymmetrical Tonic Neck Reflex
- Symmetrical Tonic Neck Reflex
- Tonic Labyrinthine Reflex
- Draw a Person Test (Aston Index based on the Harris-Goodenough 1963, Draw a Person Test)
- SATS scores for reading, writing and maths for the 7+ year old group
- Reading and spelling for the 4 – 6 year old group

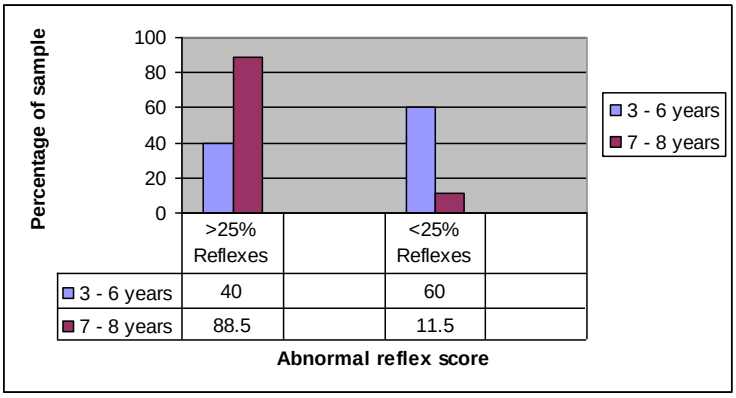
The results were submitted for independent statistical analysis.

Results

1. Is neurological dysfunction (measured by retained reflex scores) present in children in mainstream schools in this sample?

Yes. In this sample 88.5 % of children in the 7-8 year old group and 40% of children in the 4–6 year old group were had a total score of >25% on tests for the ATNR, STNR and TLR.

Figure 1. Percentage of sample scores of >25% on tests for retained reflexes in both age groups.



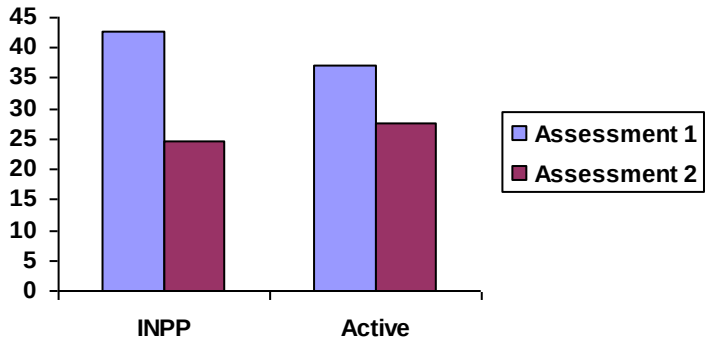
2. Is there a relationship between retained reflexes (neurological score) and poorer scores on the Draw a Person test?

Yes: there is a significant correlation between neurological scores and mental age measured by the Draw a Person test. Children who score higher on the neurological score perform less well on the Draw a Person test ($r = -0.275$, $p = 0.048$).

3. Do children in the 7 – 8 year old INPP group have a greater reduction in retained reflexes (measured by neurological score) than those in the Activate group?

Yes: Figure 2 shows that children in the INPP group show a significantly greater reduction in reflexes than those in the Activate group ($F=9.68$, $p=0.003$).

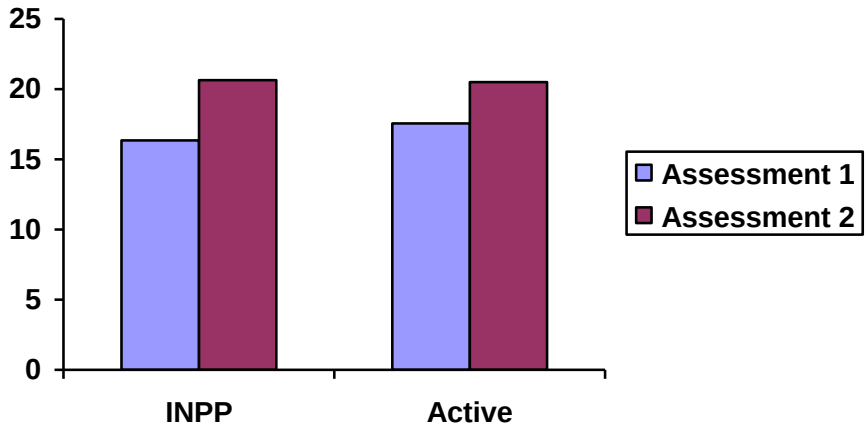
Figure 2. Reflex scores for INPP and Activate groups at Time 1 and Time 2



4. Do children in the 7 – 8 year old INPP group have a greater increase in score for mental age on the Draw a Person Test than those in the Active group?

No, while both groups improved their score, there is no statistically significant difference between children in the INPP group and those in the Active group (F=0.82, p=0.37).

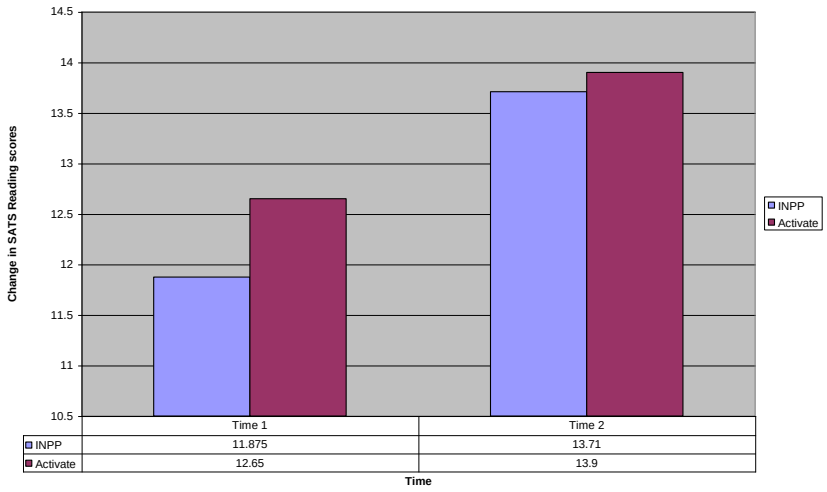
Figure 3. Scores for mental age for INPP and Activate groups at Time 1 and Time



5. Do children in the 7 – 8 year old INPP group have a greater increase in SAT reading score than those in the Activate group?

No: while both groups improved their SAT reading scores from Time 1 to Time 2 ($F(1,50) = 28.60$, $p < .001$), there was no evidence that the increase was greater for the INPP group than for the Activate group ($F(1,50) = 1.05$, non-significant, see Figure 1).

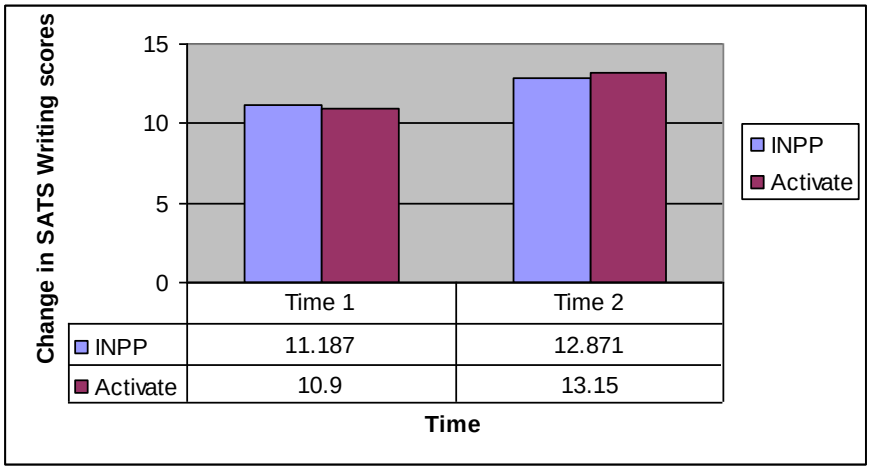
Figure 4: Mean SAT reading scores of the Activate and INPP groups at times 1 and 2.



5. Do children in the 7 – 8 year old INPP group have a greater increase in SAT writing scores than those in the Activate group?

No: while both groups improved their SAT writing scores from Time 1 to Time 2, ($F(1,50) = 12.13$, $p = .001$), there was no evidence that the increase was greater for the INPP group than for the Activate group ($F(1,50) = .35$, non-significant, see Figure 2).

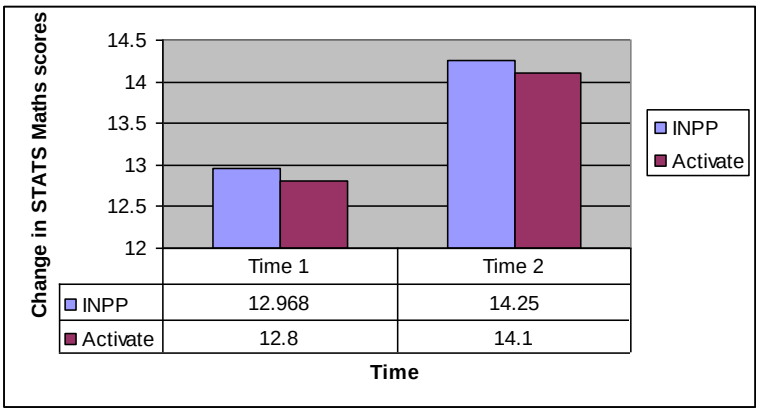
Figure 5:
Mean SAT writing scores of the Activate and INPP groups at times 1 and 2



6. Do children in the 7 – 8 year old INPP group have a greater increase in SAT maths scores than those in the Activate group?

No: while both groups improved their SAT maths scores from Time 1 to Time 2 ($F(1,50) = 25.21$, $p < .001$), there was no evidence that the increase was greater for the INPP group than for the Activate group ($F(1,50) = .001$, non-significant, see Figure 3).

Figure 6:
Mean SAT maths scores of the Activate and INPP groups at times 1 and 2



Do children in the younger INPP group show an improvement in reading age from time 1 to time 2?

Yes: this improvement was significant: t(24) = 7.22, p<.001. Mean reading age was 69.4 (SD = 13.4) at Time 1 and 87.9 (SD = 19.2) at Time 2.

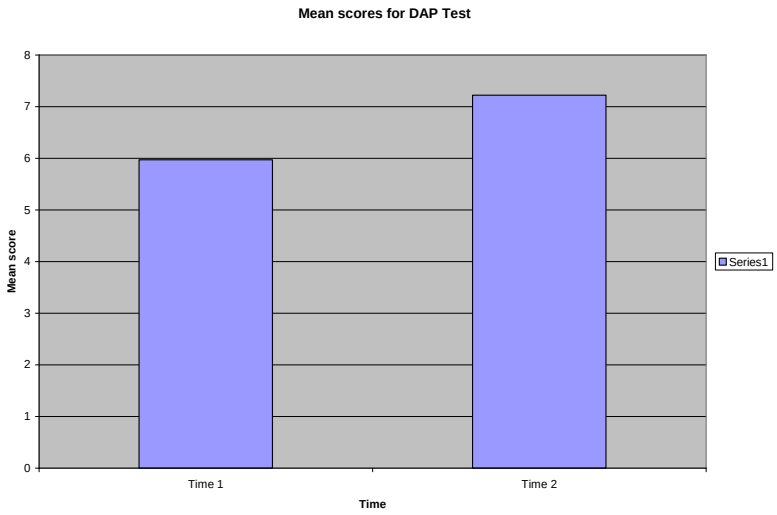
9. Do children in the younger INPP group show an improvement in spelling age from time 1 to time 2?

Yes: this improvement was significant: t(24) = 11.66, p<.001. Mean spelling age was 68.7 (SD = 8.6) at Time 1 and 90.3 (SD = 10.1) at Time 2.

10. Do all children in the INPP group (i.e., the younger children and the older children) show an improvement in Aston Index draw a man mental age score?

Yes: this improvement was significant: F (1,55) = 69.20, p<.001. Mean Aston Index draw a man mental age score was 5.97 (SD = 1.39) at Time 1 and 7.22 (SD = 1.24) at Time 2. This difference is shown in Figure 4.

Figure 7: Mean Aston Index draw a man mental age score at Time 1 and Time 2.



II. The St John's School Project

Aims

- To investigate whether abnormal reflexes were present in a group of 6 children in Key Stage 2 who had been identified as under-achieving in reading, spelling and writing. These children were not classified as having a Specific Learning Difficulty.
- To investigate whether *The INPP Developmental Exercise Programme for Children in Schools with Special Needs,* was effective in reducing scores on tests for abnormal reflexes.
- To compare the reading progress of 6 children in the INPP group to 6 children identified with reading disabilities who did not participate in a daily movement programme.

Participants

The Special Educational Needs Coordinator identified 6 children of similar age from key Stage 2, where concerns had been raised by teachers that the children experienced difficulties with reading skills, writing including spelling and hand writing.

Following the completion of the INPP programme, the school compared gains in reading ages of a similar age group of 6 children from within Key stage 2 using the Salford Reading Test results from September 2006 and September 2007.

Method

Reading ages using the Salford Sentence Reading Test were identified at the start, after 3 terms and finally at the end of the 4th term programme. The Salford Sentence Reading Test demands a range of strategies to be employed by the child from initial sounds and blends to segmenting and use of syllables. Sequencing, memory and organisational skills all being required to decode the unfamiliar words.

Baseline assessments were carried out on the INPP group before and after the programme using The INPP Developmental Test Battery for Schools.

Both the INPP group and the comparison group received the same spelling intervention programme and individualised handwriting support, but the comparison group did **not** take part in the INPP exercise programme.

Results

1. Are abnormal reflexes present in a group of 6 children identified with under-achievement in reading, spelling and writing?

Yes: every child in the INPP group had a total score of >25% on tests for the ATNR, STNR and TLR.

2. Is there a reduction in reflex scores in the INPP group between Time 1 and Time 2?

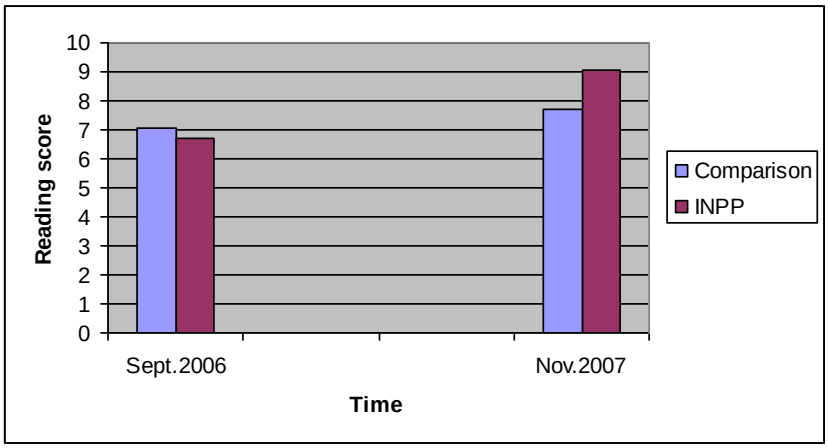
Yes: the reflex scores of all children in the INPP group decreased between Time 1 and Time 2.

3. Do children in the INPP group have a greater increase in reading scores than those in the comparison group?

Yes - $F(1,10) = 34.40$, $p < .001$ (see Figure n)

Figure 8

Mean reading scores of the INPP and comparison groups at times 1 and 2



Discussion

1. Northumberland Project

- Retained primitive reflexes were present in children in mainstream schools in the Northumberland sample. Previous research (North Eastern Education and Library Board 2004), which examined a sample of 663 children in mainstream schools in Northern Ireland had found total scores of >25% on tests for the ATNR, STNR and TLR in 48% of children aged 5 – 6 years and 35% of children age 8 – 9 years. The Northumberland sample found scores of >25% on the three reflexes were present in 40% of children aged 4 – 6 years and 88.5% in 7 – 8 year olds. The discrepancy in the proportion of children identified with neuro-motor immaturity between these

two studies carried out at different times shows considerable variation in the incidence of residual reflexes across studies. However, all studies cited have shown immature reflexes to be present in a large percentage of children in mainstream schools.

Primitive reflexes and motor skills at key stages in development provide indications of neuro-motor maturation and of a child's developmental readiness in terms of the physical skills needed to support cognitive performance. Developmental testing of all children to evaluate primitive reflex status could help to identify children who are at risk of under-achieving as a result of immature motor skills. These tests could be conducted at the time of school entry and repeated at key stages during education to identify children who would benefit from physical intervention programmes.

- There is a significant correlation between neurological scores and mental age measured by the Draw a Person test. The Draw a Person test provides one measure of non-verbal cognitive performance. While many educational measures focus on verbal skills, non-verbal skills are necessary to support operations in space, body awareness and social skills. It is thought that the non-verbal aspects of language contribute up to 90% to effective communication. Children who have immature non-verbal skills tend to find it difficult to read the body language of others and react appropriately, which can affect how children interact in social situations and also behaviour.

- Children in the 7 – 8 year old INPP group had significantly greater reduction in abnormal reflexes than children in the Activate group. These results reflect those reported in earlier studies (Goddard Blythe 2005) which revealed a similar effect on abnormal reflexes when a general physical exercise programme was compared to the INPP developmental movement programme.

- All groups involved in the Northumberland project improved their scores on the Draw a Person Test between Time 1 and Time 2, suggesting that both physical intervention programmes were beneficial in improving children's spatial awareness and non-verbal cognitive skills.

- There was no significant difference between the INPP and Activate groups in SATS scores for reading, writing or maths between Time 1 and Time 2. Two factors may be involved in this result:

a) Due to teachers' unwillingness to introduce a control group, both groups were intervention groups. The statistical analysis therefore only measures the differences between two intervention groups on educational measures.

b) There was no pre-selection of participants. Previous studies (North Eastern Education and Library Board 2004, Goddard Blythe 2005) indicated that children who benefited most from the INPP programme were children who presented with *both* total reflex scores of >25% on tests for the ATNR, STNR and TLR *and* a reading age > than 6 months below their chronological age at the outset. The current sample contained children with mixed reading ability and mixed reflex status at the outset.

Teachers and schools involved in the project also reported:

- Children in the 4–6 year INPP group showed significant reduction in abnormal reflexes and improvements in reading and spelling.

- All schools who participated in the project have chosen to continue the INPP exercise programme.

- The five pupils who had been referred to the Behaviour Support Service during the research period responded well to the INPP exercises and all case referrals to the Behavioural Support Service were closed within one term of starting the INPP programme. Although these pupils had been referred to the service, no intervention work was undertaken in addition to participation in the INPP programme.

- Teachers reported that the experience of teaching the INPP exercises permeated into good behavioural strategies including the continuation of a calm and positive atmosphere in the classroom after the exercise sessions.

- In schools where the whole school used the INPP programme (two schools) head teachers commented on improved playground behaviour.

- A member of staff commented that pupils settled to work more easily after the exercise session. One head teacher commented that, "we see evidence of poise and self control with a lovely sense of pride in their achievement".

- Schools where teachers had attended the training day in the use of The INPP Test Battery and Developmental Exercise Programme for use in Schools found that the training helped them to understand pupil behaviour and offer more effective supporting strategies.

- Parents have valued information about the INPP programme and supported strategies at home

2. St John's School, Berkshire.

- Total scores of >25% for the ATNR, STNR and TLR were present in six children who had been identified as under-achieving in reading writing and spelling.

- The reflex scores of children in the INPP group decreased between Time 1 and Time 2 indicating that the INPP programme was effective in reducing evidence of primitive reflexes.

- There was significantly greater improvement in the reading scores of children in the INPP group compared to the group of children with similar problems who had not taken part in a daily physical programme but who had received the same educational support in reading, writing and spelling.

When the progress of both groups of children over the 3 term period from September to September was compared using the Salford data available, the INPP group made an

average gain of 22.5 months in reading compared to a gain of 8.5 months in the comparison group.

The numbers in this sample were small and therefore any inferences derived from the results should be treated with caution. However, the difference in reading improvement in the experimental group suggests a link between neuro-motor maturation and improvement in reading in this sample.

Conclusions

If the findings of these two projects are representative of children in the general population, they suggest that neuro-motor immaturity is present in a significant percentage of children in mainstream schools in the United Kingdom. These are children who are not generally identified as having either specific learning difficulties or developmental immaturity and who therefore "slip through the net" of services which should be in place to identify underlying problems and provide effective remedial intervention.

Neuro-motor immaturity is linked to lower performance on the Draw a Person (DAP) Test in this sample. The DAP provides an indication of non-verbal cognitive performance, which plays an important part in supporting many aspects of learning and behaviour.

The progress of children aged 4 –6 years following the INPP programme in tests for neuro-motor maturity and reading and spelling suggest a possible link between neuro-motor maturity and educational attainment. This should not be confused with educational potential or intelligence but raises questions as to whether children with immature motor skills tend to under-achieve at school. If such children are already performing at or close to their chronological age, under-achievement is often not identified. They are simply assumed to be performing "as well as can be expected". Discrepancy between ability and performance can result in frustration, which tends to be acted out in behaviour. The observation that 5 children referred to the Behavioural Support Service before the first assessment, were removed from the referral list after one term using the INPP programme, suggests that improvement in neuro-motor skills may also have a beneficial effect on behaviour. A study involving larger numbers would need to be carried out to support this observation.

Routine testing of neuro-motor maturity at key stages in education in the future could help to identify children who are at risk of under-achieving as a consequence of immature motor skills, so that effective physical and remedial intervention programmes could be implemented.

This observation is supported by the results from the small sample at St John's School, where children had been identified as under-performing in reading, writing and spelling and maths, but had not been classified as having Specific Learning Difficulties. As the neuro-motor skills of this group matured, reading performance also improved indicating a possible relationship between the two.

Children in both intervention groups (INPP and Activate) showed improvement on all measures over time. The INPP group had greater reduction of primitive reflexes than the Activate group but there was no significant difference between the two intervention groups in attainment on educational measures. This suggests that both the daily physical

intervention programmes were of benefit but that using a specific movement programmes such as The INPP Programme may be more effective when addressing specific developmental needs such as the retention of primitive reflexes in the school-aged child.

It is recommended that a follow-up study involving larger numbers and a control group be carried out to see if the above findings can be replicated.

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Appendix 1
The INPP Test Battery for use in Schools:

Table 1. The INPP Test Battery for Children from 7½ years of age

Function	Test
Gross muscle coordination and balance	Tandem Walk
	Fog Walk
Aberrant primitive reflexes	Quadruped test for the ATNR (Ayres)
	Erect test for the ATNR (Hoff-Schilder)
	Quadruped test for the STNR
	Erect test for the TLR (INPP)
Visual tracking	Valett RE, (1990) *Dyslexia – a neurophysiological approach*.
Visual integration	Valett RE, (1990)
Visual perception, VMI and spatial	Tansley Standard Figures
	Bender Visual Motor Gestalt Figures
Drawing/non-verbal cognitive performance	Draw a person test (Aston Index)

Table 2. The INPP Test Battery for Children age 4 – 6 years

Function	Test
Proprioception and static balance (from 4 years of age)	Romberg test
Static balance	One leg stand
Integration	Creeping on hands and knees
Crossing the midline	Passing an object from hand to hand
	Touching the opposite ear, knee and foot
Dysdiadochokinesia (5- 6+ years)	Finger-to-thumb opposition test
Aberrant reflexes	Quadruped test for the ATNR (Ayres) (from 4 -5+ years of age)
	Quadruped test for the STNR
	Erect test for the TLR (INPP) (from 6 years of age)
Visual perception, VMI and spatial	Selected age appropriate figures from the Tansley Standard Figures.

Drawing/non-verbal cognitive performance	Draw a person test (Aston Index) (from 4 years of age)

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