



Sally Goddard Blythe

# Neuromotor Immaturity in Children and Adults

The INPP Screening Test for  
Clinicians and Health Practitioners

**WILEY** Blackwell

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# **Neuromotor Immaturity in Children and Adults**

**The INPP Screening Test for Clinicians  
and Health Practitioners**

**SALLY GODDARD BLYTHE**

**WILEY Blackwell**

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# Dedication

*For Peter Blythe*

*If I have seen further, it is by standing on the shoulders of  
giants*

Sir Isaac Newton, Letter to Robert Hooke, 5 February  
1675.

## Foreword

As a paediatrician with a special interest in neuro-development, I have been inspired by Sally Goddard Blythe's work and the work of INPP. To me, the link between balance and movement difficulties and learning difficulties is self-evident. Much, if not all, of what Sally Goddard Blythe has written in the past has been written for parents and teachers. Here is a book for doctors. Teachers and parents look to doctors for an explanation of their child's developmental problem, but doctors (particularly primary care doctors) consider neuro-development as 'specialist territory'. The doctors who have insight into child development work from child development centres, and these are often in specialist centres, which may not always be easy to access. However, children with neuromotor immaturity, whose development is not quite normal, and children with school-related problems are very common - so common that they could be considered part of the wider spectrum of normality. The medical culture now is the culture of specialism. The system demands that and parents expect a specialist opinion and a specific developmental diagnosis.

As a paediatrician with an interest in development, children were referred to me with a range of symptoms with the expectation of one or other specific diagnosis. Parents would often bring a checklist of symptoms for specific conditions (taken from a book or the Internet). Their child fulfilled most of the criteria. They wanted me to confirm their diagnosis, as it would then open doors to access funding from the education department. I was struck by the fact that checklists for separate specific conditions had so many overlapping symptoms. On examination, the physical

findings overlapped considerably. Most had signs of neuromotor immaturity. I had this perception that most of these children were potentially normal children, who had for whatever reason, drifted from a normal developmental pathway, and with the correct support and nurture could be welcomed back to normal health and development.

Do all children have to be referred to a specialist? Should not a generalist have insights into common problems; into those conditions that are not yet diseases and disorders but deviations from normal; the grey areas?

A good health promotion and preventive service sees grey areas as its bread and butter! There was once a group of doctors who understood this grey area very well. These were the Community Medical Officers of yesteryear. They had wide-ranging community and public health roles including immunization and screening, and they were the school doctors. It was their role to identify children who may have learning difficulties in school. They knew their communities, their schools and teachers. They also knew their child development! They knew that there was a connection between subtle developmental difficulties and learning difficulties, and they also knew that soft neurology was important. They would follow up the children with developmental difficulties in school, and support their teachers, and be advocates for them if they needed additional resources. They would have welcomed this book because this book gives an understanding and an explanation of something they always knew. However, neurologists or hospital paediatricians were somewhat dismissive about 'soft neurology'. They were only interested in neurological signs which pointed to structural damage or specific neurological lesions. Immaturity did not interest them. The bodies that recommended the health and prevention programmes were either hospital (disease oriented) doctors or public health academics. Screening,

they pronounced, had to be targeted to conditions with a medical label and medical intervention. Developmental surveillance was dropped from the programme.

Over the decades, the Community Medical Officers have been reorganized out of existence. Their duties have been divided up between health visitors, GPs, school nurses and community paediatricians. Community paediatricians' work is diluted between so many responsibilities (including child protection work, children in the care system, adoption and fostering and in working in specialist child development centres) meaning that the work for school is now confined to the statutory role of providing medical advice for the statement of special educational needs; this is an essentially bureaucratic role. They have little time left for that valuable preventive and health monitoring role that was the follow-up of children with developmental delays and motor immaturities and in liaison with the teachers.

We are told that various emotional and developmental disorders (e.g., dyslexia, dyspraxia, Asperger's syndrome, autism and ADHD) are on the increase, and we are facing an epidemic of mental health problems. Many mental health problems that society faces today have their origins in childhood. We cannot afford to drop our health promotion and prevention. We know that in general better nurture of our children could lead to better mental (and physical) health in adults, but beyond these vague generalizations, we have had no models or specific programmes. This book provides the evidence and the rationale and the methods for such a model.

Preventive health services understand the concept of monitoring the health of both individuals and populations. People don't need to be ill or unwell to qualify for health surveillance. We do need to understand what we are monitoring. We understand the concept of growth

monitoring. The pattern of normal growth is well understood, deviations from the normal pattern are easily recognized and specific interventions and referral pathways have been worked out. In countries or communities where undernutrition is common, health care workers will give energy or protein supplements as soon as the child's growth begins to deviate from normal and long before the clinical signs of protein calorie malnutrition are evident. (The appearance of frank signs of protein calorie malnutrition in a child or a population would be considered a failure of the health care programme.)

Could we not apply a similar model to monitor development? Examining for neuromotor immaturity is more complex than measuring and monitoring growth. The issues are a little more difficult to grasp, the procedures a little less objective. The model is still the same. Neuromotor immaturity is common and can be identified before the criteria for specific disorders become apparent. Simple measures that can be incorporated into a pre-school or school curriculum and its benefits have been demonstrated. The measures used need not even be considered as interventions or treatments (any more than nutritional supplements are considered treatments). They are means by which the child can be encouraged back onto the natural pathway of health and normal development. Surely, this is not beyond the territory of a health service. Surely, it is relevant for primary care physicians to understand these issues and be able to examine and monitor children with these difficulties.

The curative model of health care (the model that likes the idea of specific diagnosis and specific treatment) is the model that the public and politicians buy into and is supported by the media and most of the medical profession. The medical profession likes certainty and is uncomfortable with grey areas - with 'soft neurology'. Our training and



management system appears to steer us in the direction of a specific medical diagnosis and steer us away from grey areas. Yet, it is precisely the grey areas in life that lend themselves to proactive health care and primary prevention.

Relating behavioural difficulties and school-related problems (difficulties in reading, attention difficulties, dyslexia, etc.) to developmental issues may be a completely new territory to many non-specialist doctors. The first part of this book provides the research evidence and a neuro-developmental explanation as to why neurological immaturity in children results in subtle learning difficulties, and the difficulties these children have accessing the full curriculum.

The second part of the book develops the theme that neuromotor immaturity is not confined to childhood and reviews the evidence that many debilitating disorders in adult life (e.g., anxiety disorders, agoraphobia and panic attacks) not only have their origins in childhood but show clinical signs of immaturity in symptoms of movement balance and vestibular dysfunction, and as in childhood, these conditions can respond to remedial movement programmes. It is an exciting prospect that many of these debilitating conditions could be prevented by movement- and balance-oriented remedial education in childhood. All this strengthens the case for proactive programmes in childhood.

The clinical methods described in this book will enable the doctor to do more than take a history of development. It describes a thorough clinical examination to demonstrate motor immaturity signs in retained primitive reflexes. The link between these findings and the actual difficulties in the classroom can be explained to teachers and parents and an easily understood programme implemented. This is a

fulfilling role for the doctor and empowering to parents and teachers.

I hope this book will be of interest to paediatricians (acute and community) as well as to primary care doctors. I hope it inspires school doctors. The section comparing the various schools of thinking in the tour and movement problems (sensory integration, Vojta, Bobath, INPP) will be particularly interesting to the school doctor. I myself have been aware of these systems and have referred children to various therapists practising these methods, but have not been quite sure of their precise differences in approach.

I hope it rekindles an interest in understanding neuro-development and in primary care developmental surveillance. Can we prevent this predicted epidemic of mental health problems in the future?

Dr Arthur Paynter  
FRCP, FRCPCH, Retired Consultant Paediatrician  
(Community Child health)  
May 2013

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# 1

## Identifying Signs of Neuromotor Immaturity in Children and Adults

*If we ran a health service rather than a disease service it would focus on a physiological and evolutionary approach to health and education.*

-Paynter, A. (2011)<sup>1</sup>

### 1.1 Introduction

Health and well-being are not simply the product of absence of disease. They are the sum total of a system and systems which function well together. *Dys-ease* as opposed to the pathological features associated with disease can result from lack of synergy within the functioning of systems. *Dys-ease* produces a variety of symptoms ranging from behavioural and specific learning difficulties in children to emotional and psychological problems in adults.

Problems arising from *dys-ease* or *dysfunction* can be compounded for social reasons by the operational restrictions imposed on the various professional disciplines responsible for identifying problems and prescribing effective remedies.

Parents are often caught in this professional no-man's-land, first seeking medical advice or reassurance when concerned about aspects of their child's development. If no underlying medical condition can be found, the family tends to be passed on to the next service in the system allocated to take on responsibility for the child's development. More often than not, this is education, but few educators are qualified to investigate or treat physical dysfunction, while health practitioners are not primarily concerned with educational difficulties. Spanning these two disciplines lies the domain of the educational psychologist, well qualified to assess and diagnose conditions in which physical dysfunction plays a part (e.g. developmental coordination disorder, attention deficit disorder, attention deficit hyperactivity disorder, ASD), but not in a position to provide a remedy for a range of physical symptoms. The result is that many of these children simply 'fall through the net' of services intended to identify children at risk and offer appropriate support or intervention - neither 'bad enough' for medical treatment nor 'good enough' - to realize their potential in the classroom.

This group of children is often subjected to numerous assessments, but go on to receive either inadequate or inappropriate intervention. Inappropriate intervention is the type that tends to focus on the *symptoms* of underlying dysfunction instead of tackling underlying causes. If, for example, teaching

more of the same does not ameliorate the presenting problem, while it can provide ongoing support, it is not the solution.

Similarly, a specific group of adults who present with symptoms which formerly would have been described as 'neuroses' may have a history of a cluster of underlying physical factors which have combined over time to make the individual more vulnerable to stress.

The now redundant term 'neurosis' describes relatively mild forms of mental illness that is not caused by organic disease, involving symptoms of stress (depression and anxiety). Neurosis affects only part of the personality, is accompanied by a less distorted perception of reality than in a psychosis, does not result in disturbance of the use of language and is accompanied by various physical, physiological and mental disturbances (as visceral symptoms, anxieties or phobias). The term neurosis was coined by the Scottish doctor William Cullen in 1769 to refer to 'disorders of sense and motion' caused by a 'general affection of the nervous system'. For him, it described various nervous disorders and symptoms that could not be explained physiologically. The term was re-defined by Carl Jung and Sigmund Freud over a century later, who used it to describe a variety of mental disorders in which emotional distress or unconscious conflict is expressed through various physical, physiological and mental disturbances, which may include physical symptoms (e.g. hysteria, hypochondria) or emotional symptoms (such as phobias, panic, anxiety and depression).

Today, many of these conditions do respond to medical and behavioural therapeutic interventions, others do not. In seeking to find a solution for those who do not respond to standard treatment or who are recidivists, further investigation for signs of neuromotor immaturity can help to identify additional underlying factors which may be involved in the continuation of symptoms and which might respond either to a physical intervention programme, combination of a physical programme and behavioural therapy or a different type of medical solution.

It is stressed that in all cases, this screening test should not be used to form a diagnosis but only as a basis for further investigations.

## **1.2 How to Use This Manual**

The manual comprises four chapters.

[Chapter 1](#) provides a general introduction for all readers. It includes a definition of Neuromotor Immaturity (NMI) and its implications and a literature review of links between NMI and specific learning difficulties followed by a description of the role of primitive reflexes in normal development.

The INPP method is described and compared with other well-known motor training programmes including Sensory Integration (SI), the Bobath therapy

and the Vojta method.

[Chapter 2](#) comprises the INPP screening test for use with children (4-16 years).

[Chapter 3](#) explains the links between neuromotor immaturity and symptoms of anxiety, agoraphobia and panic disorder in adults.

[Chapter 4](#) comprises the INPP screening test for use with adults.

[Chapter 1](#) is recommended to all readers. [Chapters 1](#) and [2](#) are relevant for professionals working with children; [Chapters 1](#), [3](#) and [4](#) to professionals working specifically with adults. Professionals working with children and adults should read *all* chapters.

## 1.3 Overview

Neuromotor functioning provides one indication of maturity in the functioning of the central nervous system. It is also linked to functioning of the vestibular, proprioceptive and postural systems, which collectively provide a stable platform for centres involved in oculo-motor functioning and subsequently visual perception. Individuals with neuromotor immaturity frequently experience difficulties with related skills such as balance, coordination and visual perception, which can affect behaviour and educational performance in children and result in chronic anxiety and emotional sensitivity in adults.

Problems connected to neuromotor immaturity can be subtle and diffuse, failing to fit into any single diagnostic category but nevertheless undermining an individual's ability to function with competence and confidence. Children may present in a physician's consulting room as a behavioural problem or emerge in the classroom as a low achiever; adults seeking medical help may complain of a range of symptoms for which no abnormality is detected on clinical investigation.

One method of identifying signs of neuromotor immaturity is through the use of standard tests to assess retention of primitive reflexes and development of postural reactions and other tests for 'soft signs' of neurological dysfunction. Soft signs, which have previously been dismissed as being too generalized to be useful for diagnostic purposes, are minor neurological signs indicating non-specific cerebral dysfunction.

The presence or absence of primitive reflexes at key stages in development provides acknowledged signposts of maturity in the functioning of the central nervous system. Primitive reflexes emerge in utero, are present in the full-term neonate and are inhibited in the first six months of post-natal life as connections to higher cortical centres and frontal areas develop. Primitive reflexes are also suppressed in the course of normal development as postural reactions and muscle tone advance.

Primitive reflexes are retained under certain pathological conditions, such as cerebral palsy. In cerebral palsy, retention of the reflexes occurs as a result of damage to the brain or abnormal development which may have occurred pre-natally, at birth or post-natally (Bobath and Bobath,<sup>2</sup> Illingworth,<sup>3</sup> Capute and Accardo,<sup>4</sup> Fiorentino,<sup>5</sup> Levitt,<sup>6</sup> Brunnstrom<sup>7</sup>). Damage to the immature brain interferes with the normal process of maturation in a predictable, orderly, developmental sequence resulting in lack of inhibition, demonstrated by prolonged retention of the primitive undifferentiated patterns of movement control characteristic of infancy, accompanied by abnormal muscle tone, development of postural control, impaired patterns of movement and delayed motor development. Primitive reflexes also re-emerge in degenerative conditions such as multiple sclerosis and Alzheimer's disease, when demyelination results in deterioration of postural reactions and primitive reflexes are disinhibited. For many years, it was assumed that retention of primitive reflexes could not exist to a lesser degree in the absence of identified pathology, and therefore, primitive reflexes were not the subject of investigation in children with less severe motor delays or children who simply present with signs of a specific learning difficulty.

Physicians are familiar with the assessment of primitive reflexes as part of the paediatric neurological examination at birth and in the first six months of life, but if development is progressing normally at six months of age, these tests are rarely repeated in older children or adults, because it is assumed that primitive reflexes do not persist in the absence of pathology. This assumption has led to the development of a somewhat polarized view of how primitive reflexes are regarded within the medical professions; because there are no clear presenting symptoms of pathology, primitive reflex status in the older child is not assessed - a case of putting the telescope to the blind eye and saying, 'I see nothing through it'.

Children and adults who have *residual* primitive reflexes and/or under-developed postural reactions tend to 'slip through the net' of clinical services. Symptoms in the form of behavioural disorders, specific learning difficulties, under-achievement and anxiety states appear within the family, at school, in higher education and in the physician's consulting room, often in the form of 'secondary neuroses' or non-specific ailments, which have developed over several years and which are, in part, the result of increased levels of stress needed to recruit and maintain compensatory processes.

## **1.4 Relationship Between Neuromotor Immaturity and Learning Outcomes**

### **Literature review**

The concept that neurological dysfunction can underlie problems with learning is not new. Developmental disabilities were recognized in the nineteenth century chiefly as two forms of delay - cognitive delay in the case of mental retardation and motor delay in the case of cerebral palsy - but less severe symptoms involving discrepancy between intelligence and more specialized areas of language, learning, communication and social interaction including early infant autism only emerged in the twentieth century.

In the 1920s, the French were among the first to notice a link between 'motor awkwardness' and learning disabilities,<sup>8</sup> which they sometimes described as 'psychomotor syndromes'. In 1940, R.S. Paine described the presence of several isolated motor signs, such as awkwardness, tremor, hyper-reflexia or mild impairments in walking, in children with specific learning difficulties. He also pointed to problems in the perception of auditory or visual information, faulty concepts of space, diminished attention span, difficulty in abstract thinking and delays in academic achievement being characteristic features of children with learning disabilities. Mild epileptic symptoms were also noted as sometimes being present.<sup>9</sup>

In other countries, the term Minimal Brain Dysfunction (MBD) started to be used. MBD was formally defined in 1966 by Samuel Clements as a combination of average or above-average intelligence with certain mild to severe learning or behavioural disabilities characterizing deviant functioning of the central nervous system which could involve impairments in visual or auditory perception, conceptualization, language and memory and difficulty controlling attention, impulses and motor function,<sup>10</sup> but with more than 99 possible symptoms listed as diagnostic criteria for MBD by the 1970s, the term MBD was already being rejected as too broad.

Investigations into the presence of abnormal or immature reflexes in individuals with specific learning difficulties emerged from various schools of thought and disciplines in the 1970s.

In 1970, an Occupational Therapist (OT) at the University of Kansas carried out a study in which she compared the reflex levels of a group of neurologically impaired children with a group of children with no known neurological impairment. Every one of the group diagnosed with neurological impairment had abnormal reflexes. Eight out of nineteen subjects in the 'normal' or comparison group also showed some reflex abnormalities, and it was subsequently found that of these eight, one had behaviour problems and the remainder had either reading or writing difficulties.<sup>11</sup>

In 1972, Rider (OT), also at the University of Kansas, set out to assess the prevalence of abnormal reflex responses in normal second grade children comparing their results to a group of learning-disabled children. She found that the learning-disabled children had significantly more abnormal reflex



responses than the normal children. Using the Wide Range Achievement Test (WRAT) scores as an independent measure, she compared WRAT scores on the basis of whether there were abnormal reflex responses or not. Children with integrated reflexes scored consistently higher on the achievement tests than those with abnormal reflexes.<sup>12</sup>

In 1976 at the University of Purdue, Miriam Bender examined the effect of just one reflex, the Symmetrical Tonic Neck Reflex (STNR) on education, and found that the STNR was present in 75% of a group of learning-disabled children but not present in *any* of a comparison group of children without a history of learning disabilities. She also developed a series of exercises designed to help inhibit the STNR and observed that as the STNR diminished many of the children's presenting symptoms improved.<sup>13</sup>

In 1978, A. Jean Ayres, the originator of Sensory Integration (SI) therapy, observed that one of the major symptoms manifested by children in disorders of postural and bilateral integration was 'poorly developed primitive postural reflexes, immature equilibrium reactions, poor ocular control and deficits in a variety of subtle parameters that are related to the fact that man is a bilateral and symmetrical being'.<sup>14</sup> One of the aims of sensory integration therapy was 'not to teach specific skills such as matching visual stimuli, learning to remember a sequence of sounds, differentiating one sound from another, drawing lines from one point to another, or even the basic academic material. Rather, the objective is to enhance the brain's ability to learn *how* to do these things'.<sup>14</sup> The objective was modification of the neurological dysfunction interfering with learning rather than attacking the symptoms of the dysfunction.

In 1994, Wilkinson carried out a replica study based on Rider's (1972) research. She found not only a link between residual primitive reflexes and specific learning difficulties but also identified a connection between residual primitive reflexes and educational under-achievement. Her findings indicated that one reflex - the Tonic Labyrinthine Reflex (TLR) - underpinned many of the presenting educational difficulties and that there was a relationship between the continued presence of the Moro reflex and specific problems with mathematics.<sup>15</sup>

Goddard Blythe and Hyland<sup>16</sup> investigated differences in the early development of 72 children diagnosed with specific learning difficulties compared to children with no evidence of specific learning difficulty using the INPP Developmental Screening Questionnaire.<sup>17-19</sup> They found significant differences in the developmental histories of the two groups with children in the specific learning difficulty group having a markedly higher incidence of early life events or signs of delay in motor and language development and factors related to the functioning of the immune system. Delays in learning to walk and talk were particularly significant in the group with specific learning difficulties.<sup>16</sup>

Other studies that have investigated the persistence of abnormal reflexes in children with specific reading difficulties have found the Asymmetrical Tonic Reflex (ATNR) to be present in children with reading difficulties<sup>20-22</sup> and a cluster of abnormal primitive and postural reflexes present in a sample of children diagnosed with dyslexia<sup>23</sup> and in children with attention deficit disorder.<sup>24</sup>

Investigations into the incidence of abnormal primitive reflexes in a sample of 672 children in seven mainstream schools in Northern Ireland between 2003 and 2004 revealed that 48% of children aged 5-6 years (P2) and 35% of children aged 8-9 years (P5) still had traces of primitive reflexes. Fifteen per cent<sup>25</sup> 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 were correlated with poor educational achievement at baseline. In the younger group (P2), it was found that retained primitive reflexes correlated with poor cognitive development, poor balance and teacher assessment of poor concentration/coordination. Neurological scores and teacher assessment at baseline predicted poorer reading and literacy scores at the end of the study.<sup>26</sup>

Some research suggests that children growing up in areas of social disadvantage may also be at greater risk of educational under-achievement, not only as result of lack of appropriate stimulation in terms of opportunity for language development and reading, but also because of immature motor skills.<sup>27</sup>

Empirical findings also suggest that improvement in markers of neuromotor maturity (primitive reflex status) is associated with improvement in behavioural problems in some children.<sup>28</sup>

## **1.5 Neuromotor Immaturity in Adolescents**

Adolescents and young adults can also be caught in the transition from compulsory education to establishing an independent adult life. Dr Lawrence Beuret, an MD practicing in Chicago, specialized in treating this age group, who start to experience problems for the first time in the final stages of secondary education or when they move into higher education:

Multiple factors converge in adolescents and adults with neurological dysfunction to create elusive and diffuse symptomology. Early reading and learning difficulties are generally absent; fine motor and writing problems are minimal; gross motor coordination is little affected; athletic ability may be above average and early behaviour is within age-appropriate norms. Academically 'not working up to potential' and emotionally or behaviorally not responding to accepted therapeutic or pharmacological interventions are the hallmarks of neuromotor immaturity in this population. This differs substantially from younger children whose symptoms closely correlate with the continued presence of primitive reflexes. *The under-development or absence of postural reflexes (reactions) has a much greater influence on symptom development in this older population.*<sup>29</sup>

Postural reactions and their role in supporting perceptual stability are described more fully in [Chapter 3](#).<sup>a</sup>

Beuret went on to describe how the under-development of postural reactions has a much greater influence on symptom development and functional limitations in this older population, quoting De Quirós and Schragger<sup>9</sup> as providing one of the most detailed insights into the pathology created by incomplete development of this reflex system. In summary, he states:

Any deficiency in the critical systems of postural control must be compensated for by the intervention of the highest (most recently evolved) areas of the CNS. This follows the dictates of Jackson's Law - the most highly developed, most complex functions - will be sacrificed to maintain functions earlier evolved, more primitive, and more critical to survival. In humans these encompass high level and complex cortical activities such as comprehension, executive function, analytical, and synthetic abilities, as well as cognitive and processing competence.

In this older population vestibular-proprioceptive mismatch becomes the common thread throughout an individual's history, testing and treatment response. A history of motion sickness which continues beyond puberty or some abnormal responses to motion is present in all cases, although intensity and frequency is reported to be highly correlated with certain personality factors. Motion sickness - nausea, vertigo, headache and fatigue - being the most frequently reported symptoms, occurs uniformly in response to attempting to read or engage in some form of visual fixation (reading a map or using a screen) while riding in a moving vehicle. Other abnormal motion responses may be present concurrently with, or independently from, motion sickness. These can involve adverse reactions to lateral, vertical, interrupted and rotational forces such as those encountered on winding roads, hilly terrain, amusement rides, elevators and high speed trains.<sup>29</sup>