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Postnatal Factors Using the INPP Questionnaire

7.1 How to Use the INPP Questionnaire

7.1.1 Question 6: When Your Child Was Born, Was He/She Small for Term? Please Give Birth Weight, if Known

Studies carried out in the Netherlands in the 1980s (the Gröningen studies) found that several neonatal neurological deviations, particularly low birth weight in relation to the length of gestation, were significant background factors for minor neurological dysfunction later on [1, 2]. An association between low birth weight and the development of adult medical and metabolic diseases, such as cardiovascular diseases and diabetes, was also repeatedly demonstrated. In addition to the physical effects of low birth weight on health in later life, one study found that low birth weight for gestational age, particularly at term, was also associated with adult psychological distress, which was not mediated by childhood factors, suggesting a direct link between early life factors and adult mental health. The researchers concluded that a neurodevelopmental pathway was probably involved [3].

Early life experiences such as birth weight can have an influence on cognition [3] and behavior [4] in childhood, and may be the result of a number of other factors: premature birth with all the risks that accompany the immature infant; impaired fetal growth resulting from placental insufficiency leading to a reduced oxygen and nutrition supply to the developing brain; and structural changes to biological mechanisms such as the hypothalamic–pituitary axis [5] (with its powerful influence on hormones, emotional and cognitive responses), the growth hormone axis, and thyroid function.

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Low-birth-weight children can be born at term or before term and have varying degrees of social and medical risk. Because low-birth-weight children are not a homogeneous group, they have a broad spectrum of growth, health, and developmental outcomes. While the vast majority of low-birth-weight children have normal outcomes, as a group, they generally have higher rates of subnormal growth, illnesses, and neurodevelopmental problems. These problems increase as the child's birth weight decreases. With the exception of a small minority of low-birth-weight children with mental retardation and/or cerebral palsy, the developmental sequelae for most low-birth-weight infants include mild problems in cognition, attention, and neuromotor functioning.

Placental insufficiency leading to fetal growth restriction (FGR) is reported as being a significant risk factor for neurodevelopmental delay. "The consequence of being small for gestational age (SGA) at birth on long-term intellectual performance is also well documented. Infants born with severe FGR, with reduced head growth or preterm have the worst neurodevelopmental outcomes. There are also two distinct phenotypes of FGR which have different effects on motor, cognitive, social and behavioral domains. As yet, it remains to be determined which variables measured in the prenatal period best identify the type of fetal deterioration that is most predictive of neurodevelopmental delay. Postnatally, those children born SGA/FGR who then attain a height and head circumference similar to those who were born appropriate for gestational age (AGA) achieve better cognitive outcomes" [6].

> Long-term follow-up studies conducted on children born in the 1960s indicated that the adverse consequences of being born low birth weight were still apparent in adolescence. Adverse sociodemographic factors negatively affect developmental outcomes across the continuum of low birth weight and appear to have far greater effects on long-term cognitive outcomes than most of the biological risk factors.
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> In addition, the cognitive defects associated with social or environmental risks become more pronounced as the child ages. Enrichment programs for low-birth-weight children seem to be most effective for the moderately low-birth-weight child who comes from a lower socioeconomic group. Continued research and attempts to decrease the rate of low birth weight and associated perinatal medical sequelae are of primary importance. Ongoing documentation of the long-term outcome of low-birth-weight children needs to be mandated, as does the implementation of environmental enrichment programs to help ameliorate the long-term consequences for infants who are born with low birth weight [7].

Low birth weight is not an absolute determinant of health, neurological dysfunction in childhood, or the development of adult psychological problems, but as with many events in early life, it carries increased risks [8].

More recently, the spotlight has focused on high birth weight, indicating that large babies may also be at risk of developing health problems later. High birth weight (>9 lbs) sometimes means that the baby needs to be delivered early although the baby may not be sufficiently well developed, which can lead to problems such as breathing difficulties or jaundice. The causes for babies with the highest birth weights can often be traced to gestational diabetes or obesity. "Scientists suspect that high birth weight is a marker for unwanted foetal programming. Studies in animals suggests that too much foetal nutrition triggers a collage of changes in a fetus' gene activation, organ function and production of insulin and other hormones. In a human pregnancy, these changes conspire to make a baby too big for its own good" [9].

7.1.2 Question 7: When He/She Was Born, Was There Anything Unusual About Him/Her? That is, the skull distorted, heavy bruising, definitely blue, heavily jaundiced, covered with a calcium-type coating or requiring intensive care. If yes, please give details.

The medical condition of the child is assessed immediately after birth using the Apgar score, based on five parameters: heart rate, respiration, muscle tone, skin color, and response to stimuli. Apgar scores are typically assessed at both one and five minutes after birth. A normal infant in good condition will score between 7 and 10. A score below 7 indicates a degree of asphyxia and requires resuscitation. The need for resuscitation is significant because shortage of oxygen to the brain can result in cell death and damage—the longer the period of oxygen deprivation, the greater the risk of subsequent problems.

In addition to criteria using the Apgar score, other physical observations provide information about the condition of the baby: misshapen skull, swelling, hematoma, or bruising indicate that the baby may have had a "rough ride" while being born. Stress or strain placed on the region of the neck and on the back of the head (atlanto-occipital region) can result in structural misalignment of the spine at the base of the skull. This can affect not only posture and muscle tone as the child grows up, but may also show up earlier as a baby who is a poor sleeper, does not like being placed on either its back or its tummy, suffers from colic in the first 12 weeks of life, and, if uncorrected, may have postural-related learning problems later on.

7.1.2.1 Jaundice

Jaundice is common in the first week of life and occurs as a result of an increase in the level of bile pigments (bilirubin) in the blood and tissues. Before birth, the fetus needs a high level of hemoglobin in order to attract sufficient oxygen across the placenta. After birth, this high level is no longer required, and the excess needs to be broken down and removed. This, combined with the fact that the red blood cells of the newborn also have a short lifespan, results in an increased need for hemolysis (breaking down of blood corpuscles) and in a higher production of bilirubin, which is normally conjugated in the liver and is converted to a harmless substance by bacteria in the gut. Early feeding of the baby helps to stimulate motility in the gut and provides glucose for the manufacture of liver enzymes, which help the infant to metabolize bilirubin.

Most babies develop a slight degree of jaundice in the first few days of life (physiological jaundice, which is regarded as normal). Approximately 50% of infants become clinically jaundiced, but only in 20% of these (10% of all infants) does the level of bilirubin contained in the blood reach potentially dangerous levels.

Mild physiological jaundice is common and is due to a temporary inability to deal with the normal metabolism of bilirubin. In full-term babies, physiological jaundice appears after the first 24 hours of life and reaches a peak on the fourth or fifth day. In preterm infants, it usually begins within 48 hours after birth and may last up to two weeks. Mild symptoms of jaundice are not a cause for concern provided that

- it does not appear in the first 24 hours;
- the serum level of bilirubin does not exceed a safe limit;
- the highest level does not occur on the third or fourth day of life; or
- jaundice fades by the seventh day and the baby is otherwise well.

> *Disorders of the* basal ganglia *do not cause weakness or reflex changes. They cause problems in the control of voluntary movement, resulting in either increased or decreased movement and in changes in muscle tone and posture.*

If signs of jaundice *exceed* the limits listed in the preceding text, it ceases to be physiological and is considered pathological. Pathological jaundice should be treated at the earliest possible stage to prevent damage to the *basal ganglia*, which are particularly sensitive to the toxic effects of elevated bilirubin levels. The most effective form of treatment is exposure of the infant to blue light, which converts bilirubin into the harmless blue pigment known as *biliverdin*. More serious causes of jaundice such as blood group incompatibility or hypothyroidism require special treatment.

7.1.3 Question 8: In The First 13 Weeks of Your Child's Life, Did He/She Have Difficulty in Sucking, Feeding Problems, Keeping Food Down, or Colic?

Feeding problems can arise for a number of reasons. In premature babies, feeding problems are a direct result of complications associated with premature birth, including underdeveloped rooting and suck reflexes.

Problems with sucking and/or chewing can be connected to underdeveloped infant rooting and suck reflexes even in the full-term baby, particularly if mother and baby have been separated for a time at birth [10]. If, on the other hand, the rooting and infant suck reflexes are retained a few months later when the child must learn how to chew and to grind food, they can interfere with the development of more mature feeding movements. Chewing is important not only because it breaks down food and begins the process of digestion in the mouth, but also because it stimulates movement of the gut further down the digestive tract. It is in the gut that the majority of absorption takes place.

Odent noted that babies who are born early or unwell, when placed in an incubator, can be seen "rooting" in the first hours after birth. When their rooting attempts do not receive a reward (breast or bottle), the rooting activity, occurring as a vacuum activity, starts to decline. In other words, the rooting reflex is particularly responsive in the first hours after birth, but becomes less reactive if not used at this sensitive time.

Skeletal torsion or misalignment resulting from trauma at birth can also affect sucking, swallowing, chewing, and development of the bite because the movements involved in successful suckling are dependent on the alignment of the jaw and the palate. Babies who experienced increased pressure, torsion, or use of force at birth on the neck region (e.g., abnormal presentation or forceps) may also find certain feeding positions uncomfortable and may have difficulty or may be unwilling to feed unless a number of different positions are tried. Early difficulties with feeding in the first weeks of life can affect subsequent development of oral muscle tone, swallow pattern, and the resting position of the tongue in the mouth, with subsequent effect not only on feeding but also potentially on speech.

Some babies develop colic in the first 12 weeks of postnatal life. Colic is generally thought to be an attack of spasmodic pain in the abdomen arising from the presence of some indigestible matter in the lower part of the gut, which excites spasmodic contraction of the intestine.

Empirical evidence from analysis of families where the INPP Questionnaire has been used indicates a trend whereby babies born to mothers who suffered from severe nausea and vomiting during pregnancy or who have a history of food intolerances are more likely to have feeding-related problems (including colic) in the first 12 months of life. Allergic reactions of the skin such as infantile eczema, which are not a direct result of skin contact with a known allergen (e.g., washing powder), are sometimes indicative of problems with the gut in processing certain foods.

Some babies vomit up a significant proportion of the feed on a regular basis. If this occurs in a bottle-fed baby without any other obvious cause being present, or develops for the first time when formula feed or cow's milk is introduced, it *might* indicate an inability to break down additional proteins and fats which are present in cow's milk but are not contained in breast milk. There can also be other reasons.

On the other hand, *regular* or persistent projectile vomiting is a serious matter. There are a number of medical conditions which cause projectile vomiting and which require treatment. Additionally, regular projectile vomiting can result in dehydration, electrolyte imbalance, and malabsorption syndrome, where the baby becomes depleted of vital nutrients. This can affect not only weight gain, growth, and immune functioning, but also sleep patterns, activity levels, and mood disturbances, and may render the child more prone to allergies and related difficulties later on.

Problems experienced by the baby can sometimes arise as a secondary result of micronutrient deficiency which has occurred during pregnancy. Foresight noticed that mothers who were zinc deficient were more prone to severe nausea and vomiting during pregnancy. Vitamin and mineral analysis of older children frequently finds those who suffer from allergies also tend to have low-zinc status and essential fatty acid (EFA) deficiency. In adults, a particular type of colic can develop known as lead or "painter's" colic, which is directly due to the absorption of lead into the system. Although no connection has been made to infantile colic, it seems plausible that even slightly elevated levels of lead in the infant could lead to "colicky" spasms.

Independent vitamin and mineral analysis of school-aged children seen at INPP who have a history of feeding problems in infancy and in early childhood has found that a high percentage have a low calcium level and an elevated level of lead in the hair. This may be important because calcium and lead are antagonists—calcium helps to keep lead levels in the body normal. In these cases, it is not known whether the children have been exposed to polluting levels of lead, which have then affected calcium status, whether low levels of calcium have enabled lead level to build up, or whether there is a problem in the absorption of calcium arising either as a result of an inability to process dairy products or a shortage of vitamin D.

Vitamin D is necessary for the body to absorb calcium. Vitamin D is obtained primarily through exposure to sunlight, and in cool temperate climates it is known that there is insufficient sunlight to provide for all the body's needs during the winter months unless it is supplemented through dietary sources (e.g., fish). In the postwar years, mothers and children were advised to supplement their diet with cod liver oil, a rich source of vitamin D. In recent years, doctors in the United Kingdom and in the United States [11] have reported a return of rickets, a disease thought to have been eradicated in the 1930s with improved nutrition (the term "rickets" is said to have been derived from the ancient English word *wricken*, which means "to bend"). In several European countries, rickets is also called the "English disease," a term that probably stems from the fact that at the turn of the 19th century, rickets was endemic in larger British cities. If the mother has a low vitamin D level, the child can be born with a relative vitamin D deficiency as a result of decreased maternal transfer. Breastfeeding, usually regarded as the best source of nutrition for babies, can also lead to vitamin D deficiency in the child if the mother is deficient, and as rickets has started to return, it has led to the advice to supplement vitamin D when breastfeeding.

Whatever the reason, where there is biochemical evidence of abnormality on vitamin and mineral analysis in the older child, it provides an indication that further specialist investigation should be recommended. Digestive problems, irrespective of the source, can affect the availability of neurotransmitters, the chemical messengers of the nervous system.

Gershon [12] described the gut as being a "second brain" with "a mind of its own." He said that the gut contains an intrinsic nervous system that is able to mediate reflexes in the absence of input from the brain and the spinal cord. There are more nerve cells in the gut than in the remainder of the peripheral nervous system, and it is also a chemical warehouse containing every neurotransmitter (chemical substances through which cells communicate) found in the brain. Problems in the functioning of any part of the digestive tract have the potential, via their effect on the chemical messenger system, to affect the functioning of the central nervous system (CNS).

7.1.4 Question 9: In the First Six Months of Your Child's Life, Was He/She a Very Still Baby, so Still That at Times You Wondered if it Was a Cot Death?

Babies who exhibit little movement in the cot or crib, or when they are left to play freely when awake, may be exhibiting early signs of hypotonia (poor muscle tone) or under-arousal.

7.1.5 Question 10: Between 6 and 18 Months, Was Your Child Very Active and Demanding, Requiring Minimal Sleep Accompanied by Continual Screaming?

There is a vast range of "normal" as regards the amount of crying and sleeping a baby does across different cultures, and there can be many reasons for a demanding baby. Babies who consistently cry *excessively* through the day and night and who will not be consoled are signaling discomfort of some kind. At the other extreme, babies who are listless, rarely cry, demand attention, or engage with the people around them may be exhibiting early indications of neurological dysfunction.

Babies often cry and become restless before a feed, and some will do so frequently (every 2–3 hours) in the early weeks of life. This is normal and is more common in small babies and in preterm babies who need a high milk intake to catch up growth and weight, and who take in less food at each feed. Breastfed babies tend to want to feed more often than bottle-fed babies. It can take several weeks to establish a routine which works for mother and baby, and babies who are fed "by the clock" tend to cry more than babies who are fed on demand. This is all perfectly normal and should not be a cause for concern.

Babies who have had a traumatic birth requiring forceps, ventouse extraction, or other complications affecting the atlanto-occipital area of the spine (the uppermost portion of the spine where it enters the base of the skull), such as the cord around the neck at birth, sometimes suffer from neck discomfort or headache when laid down. Practitioners of manual medicine such as cranial osteopaths and chiropractors can often do much to relieve the discomfort if treated early.

Babies who have congestion of the upper respiratory tract (blocked nose, mouth breathers, and snorers) tend to suffer from more disturbed sleep. Pressure in the middle ear arising from an immature swallow pattern can result in pain, similar to the discomfort we experience when an aircraft descends too quickly—this type of middle ear pressure does not necessarily develop into a middle ear infection (otitis media) but can result in a miserable baby who does not like being put down.

Children who are later diagnosed with attention deficit hyperactivity disorder (ADHD) often have a history of being poor sleepers and of having sleep-related problems which persist well into childhood.

7.1.6 Question 11: When Your Child Was Old Enough to Sit up in the Pram and Stand up in the Cot, Did He/She Develop a Violent Rocking Motion, so Violent that Either the Buggy or Cot Was Actually Moved?

Rocking can be a normal part of development and often increases for a short time prior to learning a new motor skill such as just before learning to creep on hands and knees. At these times, the action of rocking helps to facilitate the transition from one stage of motor development to the next. On the other hand, occasionally children develop a persistent and at times violent rocking action, which they resume even when interrupted. Similar behavior is sometimes seen in institutionalized individuals, for instance, patients in mental hospitals, children in orphanages where they receive little sensory or social attention, in autistic spectrum disorders, and under conditions of extreme emotional distress. While in these cases a persistent rocking habit is often interpreted as being part of the "condition," there is also some evidence to suggest that babies and children who develop a persistent rocking habit may have a hypoactive vestibular system and the action of rocking provides additional vestibular stimulation, helping them to feel good. In other words, in these cases, the rocking action is fulfilling a function, and may provide pointers as to what type(s) of intervention and sensory stimulation would be helpful.

7.1.7 Question 12: Did Your Child Become a "Head-Banger," that is, Bang His/Her Head Deliberately into Solid Objects?

Head banging is sometimes seen among children who are hyposensitive to *external* sensory stimuli, but who have a high degree of *internal* excitation. Similar to the examples mentioned in relation to persistent rocking in the previous question, head banging may be an attempt at self-stimulation. It may also be seen under conditions of *extreme* frustration.

7.1.8 Question 13: Was Your Child Early (Before 10 Months) or Late (Later than 16 Months) at Learning to Walk?

Most babies learn to walk some time around the time of their first birthday, although the age range at which a child may learn to walk can vary from 9 to 18 months. Any time from 10 to 16 months is considered normal.

Walking represents an important landmark in motor development because it signifies acquisition of postural reflexes, substantial inhibition of primitive reflexes, mastery of balance, and development of muscle tone sufficient to support the weight of the body. A child who is late at learning to walk (16 months or later) may be exhibiting early signs of delay in motor or postural development and/or vestibular functioning.

Despite parents' desire to see their infant walking as soon as possible, walking early is not always in the child's long-term interests either, if it reduces the time that the infant spends in crawling and in creeping first. As discussed in earlier chapters, crawling and creeping are integrating activities which combine vestibular, visual, proprioceptive, and inter-hemispheric training through action. Early walkers can sometimes miss out on aspects of sensory–motor integration normally entrained through the experience of crawling and creeping.

7.1.9 Question 14: Did He/She Go Through a Motor Stage of: A) Crawling on the Stomach, and B) Creeping on the Hands and Knees, or Was He/She a "Bottom-Hopper" or "Roller" Who One Day Stood up?

There is often confusion between the terms "crawling" and "creeping." Crawling precedes creeping and describes forward movement carried out with the tummy in contact with the floor (commando crawl). Creeping usually begins sometime between seven and nine months of age, and describes movement carried out on hands and knees with the tummy off the ground. Both crawling and creeping develop in stages, and not all children pass through all the stages.

> *In the United States, crawling refers to commando-style crawling with the tummy in contact with the ground; creeping refers to creeping on hands and knees. In the United Kingdom, the term "crawling" is more often used to describe crawling on hands and knees, and the term "creeping" is rarely used. In this context, we have used the definition of the terms used in the United States.*

There are many children who do not crawl or creep in the first year of life and who do not develop later problems. However, among children who *do* have specific learning difficulties, the incidence of children who did *not* crawl and creep is higher. Crawling and creeping are landmarks of motor development, and of interest in the context of the child's developmental history *as a whole*.

7.1.10 Question 15: Was Your Child Late at Learning to Talk? (Two- to Three-Word Phrases by Two Years)

Children's language develops through a series of identifiable stages. Language in its broadest term describes the ability to communicate. Children go through many phases of pre-speech in the first year of life, but the emergence of recognizable words used in a meaningful sequence is a milestone in a child's development.

By 12 months, most children have one or two words that they say with meaning, and are able to comply with simple commands. By 18 months, one or two words are used to convey a more complex meaning such as "cup," meaning "I want a drink," or baby words such as "tractor" to say, "there is a tractor in the field." Intonation is often used to compensate for lack of vocabulary. By two to three years of age, a child should be able to use two or three words together, to talk about and to ask for things using short phrases such as "Daddy home now," "socks off," "want drink." They may also start to use single-word questions such as "where?" or "when?"

Development of speech depends on many factors: normal brain functioning, adequate hearing, fine motor control of the lips, tongue, and swallow mechanism combined with breathing; and adequate exposure to the sounds of language on a daily basis and also, just as important, receiving a positive response for their own attempts at vocalization. Development of speech can therefore be delayed for a number of reasons.

If a child has not started to put two words together by the end of the second year (24 months), and two- to three-word phrases by three years, it can be an indication of an existing problem with hearing, motor skills, a more generalized language problem, or lack of environmental linguistic stimulation.

7.1.11 Question 16: In the First 18 Months of Life, Did Your Child Experience Any Serious Illness Involving High Temperatures and/or Convulsions? If Yes, Please Give Details

Most children suffer from a variety of minor illnesses in the first years of life. This is important in helping the developing immune system to recognize past enemies and to launch a future defense. However, serious illnesses involving very high temperature and/or accompanied by febrile convulsions in the young child can, in some cases, result in lasting damage or may compromise the developing CNS. Illnesses that might fall into this category include pertussis (whooping cough), scarlet fever, septicemia, meningitis, encephalitis, and bronchiolitis.

A normal temperature is between 36 and 36.8 °C (96.8–98.24 °F). In children, any temperature of 38 °C (100.4 °F) or above is considered high and is classed as a fever. Conditions that can cause fevers are flu, ear infections, roseola (a virus causing a temperature and rash), tonsillitis, kidney or urinary infections, or any of the common childhood diseases such as measles, mumps, chickenpox, and whooping cough. Occasionally, a high temperature can occur if a young child (especially newborn) is overdressed. This is because young babies are less able to regulate their own body temperature. Other causes of fever may be teething or reaction within 48 hours to immunization.

7.1.11.1 Why Does Fever Occur?

A successful immune response attacks one type of microbe, overcomes it, and provides future protection against that microbe, but no other. If exposed to the microbe again, it recognizes it, remembers, and overcomes it. The human body has three lines of defense against microbial attack (infection):

1) External barriers that prevent microbes from penetrating the body such as the skin.
2) Mucous membranes of the digestive and respiratory tracts, which secrete mucus containing antibacterial enzymes which destroy bacterial cell walls. Mucus in the nose or in the mouth traps microbes at the point of entry, preventing them from entering the body. If microbes are swallowed, they are killed by a combination of acid in the stomach and protein-digesting enzymes. If they survive further into the digestive tract, the intestine is inhabited by bacteria that are harmless to the human body but secrete substances that destroy invading bacteria or fungi.
3) If microbes penetrate both the primary and the secondary defense systems, and if the natural killer cells that destroy cells of the body that have been infected by viruses fail to stop the virus proliferating, the body responds by producing a fever. Fever slows down microbial reproduction and increases the body's fighting abilities.

A fever is the body's natural assault on invading microbes. Body temperature is regulated by the hypothalamus, a part of the brain containing temperature-sensitive nerve cells which act as the body's thermostat. The thermostat is normally set at 37 °C (98.6 °F), but when foreign organisms invade, the thermostat is turned up. Raised body temperature increases the activity of white blood cells which attack bacteria and reduce the iron concentration in the blood. Many bacteria require more iron to reproduce at temperatures above 38 °C, so the fever acts to increase the body's defenses against microbes and to create unfavorable conditions for microbe reproduction. A child who has experienced a *series* of serious illnesses involving very high temperature may be showing signs of an immune system under stress and of immaturity in the ability to regulate body temperature under stress, and/or may suffer assault to the immature nervous system *as a result* of the high temperature. High temperatures can cause problems and can also be symptomatic of existing problems.

Febrile convulsions are seizures which occur when a child develops a high fever of over 39 °C (102.2 °F). They typically occur during the early stages of a viral infection such as a respiratory infection, while the temperature is rising rapidly. They are the result of immaturity in electrical systems in the brain not yet sufficiently mature or resilient to cope with the stress of a high temperature. They are most common between the ages of six months and three years, but can occur up to six years of age. Three per cent of children have at least one febrile convulsion in infancy or in early childhood. Onset before the age of one and a family history of febrile convulsion increase the risk by up to 20%. The majority of children grow out of febrile convulsions without long-term adverse effects, but about 1% of children do subsequently develop epilepsy. This is more likely if the child has a longer than normal convulsion, or has recurrent seizures in the same illness [13]. An individual *and* family history of febrile convulsions may be significant in children who later exhibit problems of attention and in adults who suffer from panic disorder.

7.1.12 Question 17: Was There Any Sign of Infant Eczema or Asthma? Yes/No

Was There Any Sign of Allergic Responses? Yes/No

An allergic reaction occurs when the immune system identifies a normally harmless substance as a potential threat and reacts by producing antibodies. When an allergen (an irritant which stimulates the immune system to react) comes into contact with its antibody, it leads to the release of substances such as histamine, which are responsible for the allergic reactions, such as asthma, hay fever, eczema, or dermatitis.

In inhaled allergic reactions such as asthma and hay fever, the individual produces large amounts of reagin antibodies, which stick to mast cells in the mucosa so that when the antigen is inhaled, histamine is released from the mast cell. There are a vast number of potential inhaled allergens from pollen to dust mites, feathers to pesticides, and in some children, asthma only occurs when they have an infection or when they take vigorous exercise. Children who suffer from allergies also seem to be more prone to infection. Allergies are caused by a combination of genes and environment, and may well be a throwback to a time when we lived in closer proximity to creatures or substances that posed a real threat to life. Generations later, the immune system continues to react to relatively innocuous substances as if the danger is real.

Allergic reactions affecting the skin can either occur as a result of direct contact with an allergen such as washing powder, or can be symptomatic of problems in the gut. Inability of the gut to handle specific substances, gluten for example, can result in damage to the hair cells (villi), which line the gut and which normally help to move food down through the system. Damage to the lining of the gut wall can then result in a "leaky" gut when substances seep through the damaged lining and leak into the blood stream from where they act as toxins and stimulate the immune system to react. Problems with the gut can develop for a variety of reasons from enzyme deficiency, inability to break down certain proteins (such as gluten or casein), and absence of "friendly" bacteria in the gut, to name but a few. Babies who are breastfed are less likely to develop allergies even when there is a strong allergic tendency within the family.

Fitzgibbon [14] and others who specialize in the area of nutritional medicine also refer to the effect of biochemical problems on mood, energy, and behavior. Overproduction of histamine results in the release of opiate-like substances into the blood stream, which have an effect on mental processes as well as in producing physical symptoms. The effect of this potent cocktail on the child can be similar to an adult who is under the influence of alcohol or who is "stoned," and may go some way to explaining why many children suffering from allergies are tired, irritable, and "below par" much of the time, in addition to sleep being affected by itching skin, snuffles, or wheezing. Poor sleep can also affect growth because growth hormone is secreted during sleep.

Stress is also known to increase allergic reactions. Children who have a retained Moro reflex tend to be more prone to allergies. This is thought to be the result of heightened sensitivity and reaction to stress which is typical of the child with a retained Moro reflex [15] and which is accompanied by biochemical changes in response to stress. Cottrell [16] noticed that the frequency and intensity of asthma attacks was reduced in a small sample of patients after the Moro reflex was inhibited.

Allergic skin reactions that cannot be explained by direct skin contact with a known allergen can be symptomatic of biochemical imbalance. Vitamin and mineral analysis can help to identify whether low levels of minerals, trace elements, and EFAs are one source of the problem, and appropriate supplementation can often help to reduce the incidence of inflammatory reactions (zinc, e.g., is often used in skin creams and in topical applications for eczema, and EFAs have anti-inflammatory properties). Analysis and supplementation should only be carried out under professional supervision, but can be a useful avenue of investigation for children who suffer not only the misery of dry, inflamed, and infuriatingly itchy skin but also the secondary effects on concentration, sleep, and mood.

7.1.13 Question 18: Was There Adverse Reaction to Any of the Childhood Inoculations? Yes/No

The aim of the routine immunization schedule is to provide protection against the following vaccine-preventable infections: diphtheria, tetanus, pertussis (whooping cough), hemophilus influenzae type b (HIB), polio, meningococcal serogroup disease (MenC), measles, mumps, rubella, pneumococcal disease (certain serotypes), human papillovirus types 16 and 18 (also 6 and 11), rotavirus, influenza, and shingles (in adults).

The childhood vaccination program has virtually eliminated some of the most feared diseases of childhood from the past. As we have lost first-hand experience of those diseases, it is easy to become complacent about the very real risks they still pose if vaccination is not maintained. In the United Kingdom, all children start their immunization program at two months of age (Table 7.1).

The majority of children receive their vaccinations with little or no side effects. Occasionally, children may become ill following one of their vaccinations, and in rare cases may exhibit marked change in behavior and/or may regress developmentally. Whether vaccination acts as a trigger for developmental regression in these cases is controversial, but some authors maintain that "an autistic spectrum disorder (ASD) phenotype has recently been described that is associated with developmental/behavioural regression, enterocolitis and immune abnormalities [17, 18]. Parental reports from the UK and the US and elsewhere frequently cite exposure to the measles–mumps–rubella (MMR) vaccine as the trigger for their child's physical and behavioural deterioration" [19]. The reasons why MMR is a suspected cause of bowel problems in a very small number of children and not in others are not yet known, although various factors have been identified as potential risk factors. These include "familial autoimmunity, pre-existing dietary allergy/intolerance, vaccination with *MCV* while unwell (including current or recent antibiotic administration), and receipt of multiple simultaneous vaccine antigens with the associated potential for immunological interference, particularly for mumps and measles" [19]. The increasing number and concentration of vaccinations that a child receives in the first 18 months of life at a time in development when both the central nervous and immune systems are developing at a rapid rate may be "one shot too far" for children with an immature CNS or a sensitive autoimmune response. Further research is needed to identify common factors within the family and the

Table 7.1 Schedule for the United Kingdom's routine immunizations (excluding catch-up campaigns) (From September 2014).

Age	Vaccine	Method of administration
Two months	Diphtheria, tetanus, pertussis (whooping cough), polio, hemophilus influenzae type b (DTaP/IPV/HIB) Pneumococcal conjugate (PCV) Rotavirus	One injection One injection One oral application
Three months	Diphtheria, tetanus, pertussis, polio, and HIB (DTaP/IPV/HIB) Meningococcal C conjugate (MenC) Rotavirus	One injection One injection One oral application
Four months	Diphtheria, tetanus, pertussis, polio and HIB (DTaP/IPV/HIB) PCV	One injection One injection
Around 12 and 13 months (within a month of the first birthday)	HIB/MenC PCV MMR	One injection One injection
Three years, four months to five years	Diphtheria, tetanus, pertussis and polio (DTaP/IPV or dTaP/IPV) MMR	One injection One injection
Girls aged 12–14 years	Human papillomavirus (HPV)	Course of two injections at least six months apart
Around 14 years of age	Tetanus, diphtheria, and polio (Td/IPV) Td/IPV MenC conjugate	One injection One injection One injection
Adult program 65 years old	Pneumococcal polysaccharide (PVP)	One injection
65 years old and older	Influenza	One injection annually
70 years old	Shingles	One injection

MCV refers to measles containing vaccine.

developmental histories of the very small number of children who it is suspected have been adversely affected by vaccination to see if it is possible to identify susceptible children and to avoid suspected vaccine damage in the future.

In the case of premature infants, doctors in the United Kingdom are advised that premature infants have their immunizations at the appropriate chronological age, according to the schedule. It is acknowledged in the literature that the occurrence of apnea following vaccination is especially increased in infants who were born prematurely, with the risk increasing in infants born before 28 weeks gestation and premature infants with a history of respiratory immaturity [20].

7.1.14 Question 19: Did Your Child Have Difficulty Learning to Dress Him/Herself?

Learning to dress is a complex task requiring both gross and fine motor skills including balance, the ability to use one limb independently of the other, a sense of direction, and in the case of items such as shoes and socks, the ability to tell the difference between left and right. Added to this are fine motor skills of handling fasteners such as buttons and zips (involving visual near-point convergence), and eventually learning to tie shoelaces and a school tie (crossing the midline, bilateral integration, and the ability to follow sequential procedures).

Children learn to dress themselves in different stages and may initially start with the easier items, such as pulling on a tee shirt while sitting down. Dressing while standing up, for example, putting on a pair of trousers or a skirt, involves standing on one leg while lifting the other one and stepping into the item of clothing while holding the trousers or skirt with both hands—this requires sufficient ability to maintain balance on one side of the body without the need to use the upper body to help support balance, a surprisingly complex task. Very young children still use their arms to support balance. This process can be seen in reverse in the elderly when balance starts to deteriorate and they revert to sitting or using one hand to support themselves when getting dressed or undressed. Children who have immature balance often have difficulty with these everyday tasks.

Putting clothes on the right way round involves directional awareness—another spatial skill—and tying of shoelaces requires the two sides of the body to be able to carry out separate manipulations, cross over and reverse the final maneuver—in terms of brain functioning, this is a highly complex task involving bilateral integration, sequencing, and reversal. Tying of shoelaces becomes possible from about seven years of age (assuming the child has had instruction and practice).

Children with immature balance and motor skills are often later at learning to dress themselves and continue to experience difficulties with tying shoelaces, putting clothes on the right way round, and so on. This is a separate issue from the increasing number of children who are late at learning to dress themselves because busy working parents have not had the time to let their child go through the slower process of learning to dress by themselves, rather than doing it for them.

7.1.15 Question 20: Did Your Child Suck His/Her Thumb Through to Five Years or More? If so, Which Thumb? Right/Left

Many children continue to suck a thumb or fingers beyond the first two years of life, and non-nutritive sucking, whether it is on a dummy or the thumb or fingers, is developmentally normal in the early years. The question was originally inserted to establish *which* thumb the child chooses to suck. Children will usually select the thumb or fingers of the dominant hand [21], and at the time the questionnaire was devised, it was thought that if the asymmetrical tonic neck reflex (ATNR) was retained on the dominant side, a child might select the non-dominant thumb/fingers to suck as the ATNR would prevent bending the arm and bringing the hand to the mouth. However, the ATNR is normally present in the first four to six months of life on both sides and does not interfere with thumb sucking at that time. The action of sucking also has an inhibitory effect on the ATNR when the head is turned to one side and may therefore serve a useful purpose.

Some children continue to suck their thumb or fingers into later childhood (beyond five years). In some cases, retention of the infant rooting and suck reflexes can result in a continued need for oral stimulation and therefore prolonged sucking, which then becomes a habit. Sucking is both comforting and calming, and some children are unable to break the habit because the action of sucking provides an additional "feel good" factor. According to some cranial osteopaths, this can be true for children who have had a difficult birth, which has resulted in a degree of intracranial pressure. By exerting pressure with the thumb on the roof of the mouth using a cantilever action, the pressure of the thumb and sucking movements help to relieve cranial discomfort. The child is treating itself!

The action of sucking is also associated with increased visual convergence, drawing nearby objects into focus and blurring or distancing the greater world outside. This point was illustrated by a teacher who became exasperated by a 13-year-old boy in her class who continued to suck his thumb noisily all through her lessons. During one recreation period, she put her coffee on one side and went down to the bottom of the school garden, where she found a secluded spot and sat down to suck her thumb for five minutes. She described how the noise and bustle of the school playground in the distance receded; she felt more "centered" and could focus on objects at near distance more easily; most of all, she felt calm. Just as sucking is comforting in infancy, it is possible that it continues to fulfill a function in children who are visually stimulus bound or who have poorly developed near-point convergence at a later age.

7.1.16 Question 21: Did Your Child Wet the Bed, Albeit Occasionally, Above the Age of Five Years?

Developmental and neurological reasons for continued bed-wetting can be linked to a retained spinal Galant reflex in the older child. Stimulation of the lumbar region when shifting position at night or the pressure from the waistband of pajamas can be sufficient to stimulate the Galant and/or associated Pulgar Marx reflexes, which in turn stimulate micturition, which is under reduced cortical control during deep sleep. However, as mentioned in earlier chapters, the spinal Galant is not present in all children who experience nocturnal enuresis, and not all children who have a retained spinal Galant continue to wet the bed, but when bed-wetting and a retained spinal Galant reflex coexist, inhibition of the reflex through a reflex integration program is often followed by cessation of bed-wetting.

The sleep phases of young children also follow a different sequence and rhythm from the sleep phases of adults. Normal sleep consists of two types of sleep: rapid eye movement (REM) and non-REM (NREM) sleep. NREM comprises four electroencephalograph (EEG) (brainwave patterns) stages associated with increasingly deeper stages of sleep and reduced arousal. Newborn babies spend more time in REM sleep, and the transition from NREM sleep is less well defined. Sleep disorders including recurrent night terrors, sleepwalking, and some cases of nocturnal enuresis are thought to be connected to brainwave variations and differences in the way that the immature brain makes the transition from one sleep phase to another. In the waking state, brainwave variants affect attention and short-term memory.

Mature patterns of sleep normally start to develop over the first two to three years of postnatal life. Nightmares are particularly common from three to four years following scary stories, television, or computer games, because this age group does not easily differentiate between fantasy and reality. Overexcitement, fear, stress, and changing routine are all factors that can affect sleep cycles in young children at various times and are quite normal if linked to specific events. However, recurring sleep disorders such as regular night terrors, sleepwalking, and bed-wetting can occur when normal sleep cycles become disturbed, if brainwave activity is immature in the older child, or at times of stress.

Links between middle ear infections (otitis media) and bed-wetting among children are often overlooked as the two are viewed as separate disorders. Otitis media is common in young children and can occur as a secondary product of infection, resulting from inflammation of nasopharyngeal cavities (nose and soft palate), allergy, unusually small ear canals, or enlarged adenoids. Normally, the middle ear is ventilated at least three to four times a minute by swallowing, which maintains a normal state of pressure in the Eustachian tube (the tube between the nose and the ear). If a child has an immature swallow pattern (possibly as a result of retained rooting or infant suck reflexes), small particles of food or liquid can enter the nasopharyngeal cavity, increasing the susceptibility to infection.

Biologically, an association between upper airway obstruction and nocturnal enuresis could exist for several reasons. Obstructive sleep apnea interrupts sleep and may limit normal arousal and self-alerting mechanisms. Hormonal change [obstructive sleep apnea and lower levels of anti-diuretic hormone (ADH)] and increased intra-abdominal pressure have been suggested as possible factors.

Children who suffer from frequent ear and sinus infections, enlarged adenoids, and/or who snore are more likely to wet the bed. One theory is that breathing problems create a physical pressure in the abdomen, which stimulates urination. Another is that the breathing problems can lead to low blood oxygen concentrations, which can then affect the levels of hormones involved in urine production. There is an increased incidence of bed-wetting among children who snore [22], and studies have shown that when children had their adenoids or tonsils removed, bed-wetting ceased in 25% of the cases following surgery and in 50% within six months of surgery. Twelve children with secondary enuresis (onset of bed-wetting coincided with the development of upper airway obstruction) had all stopped bed-wetting at six months, and progress was maintained at 12 months [23].

7.1.17 Question 22: Does Your Child Suffer From Travel Sickness?

Motion sickness does not usually occur until the second year of life, after the child has learned to stand and walk. Susceptibility increases with age, tending to peak between 4 and 10 years of age and gradually decreasing thereafter [24]. Females tend to be more prone to motion sickness than males regardless of age and are more susceptible when taking oral contraceptives [25], during menses or pregnancy.

Many theories have been suggested as to the cause of motion sickness, but it is generally accepted that it occurs when there is a discrepancy in the timing and synchronicity of messages passing from different sensors involved in the perception of motion to the brain.

Three primary systems are involved in the perception of motion:

1) the balance mechanism in the inner ear (vestibular system);
2) feedback from the body via the muscles, tendons, and joints (proprioception); and
3) visual input.

Messages sent to the brain by these different systems inform the brain about the plane, direction, and degree of motion. When all three systems are in agreement, perception under conditions of motion remains relatively stable.

Motion sickness is caused if there is conflict between signals being received from the visual and vestibular systems, or between the two components of the vestibular system (semi-circular canals and otoliths), and comparison of those inputs with the individual's expectations derived from previous experience [26]. Mismatch in the timing of information being sent to the brain by the different motion receptors results in the onset of the physical sensations of motion sickness—dizziness, disorientation, initially warmth followed by cold sweats, nausea, and eventually vomiting. Nausea is thought to occur as a result of stimulation of axons of the vestibular nuclei which go to an area of the brainstem called the area postrema, which is an emetic (vomiting) center [27]. Symptoms can occur without the stimulus of actual bodily movement. For example, the visual stimuli alone provided by video games, simulators, and widescreen films can be sufficient to produce physical symptoms of motion sickness. When the British Broadcasting Corporation (BBC) changed its weather map to simulate movement around the map of the United Kingdom in 2006, a number of viewers wrote complaining of nausea simply as a result of watching the weather forecast! Symptoms of motion sickness are not confined to nausea and vomiting but can include drowsiness, headache, apathy, depression, and generalized discomfort [28].

Lawrence Beuret, who has specialized in the assessment and treatment of adolescents and young adults with neurodevelopmental problems, has observed that a history of motion sickness and/or regular headaches and drowsiness in response to motion, if it persists beyond puberty, is often a reliable indicator of immature postural mechanisms acting as causal factors in problems with higher-order learning processes and anxiety. The link to anxiety is significant because many of the physical sensations associated with anxiety are the same as those produced by motion sickness in response to desynchronization of messages received by the vestibular, visual, and proprioceptive systems. The significance of the overlap in both symptoms and trigger mechanisms will be explained further in Chapter 9 when we examine the effects of neurodevelopmental delay in adults.

Physical sensations associated with anxiety include increased heart rate (racing pulse), increased rate of breathing, sometimes leading to hyperventilation, sweating, and increased acid production in the stomach, leading to feelings of nausea and "jelly legs."

There can be many reasons for lack of integration in the functioning of motion sensory receptors in response to movement, which can stem directly from defects in specific receptors such as poor vision or disease of the labyrinth. People can be sensitive to movement in one plane of gravity only, being excellent travellers on land but as sick as a cat when they step onto a boat. This is because travel on water (and to a lesser degree by air) markedly increases stimulation of tilting motion. Modern high-speed trains also involve increased side-to-side tilting motion. Some people experience a mild degree of motion sickness when travelling in the back of a car but have no problem when they are front-seat passengers. This is because when seated at the back, there is increased stimulation to peripheral vision but reduced frontal vision. Frontal vision is normally used to match visual signals to the stimulation received by the vestibular and proprioceptive receptors. Others are only free from symptoms of motion sickness when they are driving. This is because the driver receives additional proprioceptive input, which is matched to cortical intent (anticipation and motor planning). Increased stimulation to one type of receptor can increase or decrease the experience of motion sickness.

Many children experience mild degrees of motion sickness at some stage in middle childhood, which settles down following major periods of myelinization that occur between six and a half and eight years of age, and again around the time of puberty. If motion sickness has been severe and persistent in early childhood in the absence of other causal factors or continues beyond puberty, then it can be indicative of underlying postural problems and lack of vestibular–proprioceptive–visual integration.

7.2 Schooling

7.2.1 Question 23: When Your Child Went to the First Formal School, that is, Infant School, in the First Two Years of Schooling, Did He/She Have Problems Learning to Read?

There is a big variation in the age at which children learn to read. Some children are able to make sense of words before their fifth birthday, while others may be approaching seven before reading starts to take off.

The National Curriculum in some parts of the United Kingdom insists that all children are taught to read at the same age, and much of subsequent teaching and educational assessment is built upon the premise that chronological age is consistent with reading level. This policy condemns some children to underachievement from the moment they enter school.

Rudolf Steiner, Maria Montessori, Louise Bates Ames, and other experts in child development and education, all recognized that chronological age is not the only deciding factor in reading readiness. Neurological and physiological development are of equal importance, and a number of people have suggested that true readiness for reading coincides with the timing of the shedding of the first milk teeth, which usually occurs at about six years of age. Children seen at the INPP with neurodevelopmental issues are often late in shedding their first milk teeth, suggesting that developmental delay affects more than simply the functioning of the nervous system.

Delay in motor development also affects far more than the coordination needed for catching a ball. Motor skills extend from control of posture and balance through to the eye control needed to maintain focus on one part of a page (fixation), for the two eyes to fuse the two separate images seen by each eye into one clear image (convergence), for the eyes to follow along a line of print without jumping ahead to the line below or the line above (saccades), and the ability to adjust focusing distance at speed (accommodation). The visual system depends on postural mechanisms and motor skills to support the visual skills needed for reading. Children who have immature postural control frequently exhibit immaturity in the oculomotor skills necessary for reading.

Reading is also connected to hearing. The English language, in particular, requires the ability to match visual recognition of a symbol to the sounds that the symbol represents (phonological awareness). Unless a child can *hear* the difference between *b* and *d, m*, and *n*, the rules of spelling in the English language are meaningless. Symbols such as *b* and *d, p*, and *q* only face in different directions on the basis of the fact of the individual letter *sounds* that they represent. Children who have difficulty with auditory discrimination (being able to hear the difference between similar sounds such as *d* and *t, s* and *f*, and *f* and *th*) will often substitute the wrong letter for a similar sound. No amount of teaching will help them to understand the mistake, unless they can hear the difference themselves.

Reading is also a directional skill. You will remember that a cognitive sense of direction is linked to secure knowledge of where the body is in space (vertical orientation). Children with poor balance and body control also often have poorly developed cognitive directional skills. The *b* or *d* dilemma can arise from directional as well as, or as a result of, hearing discrimination problems.

Finally, learning to read is closely linked to developmental readiness in terms of physical abilities. If a child is still struggling to learn to read by the age of 7 years, physical factors should always be investigated. Ideally, these should include eliminating any problems with eyesight (optometrist), oculo*motor* functioning and postural control (neurodevelopmental practitioner), and hearing including *auditory discrimination*.

Standard audiometric tests will identify hearing deficit, but more detailed tests are needed to identify problems with auditory discrimination *and* auditory processing.

7.2.2 Question 24: In the First Two Years of Formal Schooling Did He/She Have Problems Learning to Write? Did He/She Have Problems Learning to Do "Joined Up" or Cursive Writing?

All of the developmental factors listed under reading also apply to writing: posture, balance, fine motor skills, visual functioning, and hearing. However, there is an additional component added to writing—the need to use the hands *and* the eyes together. Some children can control the eye movements necessary for reading through the process of conscious compensation as long as they only have to use their eyes. When control of the hand is added to the task, they cannot get eyes and hand to work together (visual–motor integration), resulting in a discrepancy between verbal performance (oral), reading age, and written performance.

7.2.3 Question 25: Did He/She Have Difficulty Learning to Tell the Time from a Traditional Clock Face as Opposed to a Digital Clock?

Most children learn to tell the time using an analogue (as opposed to a digital) clock at some time between their seventh and ninth birthdays. Learning to tell the time using a traditional clock is a spatial skill—a child needs to be able to see the difference between up and down, left and right, before and after, big and little—as well as to recognize the numbers on the clock face. Spatial skills, like directional skills, are supported by secure knowledge of one's own position in space (postural control). Children who have immature balance and posture are often delayed in learning to tell the time.

7.2.4 Question 26: Did He/She Have Difficulty Learning to Ride a Two-wheeled Bicycle?

Children usually master riding a bicycle without stabilizers sometime between their sixth and eighth birthdays. Riding a bicycle combines a number of physical skills: children must find their center of balance and must be able to control it over a narrow base of support. They must be able to keep their upper body in one position, while getting their two legs to move from opposing positions. They must also be able to turn their arms in either direction without losing their balance and to look at where they are going. In the early stages of learning to ride, balance is easier to control once the child starts to move, but wobble sets in when he or she stops, sets off, or slows down. This is because speed helps to compensate for insecure balance, and children with poor balance control will often use speed at the expense of accuracy in other situations such as sports, or when writing, to compensate for the underlying dysfunction.

> *In the Netherlands and in some other parts of Europe, children learn earlier as bicycles are more widely used for transport.*

Being late at learning to ride a bicycle (assuming the opportunity to learn has been available) may be an indication of immature balance, postural control, and motor skills including difficulty in getting the two sides of the body to carry out separate tasks (bilateral integration). Several retained primitive and underdeveloped postural reflexes are implicated in the difficulty of learning to ride a bicycle.

7.2.5 Question 27: Was or Is He/She an Ear, Nose, and Throat (ENT) Child, that is, Suffer Numerous Ear Infections, Is a "Chesty" Child or Suffer from Sinus Problems?

Most children will suffer from colds, coughs, and the occasional chest or ear infection in the first seven years of life. Minor illnesses are probably quite important in exposing the immune system to a range of germs and in building up resistance so that when we meet the same or similar enemies later in life, the immune system can launch an effective defense. *Frequent* ENT infections, on the other hand, can have an effect not only on hearing at the time, but also on the child's auditory processing later on.

Otitis media or infection of the middle ear usually occurs as a result of infection spreading up into the Eustachian tubes from the nose, throat, or one of the sinuses. In other words, it usually develops as a secondary consequence of a cold, enlarged tonsils (which are the first line of defense for germs entering the upper respiratory tract), sinusitis, or enlarged and infected adenoids. Ear infections are usually accompanied by throbbing or acute pain, deafness, and tinnitus, which either occur during the acute phase of the infection or during the recovery phase. Treatment is usually with antibiotics, but persistent and recurring infections may require more radical treatment such as minor surgery to perforate the ear drum, to relieve pressure, and to drain fluid; insertion of grommets to improve ventilation of the middle ear and to prevent future build-up of fluid; or, in cases where infected, inflamed, or enlarged adenoids are thought to be contributing, adenoidectomy and/or tonsillectomy.

While treatment with antibiotics or surgery may solve the problem in the short term, the longer-term effects of repeated ENT infections can be more widespread. Hearing can be impaired for up to eight weeks after the acute period of infection has cleared up. It is in the first three years of life that children learn to “tune in” to the sounds that are specific to their mother tongue. This is one of the “sensitive periods” or developmental windows for learning and for practicing the sounds of speech. Frequent or prolonged periods of intermittent deafness resulting from congestion or infection can have an effect on the child’s ability to discriminate between similar sounds later on. When tested on a standard hearing test, hearing levels may be found to be within the normal range, but the *brain’s* ability to hear the fine-tuning differences can be impaired, particularly to sounds in the higher frequencies such as *s* and *f, sh*, and *ch*.

It is also during the early years that children learn to orient to sound (localization), to “switch off” attention to unwanted sounds, and to focus attention on specific sounds. Paradoxically, some children who have had frequent ENT infections in the early years appear to be *hyper*sensitive to certain sounds at an older age, presumably because they could not hear them during periods of infection or postinfection and did not develop an adequate mechanism to shut them out or to dampen them down at the time. Both hearing impairment and hypersensitivity (hyperacusis) can cause problems with effective listening, attention, and also potentially speech and language later on. French ENT surgeon Guy Berard, who developed the method of sound therapy known as auditory integration training (AIT), said that “hearing equals behaviour” [29].

Why might a history of repeated ENT infections have an impact on balance and behavior?

Physiologically, balance and hearing have a number of pathways in common: both the vestibular apparatus (balance) and the cochlea (hearing) are located in the bony labyrinth of the inner ear; sensory information from both vestibular and hearing systems is transmitted to other centers using the same cranial nerve—the eighth—or vestibular–acoustic cranial nerve; both share the same fluid—the endolymph—which is set into motion by movements of the head (vestibular stimulation and low-frequency vibration [30]) or vibrations which fall within the frequency range of the cochlea (hearing).

Both systems are involved in orientation. The vestibular system informs the brain about *internal* equilibrium based upon position and movements of the head, while the auditory system detects and locates external acoustic stimuli. Balance functions in cooperation with vision in response to external stimuli that fall within the range of vision (to the front and the periphery); hearing supports balance in alerting us to external stimuli that occur outside of the range of vision, particularly behind and beyond peripheral vision. The location of external auditory stimuli depends upon the difference in timing in the reception of auditory stimuli in each ear. Hearing impairment in *one* ear can therefore affect the ability to locate accurately the source of sound. Hearing impairment in both ears can affect awareness of events outside of the field of vision, particularly behind the self. This can clearly be seen when hearing becomes impaired in old age and the elderly person is unaware of the presence of people behind them or trying to walk past them in a busy street. Posture and gait can also become affected by hearing impairment or loss of external auditory stimuli. The latter can be observed in people using personal stereos or iPods when walking down the street. Head position, rhythm of movements, and the part of the foot placed on the supporting surface alter, affecting the walk.

Pressure resulting from middle ear infection, glue ear, or Eustachian tube congestion alters the flexibility and response of the ear drum, reducing hearing sensitivity, and also causing pain, discomfort, reduced sensitivity to external acoustic stimuli, and increased sensitivity to internal sensation. This can result in a child who feels generally miserable, out of sorts, and who has difficulty in understanding what is being said.

Otitis media can affect taste and smell (affecting eating habits), breathing (mouth breathers), quality of sleep, and speech development as well as hearing. Children with impaired hearing do not hear instructions clearly the first time and often respond adversely to the raised tone of voice used when the instruction has to be repeated. This can make for a child who appears to be slow at following instructions and who is over-reactive and argumentative when the instruction is given a second time.

Continuous nasal congestion affects sleep and over a long period of time can have an impact on growth, because growth hormone is secreted at night and during sleep. Use of steroids and stimulants (Ventolin) for the treatment of upper respiratory tract infections and asthma can increase heart rate and can result in generalized over-arousal in susceptible children.

7.2.6 Question 28: Does/Did Your Child Have Difficulty Catching a Ball?

To catch a ball, the eyes need to be able to track a moving object approaching at speed. This involves the combined visual skills of convergence, divergence, and accommodation. When the eyes focus on an object at near distance, both eyes must converge on the object—this "fuses" the two single objects seen by each eye into one, so that the brain can see one clear, single image. When focus must be adjusted to further away, the eyes have to break out of convergence (diverge) to take in a wider visual field before converging again at the new focal distance. The ability of the eyes to converge/diverge/converge at speed is called accommodation and is necessary to adjust visual focusing at speed. This ability is needed for many activities such as driving, copying from a blackboard or from a book, or tracking an object approaching at speed.

For those children who have difficulty tracking a fast approaching object, by the time focus has been readjusted, it is too late to bring the hands together to catch the ball and they either miss the ball entirely, drop it, or let it fly past them. In some cases, the child is startled when it finally manages to visually "place" the ball at the split second before it hits them, and instead of bringing the hands together to catch it, the hands are used in a defensive action, repelling the ball, or if the Moro reflex is retained, the arms abduct. The same child may have no difficulty in throwing a ball accurately, because the target can be visually placed *before* the ball leaves the hand.

For slightly different reasons, kicking a ball can be a problem. Kicking involves standing on one leg and swinging the other one without falling over. This only becomes possible when a child has developed sufficient control of static balance to be able to stand on one leg combined with independent use of either side of the body. As with all the other questions in the preceding text, difficulty in catching or kicking a ball might provide one indication that control of eye movements and/or balance are not commensurate with chronological age.

7.2.7 Question 29: Is Your Child One Who Cannot Sit Still, that is, Has "Ants-in-the-Pants" and Is Continually Being Criticized by the Teachers?

The most advanced level of movement control is the ability to stay totally still (N. Rowe, personal communication). Stillness requires control of static balance, posture, and freedom from the need to use movement or other parts of the body to support posture. Children who cannot sit still may be fidgety for a variety of reasons: boredom, difficulty maintaining attention, distractibility, or immature control of static balance and of the postural mechanisms that support balance.

7.2.8 Question 30: Does Your Child Make Numerous Mistakes When Copying from a Book?

The most common causes of mistakes when copying are lack of attention or immature eye movements. As discussed in the sections in the preceding text relating to reading and writing, convergence, tracking, and *accommodation* are necessary to adjust focusing and to maintain visual attention.

7.2.9 Question 31: When Your Child Is Writing an Essay or News Item at School, Does He/She Occasionally Put Letters Back to Front or Miss Letters or Words Out?

7.2.9.1 Letter and Word Reversals and/or Omissions

Many children reverse letters and numbers in the early stages of learning to write, and the problem seems to be more prevalent among left-handed children, probably because the direction of western script (right to left) favors the right-handed child from a purely mechanical point of view. As children become more fluent at both the recognition and forming of letters, reversals and omissions decrease, so that the direction and sequence of letters should be stable by about eight years of age. If letter, number, or word reversals, omissions, or mirror writing persist beyond eight years of age, they are usually a sign of a dyslexic-type specific learning difficulty and further assessment by an educational psychologist should be sought.

Although reversals and omissions can point to a specific learning difficulty at an earlier age, there is a neurological reason why they are not considered a definitive sign before eight years of age. The nervous system of the child goes through periods of increased myelinization at key stages in development. These are the first year of life, years one to three, six and a half to eight years, puberty, and again in the early to mid-20s. At the same time that myelinization is taking place, the brain also goes through a period of neural "spring cleaning," when pathways and cells that are not commonly used are allowed to die off while connections between others are strengthened. This pruning or clearing of neural clutter is similar to the neurological equivalent of tidying your bedroom—the less you have, the easier it is to find what you need.

If children are still showing signs of difficulty above eight years of age, it may suggest a number of unresolved problems which require further investigation:

1) *Directionality*—this is a spatial skill partly dependent on the efficient functioning of the vestibular–cerebellar loop and its related pathways.
2) *Immaturity* in the development of eye movements necessary for reading and writing. This can be the result of a specific oculomotor problem but is often connected to existing problems with balance and coordination, because balance provides the platform on which stability of eye movements depends.

3) *Phonological processing* problems. The child may have difficulty with auditory *discrimination* (hearing the difference between similar letter sounds) or *speed of auditory processing,* which is a factor in being able to hear individual sounds within a word, particularly vowel sounds. Timing is also important because the difference between the brain hearing a sound as *d* or as *t* is a difference of just 40–60 milliseconds in the timing of the onset and offset of the first and second bursts of sound. Children can also have problems with *locating* sounds (orientation), filtering out background noise, and *hyperacusis* (hypersensitivity). Any one or a combination of these can cause difficulty in the accurate decoding of auditory information or the translation of sounds into the correct visual symbol.

7.2.10 Question 32: If There Is a Sudden, Unexpected Noise or Movement, Does Your Child Over-React?

Some children are hypersensitive to sound or to specific sound frequencies. There can be many reasons for hypersensitivity, and *hyperacusis* is particularly prevalent in children diagnosed with autistic spectrum disorder. As with many other questions on the INPP questionnaire, hyperreactivity to sound can be both a cause of other learning and behavioral problems and/or symptomatic of an existing underlying disorder.

Children who have a history of intermittent conductive hearing loss due to middle ear infections are sometimes hypersensitive to the frequencies that have been impaired as a result of a period of infection. This is thought to be because the normal protective mechanisms against loud or unwanted sounds which develop in the first months of life (acoustic stapedius reflex) are not required at the same level of sensitivity when hearing is impaired. When hearing is restored, the protective mechanism is underdeveloped and the child has reduced tolerance for certain sounds.

> Hyperacusis *is defined an inability to tolerate everyday sounds. People with hyperacusis may find that certain sounds are more difficult to listen to than others, and some sounds may cause pain in the ears, even when those sounds do not bother others. Often, the most disturbing or painful sounds can be sudden high-pitched noises like alarms, bus brakes, silverware and dishes, children's screams and clapping. Sometimes, hyperacusis can be so severe that people avoid public or social settings.*
>
> *Source*: http://health.groups.yahoo.com/group/HyperacusisSupport

Individuals who have a retained Moro reflex tend to have increased sensitivity to sudden loud noises. Auditory sensitivity resulting from a retained Moro reflex can be helped in two ways: (1) a reflex stimulation and inhibition program, which helps to reduce overreaction to sounds and increases cortical involvement in the perception of sensory stimuli; and (2) an auditory training program, which can help to reduce sensitivity to specific frequencies and to improve the functioning of the acoustic stapedius reflex.

7.3 Scoring the INPP Questionnaire

Each numbered question on the questionnaire is given a score of 0 or 1.

0 = negative response to the question (*no*)

1 = positive response to the question (*yes*)

Maximum possible score = 32/32.

Minimum score = 0/32.

Although there are a number of sub-questions included under the main numbered questions, a score is only assigned for each *numbered question*. No additional score is given for the sub-questions, irrespective of the number of additional factors/sub-questions present within each numbered question.

The total number of positive answers is then added up. If a child scores 7 or more positive answers, it indicates that it is highly probable that further investigations/assessment of neurodevelopmental status will provide evidence of neurodevelopmental delay. The questionnaire should *not* be used in isolation as a diagnostic device. It should *only* be used as *an initial screening tool* to ascertain whether further investigations or referral should be carried out.

7.4 Research into the Reliability of the INPP Questionnaire

An abridged version of a study carried out in 1997 is included in Appendix 1. This study (reproduced with the permission of the *British Journal of Occupational Therapy* [31]) compared the early developmental profiles of 70 children aged 8–10 years who had developed problems with reading, writing, and/or copying with 70 children of the same age who had no problems with reading, writing, or copying using the INPP Screening Questionnaire. The study showed clear differences in the developmental history of children who had later developed reading, writing, or copying problems compared to children of the same age who had no specific learning difficulties.

Differences were present, not only in the total number of positive answers obtained for the group with specific learning difficulties—all total scores for this group were greater than 6, with some children scoring more than 12, whereas none of the comparison group scored more than 4—but also differences on individual questions. The results of the differences on individual criteria between the two groups can be seen in Tables A1 and A2 in Appendix 1. Certain criteria, such as being late at learning to walk and being late at learning to talk, were present in more than 40% of the sample with educational difficulties, but were not present in *any* of the comparison group.

A subsequent unpublished analysis of the screening questionnaire involving 87 children who had received a diagnosis of either dyslexia, DCD, ADD, ADHD, Asperger's syndrome, or ASD who were later seen at INPP and all of whom scored >7 "yes" answers on the INPP questionnaire, identified the following factors as being present in more than 50% of the sample [32]:

Criteria present in more than 50% of the sample	**Possible related factors**
Family history	Heredity or "modeling" of behavioral patterns
Medical problems during pregnancy	
Unusual appearance or need for special care following birth	Possible birth trauma
History of early feeding problems	Motor or nutritional
History of illnesses involving very high temperatures in the first 18 months	
Difficulty learning to dress	Balance, fine motor, spatial
Difficulty sitting still	Static balance, postural stability, cortical inhibition
Difficulty learning to tell the time using an analogue clock	Spatial
Difficulty catching a ball	Hand–eye coordination; visual accommodation
History of letter, number, or word reversals when writing	Spatial/directional; auditory processing; visual tracking
Hypersensitive to certain sounds	Auditory

This analysis was not submitted to statistical analysis and did not include a comparison group; therefore, the criteria in the preceding text should be treated with caution and should not be seen as indicative of *causal* factors. However, it does reveal the multifactorial nature of underlying factors present in specific learning difficulties. In addition to criteria present in more than 50% of the sample individual factors were of interest. For example, 10% of the sample had been conceived as a result of IVF. Taking into consideration that the sample represented a group of children already diagnosed as having problems, 10% seems to be quite a high incidence. Nearly 40% had omitted the developmental stage of crawling, more than 30% had a history of delayed speech, and 20% were late at learning to walk. Further research involving larger numbers and comparison groups is needed to reach conclusions about the significance of these individual factors.

In an earlier analysis of developmental factors using the INPP questionnaire, Beuret found that the time of emergence of specific learning difficulties or symptoms of an emotional nature varied according to whether adverse events had occurred in pregnancy or during the birth process. He noticed that children who had a difficult birth were more likely to show up as having specific learning difficulties in the first 10 years of life. Children whose mothers had had medical problems during the pregnancy but had given birth without difficulty were less likely to show signs of specific learning difficulties in the childhood years, but were more likely to develop problems in late secondary school or higher education, and were more prone to suffer the effects of stress [33]. While differences on individual criteria on the questionnaire suggest various trends, they should not be used in isolation for predictive or diagnostic purposes. The *total* score on the questionnaire provides the most accurate indication of underlying neurodevelopmental problems.

Before turning our attention to the problems that can emerge in adolescence and in adult life as a result of neurodevelopmental issues, it is necessary to examine the role of the vestibular–cerebellar system in further detail. Because this system is so closely connected to the functioning of balance, posture, coordination, and emotional functioning, and has been the subject of a number of discoveries, theories, and approaches over the last 200 years, the next chapter focuses on the history of the development of a vestibular–cerebellar theory and its implications for treatment.

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