Children acquire functional skills throughout childhood. The term ‘child development’ is used to describe the skills acquired by children between birth and about 5 years of age, when there is a rapid progress in mobility, speech and language, communication and independence skills. During school age, evidence of developmental progression is predominantly through cognitive development, abstract thinking and skills of conceptualisation, although there is also some further maturation of early developmental skills.

Normal development in the first few years of life is monitored:
- by parents, who are provided with guidance about normal development in their child’s personal child health record
- at regular child health surveillance checks
- whenever a young child is seen by a health care professional, when a brief opportunistic overview is made.

The main objective of assessing a young child’s development is the early detection of delayed or abnormal development in order to:
- help children achieve their maximum potential
- provide treatment or therapy promptly (particularly important for impairment of hearing and vision)
- act as an entry point for the care and management of the child with special needs.

This chapter covers normal development, whilst delayed or abnormal development and the child with special needs are considered in Chapter 4.

### Influence of heredity and environment

A child’s development represents the interaction of heredity and the environment on the developing brain. Heredity determines the potential of the child, while the environment influences the extent to which that potential is achieved. For optimal development, the environment has to meet the child’s physical and psychological needs (Fig. 3.1). These vary with age and stage of development:
- infants are totally physically dependent on their parents and require a limited number of carers to meet their psychological needs
- primary school age children can meet some of their physical needs and cope with many social relationships
- adolescents are able to meet most of their physical needs while experiencing increasingly complex emotional needs.
There are four fields of developmental skills to consider whenever a young child is seen (Fig. 3.2). These are:

- gross motor
- vision and fine motor
- hearing, speech and language
- social, emotional and behavioural.

Gross motor skills are the most obvious initial area of developmental progress. As fine motor skills require good vision, these are grouped together; similarly, normal speech and language development depends on reasonable hearing and so these are also considered together. Social, emotional and behavioural skills are a spectrum of psychological development.

The acquisition of developmental abilities for each skill field follows a remarkably constant pattern between children, but may vary in rate. It is like a sequential story. Thus the pattern of acquisition of skills:

- is sequentially constant
- should always be considered longitudinally.

A deficiency in any one skill area can have an impact on other areas. For instance, a hearing impairment may affect a child’s language, social and communication skills and behaviour. As a child grows, additional skills become important, such as attention and concentration and how an individual child manages to integrate his skills.

**Developmental milestones**

Chronological age, physical growth and developmental skills usually evolve hand in hand. Just as there are normal ranges for changes in body size with age, so there are ranges over which new skills are acquired. Important developmental skills are called developmental milestones.

When considering developmental milestones:

- The **median age** is the age when half of a standard population of children achieve that level; it serves as a guide to when stages of development are likely to be reached but does not tell us if the child’s skills are outside the normal range.
- **Limit ages** are the age by which they should have been achieved. Limit ages are usually 2 standard deviations from the mean. They are more useful as a guide to whether a child’s development is normal than the median ages. Failure to meet them gives guidance for action regarding more detailed assessment, investigation or intervention.

**Median and limit ages**

The difference between median and limit ages can be demonstrated by considering the age range for the important developmental milestone of walking unsupported. The percentage of children who take their first steps unsupported is:

- 25% by 11 months
- 50% by 12 months
75% by 13 months
90% by 15 months
97.5% by 18 months.

The median age is 12 months and is a guide to the common pattern to expect, although the age range is wide. The limit age is 18 months (two standard deviations from the mean). Of those not achieving the limit age, many will be normal late walkers, but a proportion will have an underlying medical problem, such as cerebral palsy, a primary muscle disorder or global developmental delay. A few may be understimulated from social deprivation. Hence, any child who is not walking by 18 months should be assessed and examined. Thus 18 months can be set as a 'limit age' for children not walking. Setting the limit age earlier may allow earlier identification of problems, but will also increase the number of children labelled as 'delayed' who are in fact normal.

Variation in the pattern of motor development

There is variation in the pattern of motor development between children. For example, normal motor development is the progression from immobility to walking, but not all children do so in the same way. Whilst most achieve mobility by crawling (83%), some bottom-shuffle and others crawl with their abdomen on the floor, so-called commando crawling (creeping) (Fig. 3.3). A very few just stand up and walk. The locomotor pattern (crawling, creeping, shuffling, just standing up) determines the age of sitting, standing or walking.

The limit age of 18 months for walking applies predominantly to children who have had crawling as their early mobility pattern. Children who bottom-shuffle or commando crawl tend to walk later than crawlers, so that within those not walking at 18 months there will be some children who demonstrate a locomotor variant pattern, with their developmental progress still being normal. For example, of children who become mobile by bottom-shuffling, 50% will walk independently by 18 months and 97.5% by 27 months of age, with even later ages for those who initially commando crawl.

Adjusting for prematurity

If a child has been born preterm, this should be allowed for when assessing developmental age by calculating it from the expected date of delivery. Thus the anticipated developmental skills of a 9-month baby (chronological age) born 3 months early at 28 weeks’ gestation are more like those of a 6-month baby (corrected age). Correction is not required after about 2 years of age when the number of weeks early the child was born no longer represents a significant proportion of the child’s life.

Is development normal?

When evaluating a child’s developmental progress and whether it is normal or not:

- Concentrate on each field of development (gross motor; vision and fine motor; hearing and speech/language; social, emotional and behavioural) separately.
- Consider the pattern of development reached by thinking longitudinally about each developmental field. Ask about the sequence of development already achieved as well as those skills to be anticipated shortly.
- Determine the stage the child has reached for each skill field.
- Relate the progress of each developmental field to the others. Is the child progressing similarly through each skill field, or does one or more field of development lag behind the others?
- Then relate the child’s developmental achievements to his age (chronological or corrected).

This will enable you to decide if the child’s developmental progress is normal or delayed. Normal development implies steady progress in all four developmental fields with acquisition of skills occurring before recognised limit ages are reached. If there is developmental delay, does it affect all four developmental fields (global delay), or one or more developmental field only (specific developmental delay)? As children grow older and acquire further skills, it becomes easier to make a more accurate assessment of their abilities and developmental status.

Figure 3.3 Early locomotor patterns. Most children crawl on all fours en route to walking, but some 'bottom-shuffle' and others 'commando crawl' (creep). Bottom-shuffling often runs in families, but the late walking that often goes with the locomotor variant needs to be differentiated from an abnormality such as cerebral palsy.
Normal child development

Assessing child development
When assessing a young child’s development:
- consider the four fields of developmental skills – gross motor; vision and fine motor; hearing and speech/language; social, emotional, behavioural
- the acquisition of developmental abilities follows a similar pattern between children, but may vary in rate, and still be normal.

Terms used are:
- developmental milestones: the acquisition of important developmental skills
- median age: when half the population acquire a skill; serves as a guide to normal pattern of development
- limit age: when a skill should have been acquired; further assessment is indicated if not achieved.

When evaluating a child’s development, consider:
- the stage the child has reached for each skill field
- the sequence of developmental progress
- if progress is similar in each skill field
- how the child’s developmental achievements relate to age.

Pattern of child development
This is described in detail for each field of development, including key developmental milestones and limit ages:
- gross motor development (Fig. 3.4 and Table 3.1)
- vision and fine motor (Fig. 3.5)
- hearing, speech and language (Fig. 3.6)
- social, emotional and behavioural (Fig. 3.7).

In order to screen a young child’s development, it is necessary to know only a limited number of key developmental milestones and their limit ages.

Cognitive development
Cognition refers to higher mental function. This progresses with age. In infancy, thought processes are centred around immediate experiences. The thought processes of preschool children (which have been called preoperational thought by Piaget), tend to be:
- that they are the centre of the world
- that inanimate objects are alive and have feelings and motives
- that events have a magical element
- that everything has a purpose. Toys and other objects are used in imaginative play as aids to thought to help make sense of experience and social relationships.

In middle school children, the dominant mode of thought is practical and orderly, tied to immediate circumstances and specific experiences. (This has been called operational thought.)

It is only in the mid-teens that an adult style of abstract thought (formal operational thought) begins to develop, with the ability for abstract reasoning, testing hypotheses and manipulating abstract concepts.

Intelligence testing (IQ)
Cognitive function can be assessed objectively by formal IQ tests but disadvantages are that the tests:
- may be affected by cultural background and linguistic skills
- do not test all skill areas
- do not necessarily reflect an individual child’s ultimate potential
- may be compromised by individual disabilities, such as a motor disorder as in cerebral palsy, necessitating care in interpreting results.

‘Performance’ or ‘non-verbal’ intelligence tests assess abilities independent of language. ‘Verbal’ intelligence tests, especially those for younger children, reflect general intellectual skills, particularly relating to language. Performance and verbal intelligence testing allows formulation of a performance IQ (PIQ) and verbal IQ (VIQ) which together give an overall IQ figure. Children with disabilities may have problems such as with speech or hand skills that may compromise testing so that results in these situations have to be interpreted with care.

### Summary
Assessing child development
When assessing a young child’s development:
- consider the four fields of developmental skills – gross motor; vision and fine motor; hearing and speech/language; social, emotional, behavioural
- the acquisition of developmental abilities follows a similar pattern between children, but may vary in rate, and still be normal.

Terms used are:
- developmental milestones: the acquisition of important developmental skills
- median age: when half the population acquire a skill; serves as a guide to normal pattern of development
- limit age: when a skill should have been acquired; further assessment is indicated if not achieved.

When evaluating a child’s development, consider:
- the stage the child has reached for each skill field
- the sequence of developmental progress
- if progress is similar in each skill field
- how the child’s developmental achievements relate to age.

### Table 3.1 Some primitive reflexes present at birth. (These should disappear by 4–6 months)

<table>
<thead>
<tr>
<th>Reflex – mode of eliciting it</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moro – sudden head extension</td>
<td>Symmetrical extension, then flexion of all limbs</td>
</tr>
<tr>
<td>Grasp – an object is placed in the palm at the base of the fingers</td>
<td>Flexion of the fingers of the hand</td>
</tr>
<tr>
<td>Rooting – stimulus near the mouth</td>
<td>Turning of the head towards the stimulus</td>
</tr>
<tr>
<td>Placing – infant held vertically and the dorsum of the feet brought into contact with a surface</td>
<td>Lifts first one foot, placing it on the surface, followed by the other</td>
</tr>
<tr>
<td>Positive supporting reflex – infant held vertically, feet on a surface</td>
<td>Legs take body weight, may push up against gravity</td>
</tr>
<tr>
<td>Atonic neck reflex (ATNR) – lying supine, the head is turned by the examiner to one side</td>
<td>Infant adopts a ‘fencing’ posture, with the arm outstretched on the side to which the head is turned</td>
</tr>
</tbody>
</table>
Figure 3.4 Gross motor development (median ages).
<table>
<thead>
<tr>
<th>Age</th>
<th>Skill Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 weeks</td>
<td>Newborn – follows face in midline. Follows moving object or face by turning the head (illustrated).</td>
</tr>
<tr>
<td>6 months</td>
<td>Palmar grasp</td>
</tr>
<tr>
<td>7 months</td>
<td>Transfers toys from one hand to another</td>
</tr>
<tr>
<td>10 months</td>
<td>Mature pincer grip</td>
</tr>
</tbody>
</table>
| 14 months–4 years | Tower of three (18 months)  
|             | Tower of six (2 years)                                                          |
|             | Tower of eight or a train with four bricks (2 1/2 years)                        |
|             | Bridge (from a model) 3 years                                                   |
|             | Steps (after demonstration) 4 years                                             |
| 16–18 months | Makes marks with a crayon                                                       |
| 2–5 years | Line 2 years  
|             | Circle 3 years                                                                  |
|             | Cross 4 years                                                                   |
|             | Square 4 1/2 years                                                              |
|             | Triangle <5 years                                                               |

Figure 3.5 Vision and fine motor skills (median ages).
Hearing, speech and language (median ages)

**NEWBORN**
- Startles to loud noises

**3–4 MONTHS**
- Vocalises alone or when spoken to, coos and laughs

**7 MONTHS**
- Turns to soft sounds out of sight

**7–10 MONTHS**
- At 7 months, sounds used indiscriminately. At 10 months, sounds used discriminately to parents

**12 MONTHS**
- Two to three words other than 'dada' or 'mama'

**18 MONTHS**
- Where is your nose?
- 6–10 words. Shows two parts of the body

**20–24 MONTHS**
- Give me teddy
- Uses two or more words to make simple phrases

**2½–3 YEARS**
- Push me fast daddy
- Talks constantly in 3–4 word sentences

*Figure 3.6* Hearing, speech and language (median ages).
Social, emotional and behavioural development (median ages)

6 WEEKS
Smiles responsively

6–8 MONTHS
Puts food in mouth

10–12 MONTHS
Waves bye-bye, plays peek-a-boo

12 MONTHS
Drinks from a cup with two hands

18 MONTHS
Holds spoon and gets food safely to mouth

18–24 MONTHS
Symbolic play

2 YEARS
Dry by day. Pulls off some clothing

3 YEARS
Parallel play, Interactive play evolving. Takes turn

Figure 3.7 Social, emotional and behavioural development (median ages).
### Summary

#### Fields of development

**Overview of developmental stages**

- Acquisition of tone and head control
- Primitive reflexes disappear
- Sitting
- Standing, walking, running
- Hopping, jumping, pedaling

**Limit ages**

<table>
<thead>
<tr>
<th>Motor</th>
<th>Limit ages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head control</td>
<td>4 months</td>
</tr>
<tr>
<td>Sits unsupported</td>
<td>9 months</td>
</tr>
<tr>
<td>Stands independently</td>
<td>12 months</td>
</tr>
<tr>
<td>Walks independently</td>
<td>18 months</td>
</tr>
</tbody>
</table>

#### Vision and fine motor

- Visual alertness, fixing and following
- Grasp reflex, hand regard
- Voluntary grasping, pincer, points
- Handles objects with both hands, transfers from hand to hand
- Writing, cutting, dressing

**Vision and fine motor**

<table>
<thead>
<tr>
<th>Motor</th>
<th>Limit ages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixes and follows visually</td>
<td>3 months</td>
</tr>
<tr>
<td>Reaches for objects</td>
<td>6 months</td>
</tr>
<tr>
<td>Transfers</td>
<td>8 months</td>
</tr>
<tr>
<td>Pincer grip</td>
<td>12 months</td>
</tr>
</tbody>
</table>

#### Hearing, speech and language

- Sound recognition, vocalisation
- Babbling
- Single words, understands simple requests
- Joining words, phrases
- Simple and complex conversation

**Hearing, speech and language**

<table>
<thead>
<tr>
<th>Motor</th>
<th>Limit ages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polysyllabic babble</td>
<td>7 months</td>
</tr>
<tr>
<td>Consonant babble</td>
<td>10 months</td>
</tr>
<tr>
<td>Saying 6 words with meaning</td>
<td>18 months</td>
</tr>
<tr>
<td>Joins words</td>
<td>2 years</td>
</tr>
<tr>
<td>3-word sentences</td>
<td>2.5 years</td>
</tr>
</tbody>
</table>

#### Social, emotional and behavioural

- Smiling, socially responsive
- Separation anxiety
- Self help skills, feeding, dressing, toileting
- Peer group relationships
- Symbolic play
- Social/communication behaviour

**Social behaviour**

<table>
<thead>
<tr>
<th>Motor</th>
<th>Limit ages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smiles</td>
<td>8 weeks</td>
</tr>
<tr>
<td>Fear of strangers</td>
<td>10 months</td>
</tr>
<tr>
<td>Feeds self/spoon</td>
<td>18 months</td>
</tr>
<tr>
<td>Symbolic play</td>
<td>2–2.5 years</td>
</tr>
<tr>
<td>Interactive play</td>
<td>3–3.5 years</td>
</tr>
</tbody>
</table>
**Analysing developmental progress**

**Detailed assessment**
So far, emphasis has been mainly on thinking about developmental progress in a longitudinal way, taking each skill field and its progression individually, and then relating the progress in each to the others and to chronological age. This is the fundamental concept of learning how to think about developmental assessment of children. Detailed questioning and observation is required to assess children with developmental problems but is unnecessary when checking developmental progress in normal clinical practice, when a short cut approach can be adopted.

**The short cut approach**
This concentrates on the most actively changing skills for the child’s age. The age at which developmental progress accelerates differs in each of the developmental fields. In Figure 3.8, this is represented diagrammatically for each developmental field by representing the rate of developmental change according the intensity of the colour; the more intense the colour, the more rapid the developmental change. This means there is for:

- gross motor development: an explosion of skills during the first year of life
- vision and fine motor development: more evident acquisition of skills from 1 year onwards
- hearing, speech and language: a big expansion of skills from 18 months
- social, emotional and behavioural development: expansion in skills is most obvious from 2.5 years.

Understanding the time when acceleration in each skill field becomes more obvious and knowing the child’s age helps guide the direction of initial developmental questioning. Thus for a child aged:

- <18 months – it is likely to be most useful to begin questions around gross motor abilities, acquisition of vision and hearing skills, followed by questions about hand skills.
- 18 months to 2.5 years – initial developmental questioning is likely to be most usefully directed at acquisition of speech and language and fine motor (hand) skills with only later and brief questioning about gross motor skills (as it is likely the child would have presented earlier if these were of concern).
- 2.5 to 3.5 years – initial questions are best focused around speech and language and social/emotional/behavioural skills.

Developmental questioning needs to cover the whole area of developmental progression but this more focused way of taking a developmental history allows a quicker and more appropriate assessment. It directs the assessment to current abilities instead of concentrating on parents trying to remember the age when their child acquired developmental milestones some time in the past.

---

**Figure 3.8** The more intense colour bands reflect the age at which particularly rapid progress occurs. Dotted lines represent more subtle progress.
Observation during questioning
Of equal importance to taking the developmental history is the examiner’s ability to observe the child throughout any visit. Not only will this provide an almost immediate guide to where to begin questioning, it will offer the opportunity for a rapid overview of the child’s abilities, behaviour, peer group and parent–child relationships, all of which will go towards determining the overall picture about the child and his developmental abilities.

Equipment for developmental testing
Simple basic equipment is all that is needed for most developmental assessment. Equipment is aimed at bringing out the child’s skills using play. Cubes, a ball, picture book, doll and miniature toys such as a tea-set, crayons and paper will allow a quick, but useful screen of mobility, hand skills, play, speech and language. These items allow the child to relax by having fun at the same time as facilitating observer assessment of his skills.

Developmental screening and assessment
Developmental screening (checks of whole populations of children at set ages by trained professionals) is a formal process within the child health surveillance and promotion programme. It is also an essential role of all health professionals to screen a young child’s developmental progress opportunistically at every health contact, e.g. by the general practitioner for a sore throat, in the accident and emergency department for a fall or on admission to a paediatric ward. In this way, every child contact is optimised to check that development is progressing normally.

There are a number of problems inherent in developmental screening:
- It is based on clinical opinion, which is subjective and therefore has its limitations.
- A single observation of development may be limited by the child being tired, hungry, shy or simply not wishing to take part.
- Whilst much of the focus of early development and progress in infants is centred on motor development, this is a poor predictor of problems in cognitive function and later school performance. Development of speech and language is a better predictor of cognitive function but is less easy to assess rapidly.

The reliability of screening tests can be improved by adding a questionnaire completed by parents beforehand. Increasingly, screening is being targeted towards children at high risk or when there are parental concerns. If an abnormal pattern of development has been identified, the child should be referred to a therapist for an early intervention programme.

Developmental assessment is the detailed analysis of a particular area of development and follows concern after screening that a child’s developmental progress is abnormal in some way. It is part of the diagnostic process and relates to investigation, therapy and counselling. Developmental assessment is by referral to a specialist service and this may be the developmental paediatrician, therapy disciplines, or the local multidisciplinary child development service, which will include a paediatrician.

A range of tests have been developed to screen development in a formal reproducible manner (e.g. the Schedule of Growing Skills and the Denver Developmental Screening Test). There are also standardised tests to assess the development of infants and young children, such as the Griffiths and the Bailey Infant Development Scales. They are used, for example, in follow-up studies of preterm infants. There are also standardised tests concentrating on specific aspects of development (e.g. the Reynell language scale, the Gross Motor Function Measure (GMFM) and the Autism Diagnostic Interview). All but the screening tests are time-consuming and require training for reliable results.

Cognitive (higher mental function) assessment of school-age children using IQ and other tests is carried out by clinical or educational psychologists.

Summary
Pattern of child development
When analysing a young child’s developmental progress:
• consider the child’s age and then concentrate your questions on the areas of likely maximum developmental progress
• offer the child suitable toys to find out about his skills
• observe how the child uses the toys and interacts with people.

Summary
Developmental screening and assessment
• Developmental screening – checks of whole populations or groups of children at set ages by trained professionals.
• Developmental assessment – detailed analysis of overall development or specific areas of development.
Child health surveillance and promotion programme

The programme of child health surveillance and promotion provides an overview of all aspects of health and development for all young children. The programme has three main elements:

• immunisation
• health promotion – to minimise hazards and promote optimum physical and mental health
• screening for the early detection and intervention of physical and developmental problems.

The programme is a compromise between the desire to detect problems and potentially intervene early whilst avoiding an excessive number of visits. The way it is organised in the UK is shown in Table 3.2. At each review, a check is made for specific physical abnormalities and on the child’s overall development, health and growth. Selected health promotion topics are considered (Table 3.2). There is an emphasis on parental opinion for vision, hearing, speech and language, as parents are usually excellent at the early detection of any problems. Details of each review are entered in the child’s personal child health record. These books are kept by the parents and they are asked to bring them whenever the child is seen by a health professional.

The child health promotion programme is carried out in primary care by general practitioners or health visitors. If problems are identified, an action plan is made for the child, which could involve giving advice and monitoring progress or referral to a specialist.

SUMMARY

The child health surveillance and promotion programme:

• is provided in primary care
• includes immunisation, health promotion and developmental screening
• emphasises the role of parents in the early detection of developmental problems.

Hearing

During the later stages of pregnancy, the fetus responds to sound. At birth, a baby startles to sound, but there is a marked preference for voices. The ability to locate and turn towards sounds comes later in the first year. A checklist for parents of normal hearing responses during infancy is shown in Box 3.1.

Box 3.1 Hearing checklist for parents (used with permission from Dr Barry McCormick, Children’s Hearing Assessment Centre, Nottingham)

<table>
<thead>
<tr>
<th>Shortly after birth</th>
<th>Startles and blinks at a sudden noise, e.g. slamming of door</th>
</tr>
</thead>
<tbody>
<tr>
<td>By 1 month</td>
<td>Notices sudden prolonged sounds, e.g. a vacuum cleaner, and pauses and listens when they begin</td>
</tr>
<tr>
<td>By 4 months</td>
<td>Quietens or smiles to the sound of your voice even when he cannot see you. He may also turn his head or eyes towards you if you come up from behind and speak to him from the side</td>
</tr>
<tr>
<td>By 7 months</td>
<td>Turns immediately to your voice across the room or to very quiet noises made on each side, so long as he is not too occupied with other things</td>
</tr>
<tr>
<td>By 9 months</td>
<td>Listens attentively to familiar everyday sounds and searches for very quiet sounds made out of sight. Should also show pleasure in babbling loudly and tunefully</td>
</tr>
<tr>
<td>By 12 months</td>
<td>Shows some response to his own name and to other familiar words. May respond when you say ‘no’ and ‘bye-bye’ even when he cannot see any accompanying gesture</td>
</tr>
</tbody>
</table>

If you suspect that your baby is not hearing normally, seek advice from your health visitor or doctor.

Hearing tests

Newborn

Early detection and treatment of hearing impairment improves the outcome for speech and language and behaviour. In order to detect hearing impairment in the newborn period, hearing can be tested by:

• evoked otoacoustic emission (EOAE) (Fig. 3.9a) – an earpiece is inserted into the ear canal and produces a sound which evokes an echo or emission from the ear if cochlear function is normal.
• auditory brainstem response (ABR) audiometry (Fig. 3.9b) – computer analysis of EEG waveforms evoked in response to a series of clicks.

Universal neonatal hearing screening has been introduced in the UK and other countries. In the UK, initial screening is performed using different
### Table 3.2 The child health surveillance and promotion programme in the UK

<table>
<thead>
<tr>
<th>Age (by whom)</th>
<th>Screening</th>
<th>General examination and immunisation</th>
<th>Health promotion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Newborn</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usually hospital doctor; may be trained midwife, neonatal nurse practitioner or GP</td>
<td>Developmental dysplasia of the hips (DDH)</td>
<td>Full physical examination Weight, head circumference and plot centiles</td>
<td>Feeding and nutrition Back to sleep, avoid overheating and parental smoking to reduce risk of sudden infant death syndrome Sibling management Car seats</td>
</tr>
<tr>
<td></td>
<td>Testicular descent in boys</td>
<td>BCG offered if at risk Hepatitis B vaccine, if indicated, (and repeat at 1, 2, 12 months)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Red reflex of fundus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hearing screening</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>5–6 days</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midwife</td>
<td>Blood test for biochemical screening (Guthrie test)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>New birth visit</strong></td>
<td>Assess child and family health needs, including parental mental health needs</td>
<td>Full physical examination Weight, head circumference and plot centiles</td>
<td></td>
</tr>
<tr>
<td>Home visit by midwife or health visitor usually around 12 days</td>
<td>Vision/hearing – parental concern? First immunisation – diphtheria, tetanus, pertussis, polio (DTaP/IPV), Hib, pneumococcal (PCV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>8 weeks</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General practitioner</td>
<td>Heart murmurs and femoral pulses</td>
<td>Full physical examination Weight, head circumference and plot centiles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Development dysplasia of the hips (DDH)</td>
<td>Vision/hearing – parental concern? First immunisation – diphtheria, tetanus, pertussis, polio (DTaP/IPV), Hib, pneumococcal (PCV)</td>
<td></td>
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<tr>
<td></td>
<td>Testicular descent in boys</td>
<td>Full physical examination Weight, head circumference and plot centiles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Red reflex of fundus</td>
<td>Vision/hearing – parental concern? First immunisation – diphtheria, tetanus, pertussis, polio (DTaP/IPV), Hib, pneumococcal (PCV)</td>
<td></td>
</tr>
<tr>
<td><strong>3 months</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Child health clinic</td>
<td>General review of progress</td>
<td>Second immunisation – DTaP/IPV/Hib, MenC</td>
<td></td>
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<tr>
<td><strong>4 months</strong></td>
<td></td>
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<tr>
<td>Child health clinic</td>
<td>General review of progress</td>
<td>Third immunisation – DTaP/IPV/Hib, PCV MenC</td>
<td></td>
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<tr>
<td><strong>8 months</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Health visiting team</td>
<td>Systematic assessment of the child’s physical, emotional and social development and family needs</td>
<td>If parental concern – hearing, vision, development</td>
<td></td>
</tr>
<tr>
<td><strong>12 months</strong></td>
<td></td>
<td></td>
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<tr>
<td>Child health clinic</td>
<td>General review of progress</td>
<td>Immunisation – Hib, MenC Immunisation – MMR (measles, mumps and rubella), PCV</td>
<td></td>
</tr>
<tr>
<td><strong>13 months</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Child health clinic</td>
<td>General review of progress</td>
<td>Immunisation – MMR, diphtheria, tetanus, pertussis, polio (DTaP/IPV)</td>
<td></td>
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<tr>
<td><strong>2–3 years</strong></td>
<td></td>
<td></td>
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<tr>
<td>Health visiting team, if indicated</td>
<td>General review of progress</td>
<td>Parental concerns – behaviour, hearing, vision and general development Assessment of vision</td>
<td></td>
</tr>
<tr>
<td><strong>4–5 years (preschool)</strong></td>
<td></td>
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<tr>
<td>Orthoptist</td>
<td></td>
<td></td>
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<tr>
<td><strong>4–5 years</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Child health clinic</td>
<td>General review of progress</td>
<td>Immunisation – MMR, diphtheria, tetanus, pertussis, polio (DTaP/IPV)</td>
<td></td>
</tr>
<tr>
<td><strong>5 years – school entry</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School nurse</td>
<td>Vision (phased out if already tested)</td>
<td>Measure height and weight, plot centiles</td>
<td>Check immunisations up-to-date</td>
</tr>
<tr>
<td></td>
<td>Hearing (audiometry)</td>
<td>Examination – only if problem identified or parental concern</td>
<td></td>
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<tr>
<td><strong>Primary and secondary schools</strong></td>
<td></td>
<td></td>
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<tr>
<td>School nurse</td>
<td>Access at open sessions or clinics by a child, parents or teachers</td>
<td>Nursing care provided according to needs</td>
<td></td>
</tr>
<tr>
<td><strong>Secondary school</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School nurse</td>
<td></td>
<td>Immunisation (13–16 years) – diphtheria, tetanus, polio (Td/IPV)</td>
<td></td>
</tr>
</tbody>
</table>

Hearing screening of newborn infants

a Evoked otoacoustic emissions (EOAE)

Click generated from ear phones

Detects normal sound vibrations from outer hair cells in the cochlea

Advantages:
• Simple and quick to perform, though is affected by ambient noise
Disadvantages:
• Misses auditory neuropathy as function of auditory nerve or brain not tested
• Relatively high false positive rate in first 24 hours after birth as vernix or amniotic fluid are still in ear canal
• Not a test of hearing but a test of cochlear function

b Automated auditory brainstem response (AABR)

Auditory stimulus – short duration clicks at different intensities via earphones

Signal via ear and auditory nerve to brain

EEG waveforms – computerised analysis determines if normal or abnormal

Advantages:
• Screens entire hearing pathway from ear to brainstem
• Low false positive rate
Disadvantages:
• Affected by movement, so infants need to be asleep or very quiet, so time consuming
• Complex computerised equipment, but is mobile
• Requires electrodes applied to infant’s head, which parents may dislike

Figure 3.9 Universal neonatal hearing screening is usually performed using (a) otoacoustic emission testing or (b) auditory brainstem response audiometry.
Hearing tests

Figure 3.10 Distraction hearing test. The test is hard to perform reliably as babies with hearing difficulties learn to compensate by using shadows, smells and guesswork to locate the presenter. The test must be done by well-trained professionals.

Figure 3.11 Visual reinforcement audiometry. While an assistant plays with the child, sounds of a specific frequency are emitted from a speaker. When the child turns to it, the tester lights up a toy by the speaker to reinforce the sound with a visual reward. This test is particularly useful at 10–18 months.

Figure 3.12 Speech discrimination testing using miniature toys to detect hearing loss in children between 18 months and 4 years of age.
combinations of evoked otoacoustic emission (EOAE) testing or auditory brainstem response (ABR) audiometry. If a normal response cannot be obtained, the child is referred to an audiologist.

**Distraction testing**
This has been the mainstay of hearing screening but has been replaced by universal neonatal screening. It is now only used as a screening test for infants who have not had newborn screening, or as a diagnostic test. It is performed at 7–9 months of age (Fig. 3.10). The test relies on the baby locating and turning appropriately towards sounds. High and low frequency sounds are presented out of the infant’s field of vision. Testing is unreliable if not carried out by properly trained staff since it can be difficult to identify hearing-impaired infants as they are particularly adept at using non-auditory cues.

**Visual reinforcement audiometry**
This is particularly useful to assess impairment in infants between 10 and 18 months, although it can be used between the age of 6 months and 3 years. Hearing thresholds are established using visual rewards (illumination of toys) to reinforce the child’s head turn to stimuli of different frequencies. Localisation of the stimuli is not necessary and insert earphones may be used to obtain ear specific information, thus making it more useful than free field tests such as distraction and performance testing (Fig. 3.11).

**Performance and speech discrimination testing**
Performance testing using high- and low-frequency stimuli and speech discrimination testing using miniature toys can be used for children with suspected hearing loss at 18 months to 4 years of age (Fig. 3.12).

**Audiometry**
Threshold audiometry can be used to detect and assess the severity of hearing loss in children from 4 years old.

**Parental concern**
At all ages, parental concern about hearing warrants further assessment.

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### Vision

A newborn infant’s vision is limited; the visual acuity is only about 6/200. The peripheral retina is well developed but the fovea is immature. Well-focused images on the retina are required for the acquisition of visual acuity and any obstruction to this, e.g. from a cataract, will interfere with the normal development of the optic pathways and visual cortex unless corrected early in life.

Most newborn infants can fix and follow horizontally. There is a preference for patterns such as faces. Initially the eyes may appear to squint; this is particularly noticeable when the baby tries to look at near objects and the eyes over-converge. By about 6 weeks of age, both eyes should move together when following a light source. By 12 weeks no squint should be present. Babies slowly develop the ability to focus at different distances. Visual acuity also improves: from 6/60 at 3 months to being able to poke at 1 cm objects at 8 months and at 1 mm objects (e.g. hundreds and thousands) at 15 months. Adult levels are reached by 3–4 years of age, when they can match letters at 6/6 using both eyes together.

### Vision testing

The assessment of vision at different ages is shown in Table 3.3. All children in the UK are screened for visual acuity and squint at school entry. In some parts of the UK screening is carried out in preschool children at 4–5 years.

<table>
<thead>
<tr>
<th>Age</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth</td>
<td>Face fixation and following</td>
</tr>
<tr>
<td></td>
<td>Preferential looking – preference for patterned objects to plain ones</td>
</tr>
<tr>
<td>6 weeks</td>
<td>Optokinetic nystagmus (normal) demonstrated on looking at a moving,</td>
</tr>
<tr>
<td></td>
<td>striped target</td>
</tr>
<tr>
<td>6 months</td>
<td>Reaches well for toys</td>
</tr>
<tr>
<td>2 years</td>
<td>Can identify pictures of reducing size charts (log MAR)</td>
</tr>
<tr>
<td>3 years</td>
<td>Letter matching using single letter</td>
</tr>
<tr>
<td>onwards</td>
<td>or Snellen chart by name or matching</td>
</tr>
<tr>
<td>5 years</td>
<td>Can identify a line of letters on a log MAR</td>
</tr>
<tr>
<td>onwards</td>
<td></td>
</tr>
</tbody>
</table>

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### Summary

**Regarding hearing:**
- Early detection and treatment of hearing impairment improves the outcome of speech and language and behaviour.
- Newborn hearing screening is performed for the early identification of hearing impairment.
- If there is parental concern about hearing, further assessment is warranted.