Infancy Physical Development

This chapter introduces physical development during the infancy phase. You will learn about key explanations and approaches during this age period and develop a better understanding of the infants' and toddlers' physical development and learning.

CHAPTER OBJECTIVES

1. Understand key physical development during infancy and its consequences for infants' early growth.
2. Understand aspects of the brain and its links to motor developments in infants and toddlers.
3. Explore cultural differences in motor development during infancy.
4. Discuss and link the main ideas around Piagetian concepts to infants' and toddlers' motor development and learning.

KEY TERMS

acuity
brain
continuous development
discontinuous development
fine motor skills
gross motor skills
reflex

Case study

LULU

Lulu is a year old today and her parents have planned a family birthday party with her 6-year-old twin brothers, Jake and Jamie. Her parents, Chelsea and Mike, rave about how Lulu is an active baby. They talk about how she started walking at 9 months old, since her brothers only walked at 1 year old. Chelsea especially thinks that baby Lulu is very clever because she can waddle and hold her toys without aid. Lulu can also crawl up the stairs in the family home and has recently tried to stand on the stairs. For her birthday, Lulu got a push pram with her own baby doll. She walked around a full 10 minutes pushing her pram!

Lulu's physical development can be typical for a child of her age. From birth, infants like Lulu go through rapid developments with their physical growth. Physical development or growth consists of physical appearance and motor capabilities. Physical appearance is the composition of body parts such as head size, limb length and body proportions. Motor capabilities include gross motor skills such as crawling and walking, and fine motor skills such as holding a spoon. Changes in infants' physical appearance and motor capabilities are clearly visible, especially in the early years.

INTRODUCTION

As a preamble to this chapter and in understanding physical development and learning in infants like Lulu, one of the first 'theories' to be noted is the debate of nature and nurture. It must be noted that both physical appearance and psychomotor can be both a genetic inheritance (nature) and environmental influence (nurture). Which influence is more pertinent in a child's development has been the debate of the past century. It is now recognised that both influences can have vital effects on a child's physical growth, with the environmental influences having more impact on future growth (Shonkoff, 2012).

For example, Lulu is a petite-looking girl who probably has inherited her mother's genetics, as Chelsea herself is rather small in stature. This observation can be seen as a clear example of genetics influence. By her first birthday, Lulu has started holding utensils to help feed herself. We can contribute this achievement to an environmental influence: a home with parents who are encouraging and loving. Had Chelsea and her husband not encouraged their daughter to be independent in feeding herself, then Lulu's development in feeding herself with a spoon or cutting her own birthday cake would have been delayed. Hence, it is important to understand that though child development can be impacted by genetic factors, the growing and learning a child does is influenced and promoted by parenting, care and education in a child's environment.

continuous development
Development is seen as a cumulative process where the same characteristics or skills are gained over time.

discontinuous development
Takes into account the qualitative changes as well as the quantitative and cumulative changes of a child's growth.

The second 'theory' to note is the concept of continuous and discontinuous growth. **Continuous development** translates to how development is seen as a cumulative process where the same characteristics or skills are gained over time. For example, changes in Lulu's length, height and weight prior to adulthood is seen as cumulative; hence, continuous in development. **Discontinuous development** is one that takes into account the qualitative changes as well as the quantitative and cumulative changes of a child's growth. Changes in physical attributes or motor skills can be viewed as discontinuous as infants' appearances change, as they put on weight, and grow taller and stronger with more new skills like rolling over and crawling. There is now a broad agreement among child developmentalists that both continuous and discontinuous growth can be seen in children's development at all stages of their lives prior to adulthood. Keeping this understanding in mind, we begin the chapter by exploring infants and their development in relation to their brain functions, physical appearances and motor reflexes.

THE BRAIN

brain
An organ that plays a major role in control and regulation of the whole body.

The **brain** is a unique organ of the human body that plays a major role of control and regulation of the whole body. The brain is stimulated by the interaction with the environment and helps a child to make association with mental concepts and everyday experiences that are filled with emotions, feelings and thoughts. An infant's brain has neurons; cells that transmit information to other cells. Each neuron has a number of dendrites that react to chemicals produced by the neurons. The glial cells produce this chemical to help neurons function, repair and regenerate. The neurons also have axons that look like chains that connect every neuron to another, which works more as an information transmitter. The synapses are the junctions where both dendrites and axons come close enough for neurons to receive and fire in response. The lack of these interactions can contribute to delayed brain processes that result in delayed physical development (Carlson & Birkett, 2017).

There are different ways of dividing the brain anatomically into regions. Let's use a common method and divide the brain into three main regions based on embryonic development: the forebrain, midbrain and hindbrain. The hindbrain (or rhombencephalon) consists of the remaining brainstem as well as our cerebellum and pons. The hindbrain is important for all our physiological reflexes and movements. The forebrain (or prosencephalon) is made up of our incredible cerebrum, thalamus, hypothalamus and pineal gland among other features. This part of the brain plays a role in all complex thinking, emotions and motivation. The midbrain (or mesencephalon), located near the very centre of the brain between the interbrain and the hindbrain, is composed of a portion of the brainstem. This part of the brain works as a bridge between the forebrain and the hindbrain by bringing to our attention and action the priorities we have. For example, if we want to wake up early our forebrain will wake us up early and, through the midbrain, inform the hindbrain to put our body into waking action.

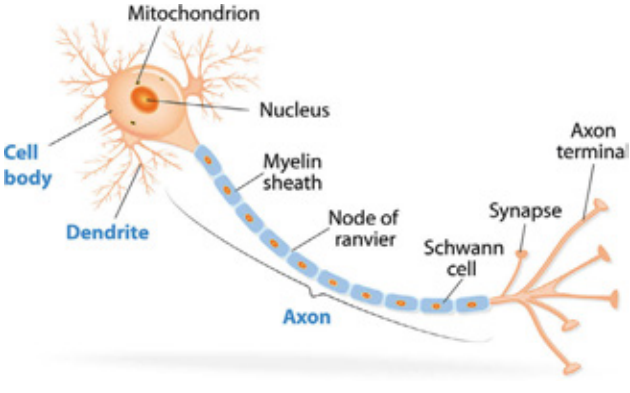

Figure 1.1 Neurons and synapses

Infant appearances

As discussed earlier, growth can be influenced by nature/nurture dispositions and continuous and discontinuous growth. An infant ideally needs a healthy body and a well-functioning brain as a good beginning to their life. To begin with, genetic influences and brain functions can be seen with differences in infant physical condition and appearance at birth.

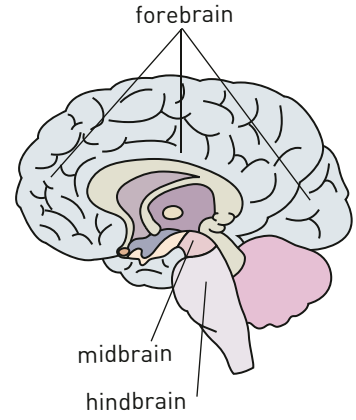

Figure 1.2 The 3 regions of the brain

At birth, Lulu had an Apgar score of 8. The kind of score that Lulu got is hoped for all children. However, prenatal nutrition and genetic influences can vary this expected score, which indicates a measure of infants' physical characteristics. Hence, each infant's physical attributes can be different, and these differences in physical conditions are noted and assessed at birth using the Apgar scale (see Table 1.1). This scale, named after its creator, Dr Virginia Apgar, involves scorings of 0–2 on five characteristics, namely heart rate, efforts to breathe, muscle tone, skin colour and reflex irritability. A total score of 7 and more indicates a healthy baby and such an infant usually has more than 100 heart beats per minute, cries heartily, coughs and sneezes, has strong active movements of the limbs, and colour of body is generally pink (Apgar, 1953). A total score of 4–7 after a lapse of 1 minute since birth flags paediatric attention. A score of 3 and below in the Apgar scale after the lapse of 1 minute since birth signals immediate resuscitation that can be life-saving.

A good score on the Apgar scale is an indication that an infant's nervous system and brain structure is healthy for a child. An infant's brain and the connected nerve cells of the spinal cord are responsible for the coordination and control of perception and motor responses. The maturation of the nervous system at the infancy stage allows infants to develop their motor movements in gradual stages and these can be seen as leaps of development within small periods of time in the first 3 years of a child's infancy phase. However, it must be noted that the Apgar scale isn't designed to predict an infant's long-term health or development, though it is agreed to be a useful indicator of a more immediate mortality rate (Li et al., 2013). The medical profession are now careful not to infer too much from the scores; there are recommendations for doctors and nurses to take into account various impacting factors of the infants' birth.

Table 1.1 Apgar scale

Indicator	0	1	2
Activity and muscle tone	Flaccid, limp	Weak but flexed arms and legs	Strong and active motions
Pulse (Heart rate)	Absent	Less than 100 beats per minute	More than 100 beats per minute
Grimace (Reflex irritability)	Absent	Frown or grimace	Vigorous crying, coughing and sneezing
Appearance (Skin colour)	Body pale or blue	Body pink; blue extremities	Body and extremities pink
Respirations (Efforts to breath)	No response	Slow and irregular	Good and infant crying

Apgar (1953)

Figure 1.3 Infant to toddler growth

At birth, Lulu weighed 3.5 kilograms and this weight is considered average and healthy for a full-term baby born at 38 weeks of gestation. Most infants weigh about 3 to 4 kilograms at birth and are about 51 centimetres in length. Lulu's parents have a growth chart on one of the kitchen walls to measure their children, with markings already indicated for Lulu's twin brothers. At her first birthday, they marked Lulu's height. Growth charts are a way parents and carers can keep track of a child's growth and by the time she is 3 years old, Lulu can be expected to grow as tall as 105 centimetres. Growth charts can consist of percentiles of measurements that provide proportionate height and weight for a healthy growth. For example, girls can weigh from 2.5 kilograms at birth to 17 kilograms by 3 years old, while their length can range from 45 centimetres at birth to 102 centimetres at 3 years old. Whereas boys can weigh from 2.75 kilograms at birth to 17.5 kilograms by 3 years old, while their length can range from 45 centimetres at birth to 105 centimetres at 3 years old. A study in Germany in 2012 found that children who are overweight tend to put on more weight, and the same children tend to be slower in developing motor skills (Krombholz, 2012).

There is no ideal length (or height) and weight for an infant but there is a discernible pattern of expected growth that babies should show. A growth chart is usually used to see whether an infant is showing indicative growth and the growth is usually different for boys and girls. On average, boys tend to be slightly heavier and taller than girls, and their growth patterns are different. A full growth chart for boys and girls is shown in Chapter 2 with a fuller discussion in relation to growth.

The growth in height and weight comes together with noticeable changes in muscular development associated with ambulation (to coordinate positions for movement such as sitting and walking), teeth and hair. Infant teething is called 'eruption' as the tooth breaks through the gum line. The timing of tooth eruption varies among infants though there is an order of growth, starting with the incisors, premolars, canines to molars. Figure 1.4 shows the positioning and timing of teeth eruptions in childhood. Infants start showing signs of their first white cap by 3 months old, usually in the front at the bottom, and have their first teeth by 5–6 months old. Some infants are late in their teething and can have a tooth only after their first birthday. Teething can be a traumatic time for both infant and parents as infants get irritable and easily cry during these periods. They can also suffer from rash and night waking. Most infants have a full set of hair by their first birthday. Nevertheless, nutrition during a mother's pregnancy and during infancy influences a child's appearance immensely. This is the key nurturing factor that parents contribute to

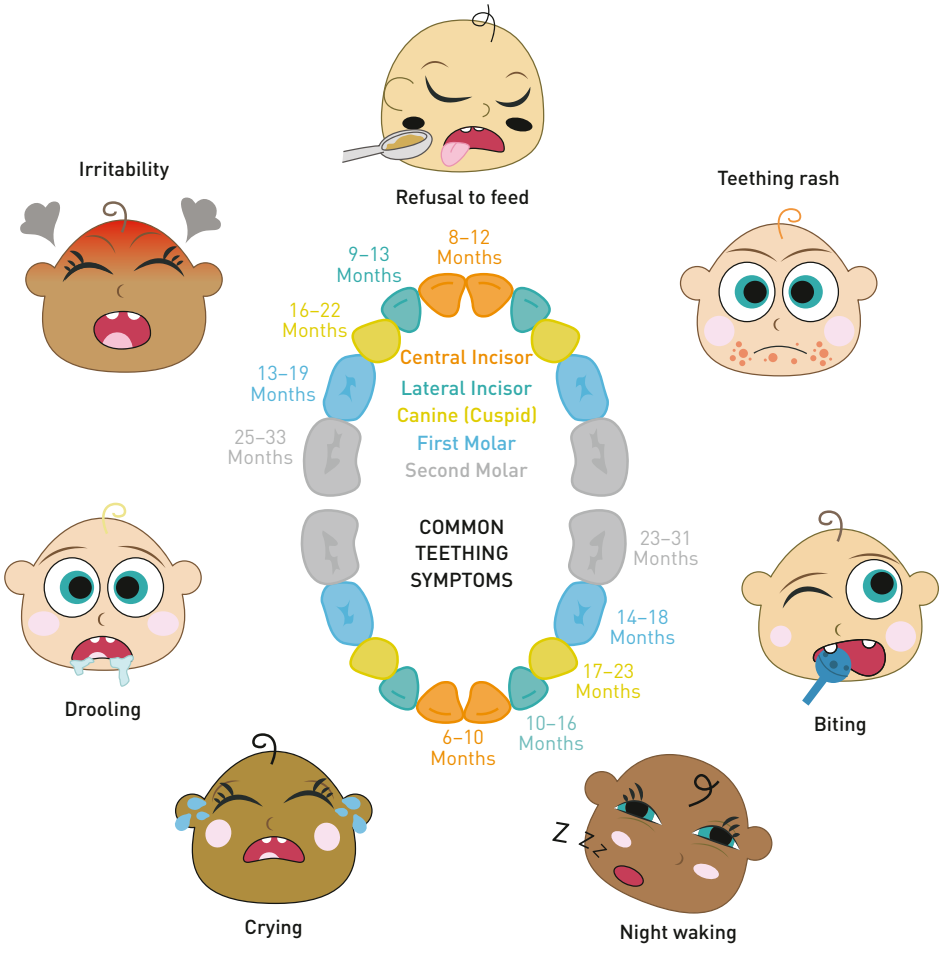

Figure 1.4 Teething in infancy

from the time the mother is pregnant with the child to the time they bring up their child. Balanced nutrition and care is fundamental to ensure an overall healthy growth.

INFANT VISION AND AUDITORY DEVELOPMENT

The brain receives information about the body's condition and surroundings from all of the sensory receptors in the body. All of this information is fed into sensory areas of the brain, which put this information together to create a perception of the body's internal and external conditions. Some of this sensory information is autonomic sensory information that tells the brain subconsciously about the condition of the body. Body temperature, heart rate and blood pressure are all autonomic senses that the body receives. Other information is somatic sensory information that the brain is consciously aware of. Touch, sight, sound and hearing are all examples of somatic senses.

At birth, we are also concerned with infants' vision and auditory responses. Infants have vision, but lack **acuity** or sharpness of vision. Infants' acuity is only 20–25 centimetres. Infants also initially are slow in scanning and tracking moving

acuity
Sharpness of vision.

objects; however, as their clarity of vision improves so does their ability to track moving objects.

Interestingly, infants are known to have a preference for faces rather than non-facial objects. Chelsea remembers how Lulu would smile at her the moment she saw her face when she was a baby of 3 months old. Such an observation resonates with research around infants' preference for face-like objects, which has been prevalent since 1963 (Otsuka, 2014). The debate as to whether this preference and recognition of faces is innate or learned is also part of this wide research. Otsuka's review of infant face recognition research concluded that infants do have an existing tendency to recognise human faces, and, therefore, it makes sense that they start recognising their mothers and fathers or carers who hold them close during their early days. By 6 months old, infants usually can see objects about 6 metres away and have the clarity of what they see as close to an adult's vision.

Ability to hear is usually present at birth. Auditory development is benchmarked as part of the language development and this is discussed in detail in the language development chapters. For the purposes of this chapter, it is important to note that indicators of this hearing ability can be seen when infants turn towards sounds that have become familiar—a parent's or sibling's voice is one such familiar sound. Chelsea remembers how she thought all her babies including Lulu were so responsive when they were merely a few days old.

Loud noise also easily startles infants (see moro reflex discussion later in this chapter). Infants prefer complex sounds rather than single tones. This characteristic explains why they react to voices that are familiar to them. By 3 months old, they will smile at the sound of a parent's voice and may even start to babble and duplicate sounds they hear from around their environment. By as early as 4 months old, infants can distinguish emotions by the tone of voice and use their own voices to react to the emotions displayed. They can also begin to recognise their own name. By 1 year old, many infants can say a few words, and imitate and respond to uttered words (McLeod & McCormack, 2015).

Infant sleep

Sleep is an important activity for an infant's growth because it is a fundamental activity that helps with overall physical development and, most of all, the health of the brain. The central nervous system of any infant consists of the brain and nerve cells of the spinal cord. Together, the brain and nerve cells coordinate and control infants' reaction and perception to stimuli and their motor controls. The brain regulates the amount of stimulation infants get when they are awake or asleep. Sleep for infants (or older children) helps not only with brain cells growth but also encourages their body growth.

While sleep may seem to be a time of rest for the brain, this organ is actually extremely active during sleep. The hypothalamus maintains the body's 24-hour biological clock, known as the circadian clock. When the circadian clock (otherwise known as body clock) indicates that the time for sleep has arrived, it sends signals to the reticular activating system of the brainstem to reduce its stimulation of the cerebral cortex. Reduction in the stimulation of the cerebral cortex leads to a sense of sleepiness and eventually leads to sleep. In a state of sleep, the brain stops maintaining consciousness, reduces some of its sensitivity to sensory input,

relaxes skeletal muscles, and completes many administrative functions. These administrative functions include the consolidation and storage of memory, dreaming, and development of nervous tissue.

Sleep in infants consists of 50 per cent Rapid Eye Movement (REM) sleep and 50 per cent non-REM sleep. Eye twitching or small limp movements that can be seen during infant sleep are associated with REM sleep. The REM sleep is as important as non-REM sleep for infants. While in the REM sleep the infant's nervous system is kept stimulated with the brain activity; the non-REM sleep gives them the much needed rest period for body growth (Coons & Guilleminault, 1982). At 6 months old an infant can sleep between 13–14 hours, decreasing to 11–12 hours by the time they are a year old.

In the first 8 weeks of her life, Lulu slept for about 18 hours of the day. Most infants are expected to sleep for about 16 hours a day at least, with some sleeping as much as 21 hours a day. Figure 1.5 shows the sleeping stages in an infant. Obviously, Lulu slept well and that made it easier for her mum to rest as well in the early days after her birth. However, not all infants sleep as much as Lulu—some sleeping as little as 11 hours a day (Buysse, 2005). Unfortunately for some parents, the waking hours of the infants who sleep less tend to be at night. Breastfeeding at night is one of the biggest contributors to these waking patterns (Galland, Taylor, Elder & Herbison, 2011). Furthermore, a variety of factors such as genetic influences or environmental/cultural practices influence the waking hours but the ability to return to sleep unaided plays a major role in determining whether or not waking persists and becomes problematic. Parenting within particular cultural contexts may play a major role in regulating the wake–sleep hours, with Asian families found to have shorter sleep patterns for their infants (Galland et al., 2011).

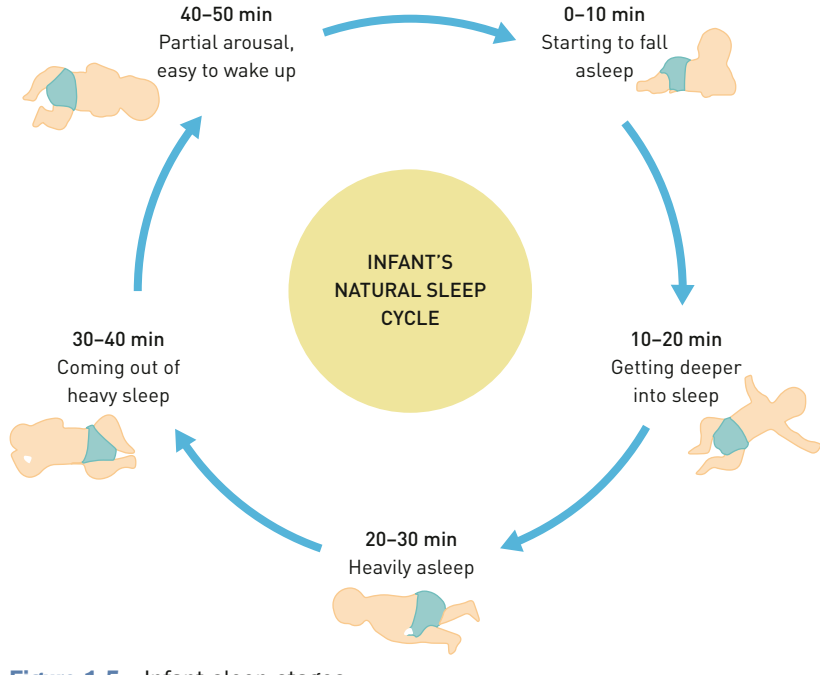

Figure 1.5 Infant sleep stages

There are instances where an infant may have even shorter and unpredictable periods of sleep, with very little amount of REM sleep within those sleep periods. This kind of sleep has been associated with Sudden Infant Death Syndrome (SIDS), where infants are found dead in their cribs, though this association is not conclusive. SIDS has been linked with brain defects, low birth weight and even suffocation due to respiratory infection.

MOTOR DEVELOPMENT

Our brain directly controls almost all movement in the body. A region of the cerebral cortex known as the motor area sends signals to the skeletal muscles to

Stop and think

Sleep patterns

We have learnt that sleep patterns can differ. How do you think parents deal with differences in children's sleep patterns? Ask a classmate or friend who is a parent of more than one child, or ask your own parent(s), how they responded to sleep differences in their children as infants. Share what you have found with your classmates. Are there any interesting trends of practice between 'new' parents and 'old' parents?

Figure 1.6 Newborn baby being tested for moro reflexes

produce all voluntary movements. The basal nuclei of the cerebrum and grey matter in the brainstem help to control these movements subconsciously and prevent extraneous motions that are undesired. The cerebellum helps with the timing and coordination of these movements during complex motions. Finally, smooth muscle tissue, cardiac muscle tissue, and glands are stimulated by motor outputs of the autonomic regions of the brain.

Motor development is fundamentally important not only for an infant's growth but also their brain development and learning. An infant's early motor capacity is an indication of how their brain is developing. At birth, loud sound and movement easily startles infants. The startled movements that infants display are known as moro reflexes. Moro reflexes have been used for decades by paediatricians to determine whether a newborn baby has expected brain and nerve constitutions. Moro reflex is also known as a primitive reflex as it is part of the progress in physical growth.

Within the primitive reflex are other actions that infants are expected to display, such as grasping, tonic neck, Babinski, stepping and swimming. Lulu at birth showed good grasping and curling of her toes (Babinski). She also had tonic neck in her first month of being born, which slowly disappeared by the time she was 3 months old. It is expected that most babies will not have tonic neck by the age of 6 months old, so Lulu certainly showed great signs of physical growth. Infants who continue to have tonic neck beyond 6 months of age indicate possible brain or nervous system damage. Lulu also showed great stepping ability when held up by her dad. This stepping is a good sign of early motor skills too. Lulu's parents also confidently took her to the swimming pool when she turned 3 months old. She loved the water and learned to paddle with her mum holding her afloat within a period of 2 weeks.

reflex
A fast, involuntary reaction to a form of internal or external stimulus.

A **reflex** is a fast, involuntary reaction to a form of internal or external stimulus. Many reflexes in the body are integrated in the brain, including the pupillary light reflex, coughing and sneezing. Many reflexes protect the body from harm. For

instance, coughing and sneezing clear the airways of the lungs. Other reflexes help the body respond to stimuli, such as adjusting the pupils to bright or dim light. All reflexes happen quickly by bypassing the control centres of the cerebral cortex integrating in the lower regions of the brain, such as the midbrain or limbic system.

Aside from primitive reflex, all infants are born with other reflexes that are basic and imperative to human survival. Survival reflexes are breathing, rooting, sucking, swallowing, eye blink and pupillary, and these reflexes are needed for an infant's everyday living. Rooting, for example, enables an infant to sense and find a mother's nipple to suck their breast milk and you can see it happen when you stroke a baby's cheek. The reflex of sucking allows an infant to feed on a mother's breast milk or milk from a bottle. Other reflexes last a lifetime rather than just in infancy. Examples of reflexes that last into adulthood are:

- Blinking the eyes when they are touched or when a sudden bright light appears
- Coughing when the airway is stimulated
- Gagging when the throat or back of the mouth is stimulated
- Sneezing when the nasal passages are irritated
- Yawning when the body needs more oxygen

Within the first two years, infant physical growth can be very rapid. During this growth, all infants and toddlers acquire two types of motor skills, **gross motor skills** and fine motor skills. Motor skills are actions that involve the movement of muscles in the body. By her first birthday, Lulu showed both skills as expected for her age. Both motor skills usually develop together since many activities depend on the coordination of gross and **fine motor skills**.

gross motor skills Abilities associated with control of the large muscles of the body.

fine motor skills Movements that children can make using the small muscles of their hands.

Internationally, there are multiple tools to assess children's physical development including the Test of Gross Motor Development 2 (TGMD-2) (Draper, Achmat, Forbes & Lambert, 2012). In Australia, maternal health professionals use a range of assessment tools to determine the gross and fine motor development of infants and toddlers. These tools (Department of Health, 2017) include:

1. Parents' Evaluation of Developmental Status (PEDS)—a 10 item questionnaire that facilitates parent and professional exchange and sharing about children's development;
2. Ages and Stages Questionnaire (ASQ)—specifically useful to detect delays in development;
3. Brigance Screens—the infant version (birth to 11 months) contains 85 items and the toddler version (12 to 23 months) contains 83 items and the items cover multiple domains, including the physical domain;
4. Child Development Inventory—this is used at early childhood level to indicate school readiness (will be referred to again in Chapter 2).

See more on PEDS at <www.rch.org.au/ccch/peds/About_PEDS>

See more on ASQ at <www.sciencedirect.com/science/article/pii/S1665114617300102>

See more on Brigance instruments at <www.curriculumassociates.com/products/BRIGANCEoverview.aspx>

See more on the Child Development Inventory at <https://childdevrev.com/cdi-research/>

Gross motor skills

Gross motor skills develop over a relatively short period of time during childhood. What are gross motor skills? Gross motor skills are abilities associated with control of the large muscles of the body that are used for activities such as crawling, sitting,

Case study

LITTLE DAYA

Little Daya attends the same day care centre as Lulu. Daya, who is 9 months old, is the only son of Sri Lankan parents who are new migrants to Australia. In the first 3 months of their life in Melbourne, Daya had trouble adapting to the new environment. When Daya's mum, Shantini, sent him to the centre when he was a year old, he cried for most of the morning session. Susan, one of Daya's carers, is alarmed that Daya has poor muscle structure in his body and does not try to walk like any of the other children. He has overall poor movement coordination and ability. Daya likes to point to toys or objects rather than reach out for them himself. Susan feels that Daya needs intervention in terms of physical exercise and possibly appropriate nutrition.

What do you think? Does Daya need a structured intervention to get him to walk and move his muscles?

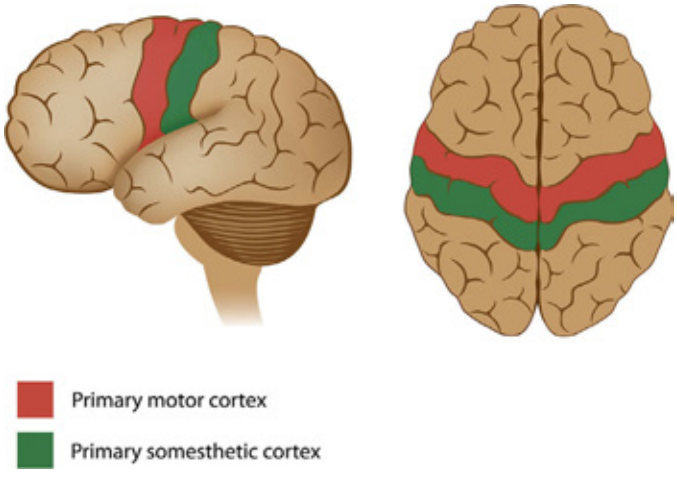

Figure 1.7 Primary motor cortex: Coloured sections are the primary motor cortex, which has a role in gross motor skills

walking, running and other activities. Obviously Daya's muscle development and coordination is somewhat delayed (see the case study on this page). The asynchrony of the development for Daya could be contributed to genetic influences, nutrition, and inhibited opportunities for physical stimulation.

Gross motor skills growth follows two trends—Cephalocaudal (head to tail) and Proximodistal (near to far). The two trends basically mean that an infant's growth to a toddler happens from the top of their head to their toe and from parts of their body to their extreme limbs. Head control is gained first, followed by the shoulders, upper arms and hands. Upper body control is developed next, followed by the hips, pelvis and legs. All these movements are controlled by the primary motor cortex of the brain (Figure 1.7).

With the acquisition of motor skills, by 2 years of age a toddler will be at least 30 cm taller than they were at birth. Lulu has long limbs like her parents and her head is no longer the biggest part of her body. The first gross motor skill infants usually learn is to lift their heads and shoulders before they can sit up, which, in turn, precedes standing and walking. Lifting the head is usually followed by head control. Although they are born with virtually no head or neck control, most infants can lift their heads to a 45-degree angle by the age of 4 to 6 weeks, and they can lift both their head and chest at an average age of 8 weeks. Most infants can turn

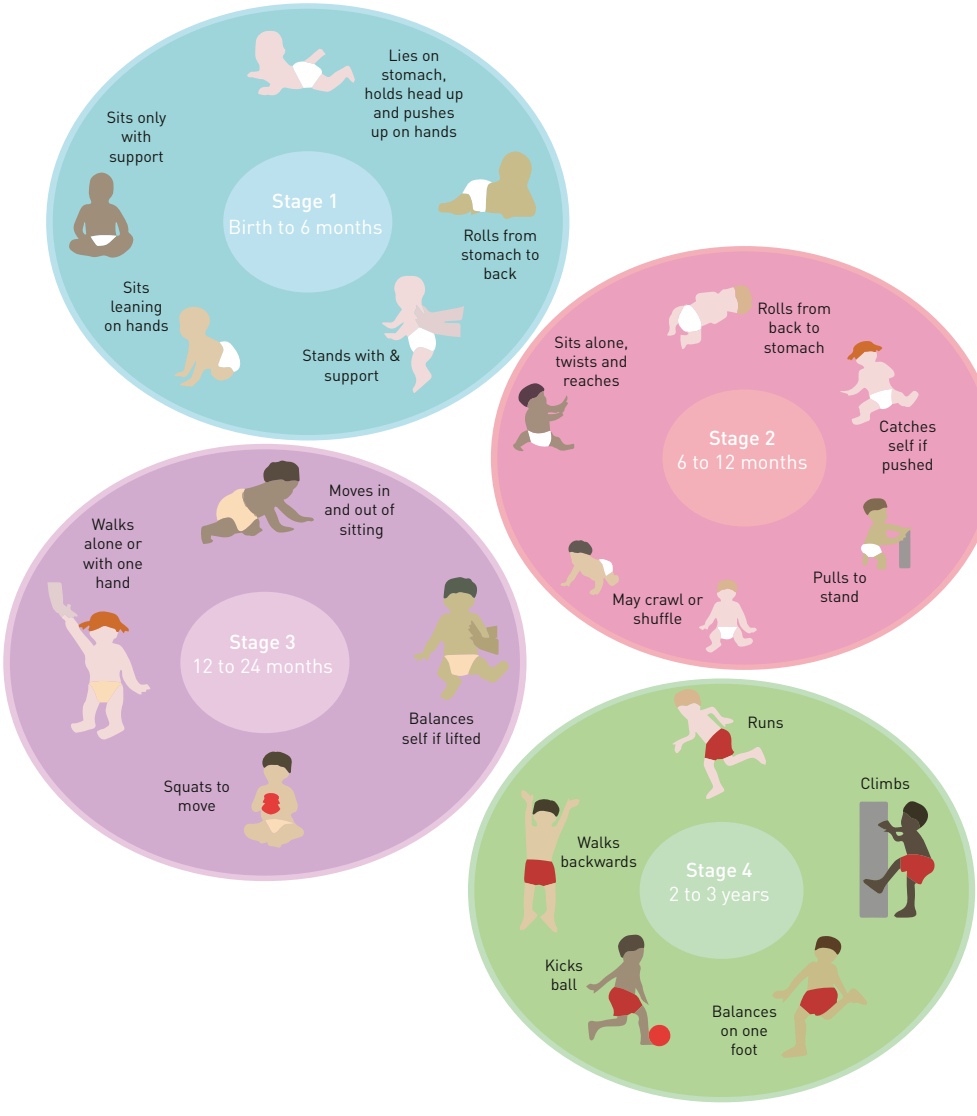

Figure 1.8 Gross motor milestone: Motor developments and generic physical appearances that are expected to happen from birth to age 3

their heads to both sides within 16 to 20 weeks and lift their heads while lying on their backs within 24 to 28 weeks. By about 9 to 10 months, most infants can sit up unassisted for substantial periods of time with both hands free for playing. This development can follow the milestone shown in Figure 1.8.

Figure 1.8 shows the different motor developments and generic physical appearances that are expected to happen during the infancy period, which is from birth to 3 years old. As you can see, the stages of physical development can be divided into four with Stage 1 being from birth to 6 months, Stage 2 being from 6 to 12 months, Stage 3 being 12 to 24 months and Stage 4 being 2 to 3 years (we will refer to this stage again in Chapter 2). The changes in the appearance and the motor skills children go through are quite distinct at each stage.

These are developmental milestones that are sometimes used by educators, maternal child health practitioners and parents to notice an infant's physical development. The milestones provide a guide for adults to monitor the progress of infants' and toddlers' development since each child's development is unique. The fundamental facts around the developmental milestones are important in understanding specific theories that are relevant to infants like Lulu's physical development and learning.

One of the major tasks in gross motor development is locomotion—the ability to move from one place to another. Infants progress gradually from one skill to another, starting from rolling (about 8 to 10 weeks) to creeping on their stomachs and dragging their legs behind them (6 to 9 months). Infants should be able to crawl by 7 to 12 months. While infants learn different means of getting mobile, they are gradually able to support increasing amounts of weight until they can support themselves to a standing position. By the second half of their first year, infants usually try to pull themselves up on furniture or other stationary objects. Once they can position themselves well, infants begin walking around by holding onto furniture to keep their balance. Eventually, they are able to walk supported by an adult with both hands and gradually walk supported with one hand held. Infants are observed to take their first uncertain steps alone between the ages of 36 and 64 weeks and are competent walkers by the age of 12 to 18 months.

By the age of 2 years, toddlers have begun to develop a variety of gross motor skills. Toddlers are usually very active physically, being able to walk, waddle and run. Toddlers are able to walk with straight posture, holding their weight and gait quite well. They can also walk backwards and run with enough control for sudden stops or changes of direction. Most toddlers, by 2 to 3 years old, climb stairs or ladders in the playground. They also have basic skills in kicking and throwing a ball, although most times they have trouble catching it because they hold their arms out in front of their bodies no matter what direction the ball comes from. They can hop, stand on one foot, and negotiate the rungs of a jungle gym. They can climb stairs alternating feet but usually still walk down putting both feet on each step. Toddlers can run fairly well and negotiate stairs holding onto a banister with one hand and putting both feet on each step before going onto the next one. Many toddlers may learn to ride a tricycle or a pushbike if they are given an opportunity to do so. They get excited about being able to push themselves around using their strong leg muscles, which they find very useful as a locomotion tool!

Fine motor skills

Fine motor skills are movements that children can make using the small muscles of their hands. It includes the coordination of small muscles in movements, usually involving the synchronisation of hands and fingers with the eyes. The complex levels of this movement and coordination can be attributed to and demonstrated in tasks controlled by the nervous system and the brain.

Children start to use their hands right at birth to explore their own bodies and people and things around them. The development of fine motor skills happens simultaneously with the growth of their whole body as regulated by their brain. Fine motor skill activities are important in preparing children for future learning

Case study

LULU FEEDING HERSELF

Lulu has, of late, started holding her own spoon and feeding herself. On her birthday, Lulu is encouraged to hold a plastic knife and cut her own cake. Sitting in her high chair, she beams into the camera as dad Mike says, 'Say cake, Lulu!' and excitedly tries to cut her cake. Lulu drops the plastic knife and tries to reach for some cake. Chelsea grabs the cake before Lulu can reach for it. Lulu starts crying but Jake strokes her arm saying, 'It's okay, Lulu … Mum will give you a piece soon … won't you, Mum?' Lulu, of course, gets a slice in a little bowl and she tries to feed herself some while Mum feeds her the rest.

Can Lulu do more? How would you encourage her to be more independent in relation to feeding and using her skills?

activities. Activities that focus on motor skill development, which improves the muscles in the fingers and hands, strengthening hand grip, and enhancing wrist movement, enable children to scribble, write and draw.

Lulu's ability to feed herself requires fine motor skills. At infancy, children with good physical growth like Lulu are able to achieve numerous skills that are expected of them. Daya's inability to reach out to objects in the same way as Lulu indicates some early warnings of delays in his physical growth. Table 1.2 provides an indicative milestone for fine motor skills in infancy that parents, carers and educators can use as a benchmark for supporting their children.

Table 1.2 Indicative milestones of fine motor skills in infancy

Age in months	Fine motor skills in approximate order of achievement
3–12	Holds objects small enough for fingers Reaches for objects and briefly holds objects Follows objects with eyes and is able to try to grab them Transfers objects from one hand to another Keeps hands open and relaxed most of the time, no longer clutching or grabbing action only Starting to use pincer fingers to pick up small items and food Able to release an object purposefully Gives toy to caregiver when asked
12–18	Self-feeds, holds cup to drink Likes to explore, turns pages of cardboard books Able to put objects/toys in a container Uses both hands to play Points at objects with index finger Can isolate index finger with other fingers closed Can build a block tower using three to four blocks

(*Continues*)

Age in months	Fine motor skills in approximate order of achievement
18–24	Inserts shape objects into modular Builds a tower with four to six blocks Puts four to five rings on a stick Puts large pegs in a pegboard Turns two to three pages of a book Scribbles with large grip crayons and pencils Turns knobs that are small enough to fit hand Throws a small ball Enjoys hand painting and manoeuvring paint brush for painting Draws a vertical line or a circle (not perfect) Begins to string large beads Feed themselves using a fork and spoon Pulls up a large zipper Starts to hold a crayon with their fingers, usually with their hand at the top of the crayon Puts large shapes into a shape sorter
24–36	Builds a tower of up to nine large blocks Puts together large linking blocks, such as Megablocks Folds paper in half Draws straight lines and circles Turns single pages of a book Snips the edges of paper with scissors (by 30 months) Holds crayons using the thumb and fingers Uses one hand more often than the other for most activities Strings half-inch sized beads Cuts across a piece of paper (by 3 years) Uses a fork or chopsticks to eat Fastens large buttons Puts on some items of clothing with supervision

Family and cultural differences in motor development

Cross-cultural research on motor development has been dominated by normative comparisons of onset ages following the prevailing emphasis on motor milestones. Nevertheless, the developmental milestone for motor development is only a guide and cannot be universally applied to all children of different cultures. In Australia and the wider Asia–Pacific, children and their families are from multicultural backgrounds. In Australia, the multicultural census is characterised by more than 300 languages spoken in homes, over 100 religions and more than 300 different ancestries, including the many cultures of Aboriginal and Torres Strait Islander peoples. The 2016 Census showed that one in five Australians (21 per cent) spoke a language besides English at home, such as Mandarin, Vietnamese, Cantonese, Hindi, Greek, Italian and Arabic. With so many cultural backgrounds come different cultural practices. Generally, Asian families (in particular, Chinese families) tend to want their children to walk earlier and support and prepare their infants' physical and motor development.

Adolph, Karasik and Tamis-LeMonda (2009) highlighted that cultural differences in daily childrearing practices are linked to accelerated and delayed development. Daily routines that include vigorous massage and stretching of limbs during bath

Stop and think

Early learning of movements

Some cultural practices show early onset of motor development. If motor skills can be learnt, why not just deliberately teach infants to coordinate movements; for example, to walk early? What do you think would be the short-term and long-term implications for the child? Research this issue in the library or on the web before you come to a conclusion.

time and exercise for infants from birth are practised in cultures like India and Africa. Many families of Indian and African origin in Australia still practise these ways as do families from China who practise ways to accelerate toilet training. In the late 1990s, Chinese families in Northern China laid their infants on their backs in sand for most of the day and this practice was found to delay the onset of sitting, crawling and walking (Mei, 1994). However, this practice is not prevalent any more.

Certain cultures do 'teach' walking much earlier, whereby infants are given more chances (and support) to stand up and practise walking from an early age. Culturally, this may be advantageous, as walking may be the primary method of getting from one place to another as reported to be found in Aboriginal families and communities. Similar advanced motor abilities are reported to occur within Aboriginal families, where independent sitting is encouraged from a much earlier age.

Applying Piagetian concepts to infant and toddler motor development

One of the earliest child developmental psychologists, Jean Piaget (1951), observed his own children, Jacqueline, Lucienne and Laurent, to see how their motor skills developed to reach conclusions on how physical skills indicated brain development. His cognitive development theory comprised a structured sequence of four stages: sensorimotor, pre-operational, concrete operations and formal operations. Each stage of development represents a different level of cognitive growth that has links to how motor and physical growth happens as well. At infancy, Piaget summed up that there are six sub-stages during the sensorimotor period, which closely aligns with how brain and motor skills develop.

It is important to note that Piaget's sub-stages need to be seen within the context of the child's growth environment, especially when they start interacting

Table 1.3 Motor reflexes and skills during the six sub-stages of Piagetian sensorimotor at infancy

Sensorimotor stages	Motor reflexes and skills
Reflex acts	The first sub-stage in the first month of an infant's life is the stage of reflex acts that include rooting and sucking. The infant, known as neonate, responds to external stimulation from a mother or father or carer with innate reflex actions. For example, if you brush an infant's mouth or cheek gently with your finger, the baby will turn its head to suck reflexively.

(*Continues*)

Sensorimotor stages	Motor reflexes and skills
Primary circular reactions	The second sub-stage is the stage of primary circular reactions, where infants will repeat pleasurable actions centred on their own body. For example, infants from the age of 1 to 4 months old usually move their fingers spontaneously and kick their legs in the air quite vigorously. They also start sucking their thumbs or fingers. These actions are not reflexive but rather purposely produced as pleasurable stimulation.
Secondary circular reactions	The third sub-stage is known as the secondary circular reactions that are observed to be evident in infants between 4 and 8 months. At this stage, infants engage in pleasurable actions using objects as well as their own bodies. An example of this stage can be seen in how an infant shakes the rattle for the pleasure of hearing the sound that it produces.
Coordinating secondary reaction and schemes	The fourth sub-stage that occurs between 8 and 12 months is the stage of coordinating secondary reaction and schemes. Instead of simply prolonging interesting events, babies now show signs of an ability to use their acquired knowledge to reach a goal. For example, infants will not just shake the rattle, but will reach out and knock to one side an object that stands in the way of them getting hold of the rattle. Another example is when an infant throws a spoon to see how it falls and crashes on the floor.
Tertiary circular reactions	The fifth sub-stage, around the ages of 12 to 18 months of age, is the stage of tertiary circular reactions. These differ from secondary circular reactions in that they are intentional adaptations to specific situations. Infants who once explored an object by taking it apart now try to put it back together. For example, infants may stack the bricks they took out of their wooden truck back again or put back the nesting cups—one inside the other. An infant will throw a spoon to gain an adult's attention once the infant realises the adult will pick up the spoon if it is thrown down.
Symbolic problem solving	In the final or sixth sub-stage, there is the beginning of symbolic thought. This is a transitional stage to the pre-operational stage of cognitive development, which allows a child to do more in relation to fine and gross motor skills. Infants, who are now toddlers of 18 to 24 months, can now form mental representations of objects, moving to remove or pick up objects expertly. This means that they have developed the ability to visualise things that are not physically present. This is crucial to the acquisition of object permanence—the most fundamental achievement of the whole sensorimotor stage of development. Also by this stage, infants and toddlers are able to draw and scribble images that represent their own view of the world. A child can hold a pen or pencil with their grip hand.

and reacting with objects. A child could become distracted or lose interest in the object and therefore lack the motivation to reach out for objects. Sometimes, a child simply may not have the physical growth or coordination to carry out the motor movements necessary for the retrieval of the object, as can be seen in Daya's case.

PRACTICAL SUGGESTIONS FOR MOTOR DEVELOPMENT

Obviously Lulu and Daya have different developmental trends. All children benefit from nurturing from adults around them. Parents, carers and educators can be these adults who are important in helping children achieve optimum development by nurturing and encouraging appropriately. Zylia's motor skills development is supported by her grandad, Shane, on occasions but mostly by her mum at home through lots of activities such as dancing, walking and running around the garden, drawing and

Figure 1.9 Grandad encouraging Zylia to hold a pen and draw circles on a piece of paper

colouring. For both Lulu and Daya, their parents are their biggest support, with Daya's parents needing more knowledge and awareness around how to make Daya stronger and skilled in his motor skills.

This kind of encouragement allows Zylia to exercise her little fingers and hone her fine motor skills for the next stage of holding with her index finger and thumb. Infant grasp can be cylindrical or digital, as shown in Figure 1.10. Zylia at 19 months shows great development with her grasp of the pencil. Shane encourages the little one with praise and by pointing to her drawing, so she'll continue to attempt to draw. Shane's knowledge of how to encourage Zylia is important in terms of how confidently he can support his grandchild to use and refine her motor skills.

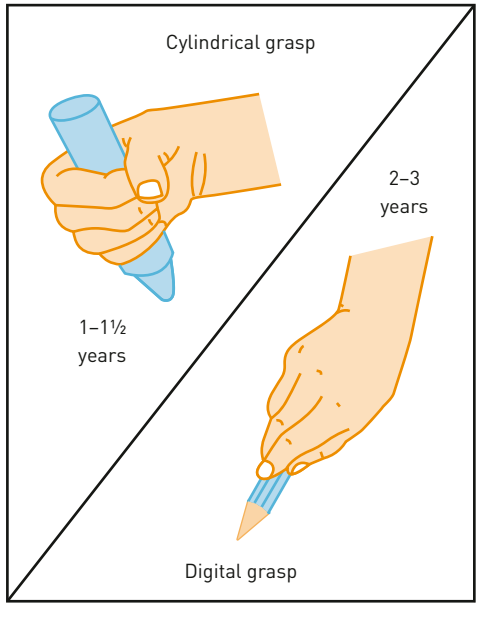

Figure 1.10 An infant's pencil grasp can be cylindrical or digital

Hence, practical knowledge of how to enhance infants' and toddlers' early motor development is critical. Table 1.4 (overleaf) includes a number of practical steps that parents, carers and educators can take in supporting early motor development in the first year of an infant's life. These activities can be followed up with other strategies for toddlers such as kicking and rolling balls, pushing prams or trolleys, and balancing on beams or rocks supported by an adult. As part of early education and care for infants and toddlers, we ideally have to be prepared in planning and supporting the physical development of children. In Chapter 21, you will learn about how to plan and support a young child's physical development in an early childhood context that you will be involved with.

Table 1.4 Practical suggestions to enhance motor skills in the first year

Age and description	What you can do
0–3 months This is when infants spend most of their time sleeping and eating. Activity time is for strengthening their growing bones and muscles for gross motor skills.	*Posture and tummy time* Important to keep changing the posture for the infant—holding them up in different positions and placing their lying positions on their back, their tummy, their sides. This is the time you can introduce more 'tummy time', which provides important physical stimulation to promote brain and motor development. Activities where parents and carers interact with baby while they are on their tummy allow the infant to develop strength in their neck muscles as they practise keeping their head up. The infant also uses their limbs to reach, push, pull, kick and twist. All these actions stimulate the neural networks that drive their motor coordination and physical balance to make new connections and grow in complexity. As their limb coordination and overall strength improves, the infant will progress to crawling and other developmental milestones. *Reach and grab* Infants need to have space and interaction to progress with their motor skills. A play mat, where infants can spend some time lying on their back while they interact with an adult or a mobile toy, is great. They will start to reach and grab the toy or the adult's face. To encourage this further, parents and carers can help out by providing all kinds of shapes and textures for them to grab on to. *Massage* Massage has been used since ancient times to stimulate infants' neuromuscular system. Gentle massages of their limbs are a good way to help infants and toddlers to progress further. There are many websites that show how to massage infants for their well-being. *Bath time* Bath time is also a wonderful opportunity for playing with different textures and movement. Infants generally love the feel of the water and get excited by the splashing of the water when they kick. Parents and carers have to supervise infants and toddlers closely during bath times.
4–6 months In these months, infants are more awake and active.	*Rolling over* Tummy time on a play mat is still important so infants can progress to rolling over. Rolling is another important motor skill for infants to master as the action has many positive implications for the development of their neuromuscular system. In fact, rolling over is a technique used to ease back pain in physiotherapy. Never force infants into rolling but encourage their progress by placing objects around them that they are interested in investigating. *Crawling and climbing* Crawling and climbing succeeds rolling and is an important milestone for infants. By creating play tunnels and placing toys far apart in open areas, an infant is encouraged to crawl and climb. Having some designated time each day to simply be down on the floor playing and exploring is a great way to ensure a lot of exercise.

Age and description	What you can do
7–9 months This is a great time to sharpen those coordination and fine motor skills.	*Moving objects from hand to hand* Infants at this stage will start reaching, grabbing and transferring things from one hand to the other. It is important to encourage infants to grab with their non-dominant hand and pass toys from one hand to the other. *Move to music* Moving to music is also fantastic for this age group. This helps them develop a sense of rhythm in their movements. *Mirror mirror* A mirror activity is fun for infants at this stage because they are usually able to sit facing you for an extended period of time. Parents and carers can sit in front of them and have them follow your movements. *Pincer grasp* The pincer grasp is often mastered during this time period and this is also a very important aspect of their fine motor control development. A bottom drawer or cupboard in a safe space where the infant can crawl to can be filled with small cups, bowls and utensils. Infants will get used to crawling, opening 'their' drawer and taking out all of their things to play with.
10–12 months Again, the most important thing to do is to provide infants with time and space.	Many of their fundamental motor skills develop at this stage, including walking, running, climbing, rolling, throwing and kicking. Encourage infants to work on all of these skills in a safe and fun environment. *Climbing the stairs* Stairs are a great way to give infants some activity and a fantastic chance for them to develop some physical skills. With close supervision, infants can be allowed to crawl up the stairs at their own pace. An adult can model how to turn around at the top and come down feet first. Tossing a favourite toy up the stairs gets the infant going up and down a few times. *Playing with balls* A great stage to introduce balls of all shapes and sizes. Encourage infants to explore the balls, and then follow up with activities where the infant is able to sit and roll the ball back and forth. Throwing the ball can be the next action. *Walking and running and more* Provide infants and toddlers with as much opportunity as possible to walk and play. This will help them develop their intrinsic foot muscles and enhance their ability to balance and stay up on their feet. The faster they master their balance, the sooner you can go to the playground where they can further explore their new movement abilities.

SUMMARY

- Nature or nurture and continuous and discontinuous factors are fundamental debates to understanding key variability in physical development.
- There are key stages of physical development for infants and toddlers during the first three years of their lives. Parents, carers, educators and professionals can use these benchmarks to gain understanding of a child's physical development. While all children develop at different rates, there are norms that can guide early identification of delays and intervention for healthy growth.

This chapter focused on two children, Lulu and Daya. Some useful and practical suggestions have been included on how to enhance their motor skills. Their needs and how you plan to care for them to enhance their physical development will be your focus when you read Chapter 21.

- The brain plays an important role in a child's development of gross and fine motor skills. Neurological development indicates that infants and toddlers require the appropriate nurturing and stimulation from their environment for a healthy gross and motor skills attainment. Factors like sleep and nutrition can affect how the brain and the whole body grows accordingly.
- Milestone indications and assessment tools allow for early detection of risks and delays in physical development.
- Family and cultural practices that accelerate or inhibit growth can explain diversity in children's physical development. Hence, the context of a child's life is fundamentally crucial for their growth.
- Piaget's theory can be applied to understand the sensory and motor development that explains early locomotion and coordination.

Questions

1. What is important for physical development—nature or nurture?
2. How does continuous and discontinuous explain development?
3. How could you create more opportunities for interactions when working with infants and toddlers?
4. What strategies would you implement to help support the development of gross motor skill development at infancy?
5. What strategies would you implement to help support the development of fine motor skill development at infancy?

Further reading and resources

Baby Centre Australia—information site for pregnancy, baby and toddler health: <www.babycenter.com.au>

To read more about Sudden Infant Death Syndrome, you can visit <www.healthdirect.gov.au/sudden-infant-death-syndrome-sids>.

You can also visit SIDS Australia (<www.sidsandkids.org>); SIDS New Zealand (<www.sids.org.nz>) for more information.

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Department of Health Australia: <www.health.gov.au/internet/publications/publishing.nsf/Content/nat-fram-ucfhs-html~es>

National Quality Standards: <www.acecqa.gov.au/Childrens-health-and-safety>

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