# Part I
# Introduction

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**1** The Scope and Methods of Developmental Psychology

**2** Theories and Issues in Child Development

**3** The Nature–Nurture Issue

# 1 The Scope and Methods of Developmental Psychology

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## KEY TERMS

affect • baby biographies • behaviourism • catharsis hypothesis • clinical method • cohort • continuous function – decreasing ability • continuous function – increasing ability • control group • correlational studies • cross-sectional design • dependent variable • developmental functions • discontinuous (step) function • ecological validity • electroencephalogram (EEG) • event-related potential (ERP) • event sampling • experimental group • experimental methods • extraversion • folk theories of development • Flynn effect • functional magnetic resonance imaging (fMRI) • Head Start • imaging methods • independent variable • intelligence quotient (IQ) • intelligence test • introversion • longitudinal design • marker task • maturation • mechanistic world view • medial temporal (MT) area • microgenetic method • moral judgement stages • observational studies • organismic world view • paradigm • personality trait • positron emission tomography (PET) • psychological tests • sequential design • social policy • stage-like changes in development • stages of moral reasoning • structured observation • Sure Start • theory of mind • time sampling • U-shaped functions

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## OVERVIEW

The evidence base is the bedrock of the science of psychology, and developmental psychology is no exception. This chapter outlines the questions to which developmental psychologists seek answers, and shows that 'folk' theories of development often contradict each other and may find little support when research is done to test them.

The authors go on to present the different world views that form the basis for evidence-based accounts of human development, contrasting organismic and mechanistic views. This leads on to a discussion of research designs for studying age-related changes in development: longitudinal and cross-sectional designs are compared and the advantages and disadvantages of each are clearly stated.

This is followed by an account of some of the most frequently used research methods and the different forms of evidence that arise from observation, experimentation, psychological testing and correlational studies. In the case of many questions experimental research is more likely to yield results that can be interpreted in terms of cause and effect.

Having provided a detailed summary of research methodologies, the authors show how well-conducted research has radically changed our views about various aspects of development. Finally, they turn to a discussion of the most common developmental curves or functions that have emerged, that is, the ways in which humans typically grow and change as development proceeds. Not all development is gradual and continuous: it can be step-like, or show reversals and U-shaped or inverted U-shaped profiles.

Throughout the chapter the authors illustrate their points with fascinating examples drawn from current literature.

# INTRODUCTION

Developmental psychology can be defined as the discipline that attempts to describe and explain the changes that occur over time in the thought, behaviour, reasoning and functioning of a person due to biological, individual and environmental influences. Developmental psychologists study children's development, and the development of human behaviour across the lifespan, from a variety of different perspectives. Thus, if one is studying different areas of development, different theoretical perspectives will be important and may influence the ways psychologists and students think about, and study, development.

In this chapter we first discuss the role of age-related factors in affecting development. Then we describe different *concepts of human development* and human nature that have helped to shape people's thinking about development. The issues raised in these sections will recur later in the chapter as we present psychological evidence relating to them. Next we will give an account of some of the *research designs* used to explore development, followed by a description of different *developmental methods*. Finally we will present some of the *developmental functions* that have emerged from the research.

# STUDYING CHANGES WITH AGE

The newborn infant is a helpless creature, with limited means of communication and few skills. By 18–24 months – the end of the period of infancy – all this has changed. The child has formed relationships with others, has learned a lot about the physical world, and is about to undergo a vocabulary explosion as language development leaps ahead. By the time of adolescence the child is a mature, thinking individual actively striving to come to terms with a rapidly changing and complex society.

It is tempting to think that the many developments we find as childhood progresses are a result of age, but in this we must be careful. Increasing age, *by itself*, contributes nothing to development. What is important is the **maturation** and changes resulting from experience that intervene between the different ages and stages of childhood: the term maturation refers to *those aspects of development that are primarily under genetic control, and which are relatively uninfluenced by the environment*. An example could be puberty: although its onset can be affected by environmental factors, such as diet, the changes that occur are primarily genetically determined. With respect to environmental factors, we would not, for instance, expect a particular 4-year-old child to be more advanced in language development than a 2-year-old if, from the age of 2, the child had not been exposed to language at all. The normal 4-year-old will have been exposed to a multiplicity of agents, forces and events in the previous two years, and will have had the opportunity actively to explore and experiment with the world.

**maturation** aspects of development that are largely under genetic control, and hence largely uninfluenced by environmental factors.

Developmental psychologists study *age-related changes* in behaviour and development, but underlying their descriptions of these changes is the clear understanding that increasing age by itself causes nothing, and so we always need to look for the many factors that cause development to take place.

# CONCEPTS OF HUMAN DEVELOPMENT

The assumptions and ideas we have about human nature will affect how we rear our own children and how we interpret the findings from studies of children. Our implicit, lay or **'folk' theories of development** often reflect the issues that psychologists investigate, with the aim of putting our understanding on a firmer, more scientific footing. We will begin by discussing two such views – 'punishment or praise?' – and then we will discuss some of the theoretical views that have influenced psychologists' thinking about development.

**'folk' theories of development** ideas held about development that are not based upon scientific investigation.

## *'Folk' theories of development: Punishment or praise?*

We all of us have theories and views on how children should be reared. These views result from our own upbringing, our peers' experiences, our parents' ideas, the media and many other sources. These views will often influence how we bring up

our own children and there is often *intergenerational continuity* of childcare practices. For example, there are several ways in which children become attached to their caregivers (see Chapter 6) and these 'styles of attachment' may show continuity and stability across generations – from grandparents to parents to children (e.g., Benoit & Parker, 1994; Shaffer, Burt, Obradovic, Herbers & Masten, 2009; but also see Booth-LaForce & Roisman, 2014 and Chapter 6, this volume).

Here are two opposing views about the usefulness of physical punishment – see which one you agree with!

## Spare the rod and spoil the child

The dauphin, Louis, was born to King Henri IV of France in 1601 ('dauphin' means the eldest son of the king, and he became King Louis XIII at the age of 9). The king wrote to Louis' governess:

> I command you to whip him every time that he is willful or naughty, knowing by my own experience that nothing else did me so much good.
>
> *(From Wallace, Franklin & Keegan, 1994, p. 4)*

John Wesley (1703–91) was the founder of the religious Evangelical movement known as Methodism. He was the 15th of 19 children born to Samuel and Susanna Wesley. Here is part of a letter from Susanna Wesley (a woman of great piety) to her son John about how to rear children (cited in Sants & Barnes, 1985, p. 24):

> Let him have nothing he cries for; absolutely nothing, great or small; else you undo your own work . . . make him do as he is bid, if you whip him ten times running to effect it. Let none persuade you it is cruelty to do this; it is cruelty not to do it. Break his will now, and his soul will live, and he will probably bless you to all eternity.

At that time infant mortality was very high (why else have 19 children?), and Susanna Wesley's views originate from a belief that children are born in a state of sin and it is therefore necessary to use all means to save their souls, almost from birth. A similar view was expressed by Theodore Dwight (1834, *The Father's Book*) – 'No child has ever been (born) destitute of an evil disposition – however sweet it appears.'

## All sweetness and light: Like begets like

Compare these views with the following: 'Your baby is born to be a reasonable, friendly human being' (Benjamin Spock, from his book *Baby and Child Care*, 1946, cited in Sants & Barnes, 1985). Spock's book had a huge impact on American parents' rearing of their children. Here is an extract from the famous poem 'Children Learn What They Live' by Dorothy Law Nolte:

> *If children live with criticism they learn to condemn*
>
> *If children live with hostility they learn to fight*
>
> *BUT*
>
> *If children live with approval they learn to like themselves*
>
> *If children live with acceptance and friendship they learn to find love in the world*

In this and the previous section we have two opposing lay, or 'folk' theories about child rearing: (1) children need to be punished regularly in order to develop as pleasant, law-abiding citizens – failure to use harsh physical punishment carries with it the possibility, if not the certainty, that the child will grow up to be disobedient, and their very soul may be at risk; (2) the contrary view is that children are born inherently good, a view that carries the implication that the use of physical punishment might be unnecessary, perhaps even harmful.

We shall see later that research has given strong support to the latter view, but clearly the views and theories that parents and guardians have about child rearing will influence their own child-rearing practices. In much the same way that parents will be influenced by their 'folk' theories, developmental psychologists will be influenced by their theoretical leanings (which are not always based on a fully objective appraisal of the evidence!), and we discuss two of the most important of these next.

## Defining development according to world views

Psychologists, and others who study children's development, also have different views of development. The manner in which development is defined, and the areas of development that are of interest to individual researchers, will lead them to use different methods of studying development. We will describe two such different views of development that have been offered by psychologists holding different *world views*.

**paradigm** literally, a pattern or sample, the term is now frequently applied to a theoretical or philosophical framework in any scientific discipline.

The eminent developmental psychologist Richard Lerner defines a world view (also called a **paradigm**, *model*, or *world hypothesis*) as 'a philosophical system of ideas that serves to organise a set or family of scientific theories and associated scientific methods' (1986, p. 42). They are beliefs we adopt, which are often not open to empirical test – that is, we simply believe them!

Lerner and others note that many developmental theories appear to fall under one of two basic world views: *organismic* and *mechanistic*. Only a superficial description of these two world views will be presented here (Lerner, 1986, Chapter 2, gives a detailed discussion, and Hultsch & Deutsch, 1981, give a concise summary). In Chapter 2 we describe some of the theories of development that 'fit into' these theoretical views.

**organismic world view** the idea that people are inherently active and continually interacting with the environment, and therefore helping to shape their own development. Piaget's theory is an example of this world view.

### Organismic world view

According to the **organismic world view** a person is represented as a biological organism that is *inherently active and continually interacting with the environment, and therefore helping to shape its own development*. This world view emphasises the interaction between maturation and experience that leads to the development of new internal, psychological structures for processing environmental input (e.g., Geldhof *et al.*, 2015; Gestsdottir & Lerner, 2008).

As Lerner states: 'The Organismic model stresses the integrated structural features of the organism. If the parts making up the whole become

reorganised as a consequence of the organism's active construction of its own functioning, the structure of the organism may take on a new meaning; thus qualitatively distinct principles may be involved in human functioning at different points in life. These distinct, or new, levels of organization are termed stages . . .' (p. 57). An analogy is the qualitative change that occurs when molecules of two gases, hydrogen and oxygen, combine to form a liquid, water. Other qualitative changes happen to water when it changes from frozen (ice) to liquid (water) to steam (vapour). Depending on the temperature these qualitative changes in the state of water are easily reversed, but in human development the qualitative changes that take place are rarely, if ever, reversible – that is, each new stage represents an advance on the preceding stage and the individual does not regress to former stages.

The point is that the new stage is not simply reducible to components of the previous stage; it represents new characteristics not present in the previous stage. For example, the organism appears to pass through structural stages during foetal development (which is discussed in detail in Chapter 4). In the first stage (Period of the Ovum – first few weeks after conception) cells multiply and form clusters; in the second stage (Period of the Embryo – two to about eight weeks) the major body parts are formed by cell multiplication, specialisation and migration as well as cell death; in the last stage (Period of the Foetus) the body parts mature and begin to operate as an integrated system, for example, head orientation towards and away from stimulation, arm extensions and grasping, thumb sucking, startles to loud noises, and so on (Fifer, 2010; Hepper, 2011). Similar stages of psychological development beyond birth are postulated to occur as well.

Piaget is perhaps the best example of an organismic theorist, and his views are discussed in the next chapter, and also in Chapters 9 and 16. In brief, Piaget suggested that cognitive development occurs in stages and that the reasoning of the child at one stage is qualitatively different from that at the earlier and later stages. The job of the developmental psychologist subscribing to an organismic viewpoint is to determine *when* (i.e., at what ages) different psychological stages operate and *what* variables, processes, and/or laws represent the differences between stages and determine the transitions between them.

## Mechanistic world view

According to the **mechanistic world view** a person can be represented as being like a machine (such as a computer), which is inherently passive until stimulated by the environment. Ultimately, human behaviour is reducible to the operation of fundamental behavioural units (e.g., habits) that are acquired in a gradual, cumulative manner. According to this view the frequency of behaviours can increase with age due to various learning processes and they can decrease with age when they no longer have any functional consequence, or lead to negative consequences (such as punishment). The developmentalist's job is to study the environmental factors, or principles of learning, which determine the way organisms respond to stimulation, and which result in increases, decreases, and changes in behaviour.

**mechanistic world view** the idea that a person can be represented as being like a machine (such as a computer), which is inherently passive until stimulated by the environment.

**behaviourism** the theoretical view, associated with J.B. Watson and B.F. Skinner, that sees directly observable behaviour as the proper focus of study, and that sees the developing child as a passive respondent to conditioning, reinforcement, and punishment.

Unlike the organismic view development is reflected by a more continuous growth function, rather than occurring in qualitatively different stages, and the child is passive rather than active in shaping its own development. **Behaviourists** represent this world view, and their views are discussed in Chapter 2.

# WAYS OF STUDYING DEVELOPMENT

Developmental psychologists have a variety of strategies with which to study development. These various strategies can be subdivided into two broad, interrelated categories – designs that enable us to study age-related changes in behaviour, and the associated research methods that are used to collect the information or data about development. These are discussed under the next two broad headings – *Designs for studying age-related changes* and *Research methods*.

## Designs for studying age-related changes

In all studies which describe behavioural changes with age, one of two general developmental designs, either the *cross-sectional* or the *longitudinal*, are used. Here we discuss the strengths and weaknesses of these designs. Many examples of research using these designs are presented later in this chapter, and throughout this book. There is a third approach – the *sequential design* – which often gives a partial solution for the limitations imposed by the use of only one method.

### Cross-sectional designs

**cross-sectional design** a study where children of different ages are observed at a single point in time.

In a **cross-sectional design** people of different ages are tested once; thus, each point on the X-axis (the horizontal axis of graphs, such as those shown in Figures 1.1, 1.3 and 1.12) is represented by a different age group. This is the most common method employed by developmental researchers because it is the least time-consuming and provides a quick estimate of changes with age. However, it only describes age differences. There is no way to derive an estimate of the continuity or discontinuity of various processes over age (e.g., stability of personality; sudden shifts in language comprehension or production) because performance is averaged over *different* individuals at each age.

**longitudinal design** a study where more than one observation of the same group of children is made at different points in their development.

### Longitudinal designs

In **longitudinal designs** people are tested repeatedly as they grow older. This method is powerful because each individual's development is measured over time, allowing one to assess *within-person* changes with age and *between-person* differences in age changes. In many cases

the data are summarised by plotting the group average as a function of age; but, by looking at each individual's data, we can determine if there is a gradual change with age or a sudden shift in performance more characteristic of stage-like development (these and other types of developmental change are discussed later under *developmental functions*). There are many types of longitudinal designs. They may take place over a long period of time. An example is the Avon Longitudinal Study of Parents and Children (ALSPAC). This is a large-scale study of children born in Avon, UK, in the early 1990s, which recruited over 14,000 pregnant mothers-to-be, and is a major resource for the study of genetic and environmental factors contributing to long-term health and development. To date, ALSPAC findings have been reported in over 700 scientific publications (Boyd *et al.*, 2013). At the other extreme there are *microgenetic* studies in which typically only a few children are tested over a short period of time: examples of such studies are given in the next section.

Unfortunately, there are several problems with longitudinal designs as well, particularly studies such as ALSPAC. The cost is very high in several respects. They are time-consuming, it may be difficult to schedule repeated visits of the same children, and the drop-out rate can be very high. If those who find the task difficult or leave the area withdraw from the study, this *participant attrition*, with the accompanying *selective survivorship* of the remaining children in the sample, can produce a population bias that can give a misleading impression of development and may limit the generality of the results.

Another major problem can be the time it takes to complete a study – it equals the age span being tested. If, for example, the task is to map changes in performance on **IQ tests** between age 20 and 80, it would take 60 years to complete the study! And, after all that work, the results may only be true for the particular age **cohort** studied (those born at about the same time), producing yet another population bias. There is one final problem we can mention, which is the possible effects of repeated testing – children might get better over age simply because they have more practice on the tasks they are given! As a result, the data might not reflect typical development in the absence of this repeated practice.

**cohort** a group of people who were raised in the same environment or who share certain demographic characteristics.

## Microgenetic methods

A combination of procedures that are becoming increasingly popular are referred to as the **microgenetic method**. Developmental psychology is fundamentally concerned with change, and with the causes and consequences of change. However, most research, whether using cross-sectional, longitudinal or other designs, provides a snapshot of developmental changes, without describing the process of change itself (Flynn, Pine & Lewis, 2006). Microgenetic methods examine change *as it occurs*, and involve individual children being tested repeatedly, typically over a short period of time, so that the density of observations is high compared with the typical longitudinal study. Thus, the method provides detailed information about an individual, or individuals, over a period of transition. The microgenetic method has been used in many areas of development, which include arithmetic, theory of mind, locomotion, memory, analogical reasoning, strategy use, conscious

**microgenetic method** a method that examines change as it occurs and involves individual children being tested repeatedly, typically over a short period of time so that the density of observations is high compared with the typical longitudinal study.

and unconscious reasoning, and, quite simply 'By examining change as it occurs this method can yield more precise descriptions than would otherwise be possible' (Flynn *et al.*, 2006, p. 154).

## When longitudinal and cross-sectional results tell a different story

Usually researchers try to obtain both longitudinal and cross-sectional data on any topic. In general, we expect to obtain similar developmental functions from cross-sectional and longitudinal data, and usually this is the case. However, this does not always happen, and the two designs can sometimes give us dramatically different results. Two instances of conflicting results will be discussed; the first concerns the *length of time between measures* (the age scale) and the second concerns *cohort effects*.

**Time between measures** In designing a developmental study one must decide what intervals to use on the X-axis, that is, at what ages the children are to be tested or how often repeated tests will be administered. When studying infants, it is common to test them monthly or bi-weekly in longitudinal studies, depending on when we expect to see an age difference in performance appear. The transition point for changes in performance with age can be estimated using cross-sectional data. While this may be appropriate in most cases, sometimes different distances between test ages can result in very different developmental functions.

An interesting example involves physical growth, which usually is represented as a continuous, increasing growth curve. This is shown in Figure 1.1, where the filled circles connected by a solid line have been estimated from a normative study

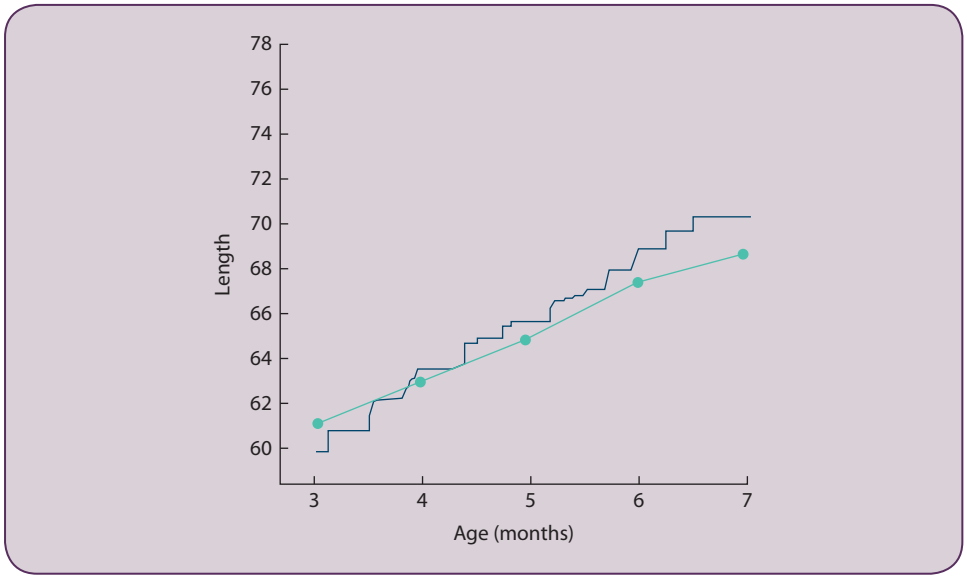


**FIGURE 1.1** *A comparison of the continuous-growth function for length/height derived from averaged data from cross-sectional studies (the solid line connected by the filled circles) with the step-like function (sudden increases in length followed by periods of no growth) derived from daily measures on individual infants.*

by Babson and Benda (1976) which is based on a combination of cross-sectional and longitudinal data. The function looks continuous, and the shape matches the monthly longitudinal data they reported for a few 'normally' growing individual infants. By contrast, a discontinuous step-like function was found by Lampl *et al.* (1992) when they made daily or weekly measures of the growth in the length of a small number of infants during the first 21 months from birth. Lampl *et al.* analysed individual growth functions and discovered that the main change in length occurred in sudden bursts followed by longer periods of no change, and they suggest that 90–95 per cent of development during infancy is growth free, and that throughout development continuous growth charts do not represent how individuals grow (Lampl & Thompson, 2007). Indeed, in daily measures, children were found to grow substantially, as much as 1 centimetre, in a sudden burst, in many cases overnight, and then not change for an average of 12 days. This is shown in Figure 1.1 where a summary of the growth pattern of one infant in Lampl *et al.*'s study is pictured by the thin line overlaying Babson and Benda's normative curve.

This may come as no great surprise to some parents who report that their babies seemed suddenly to outgrow their sleeper (or 'babygrow') overnight! The main point is that according to Lampl *et al.* changes in size occur in a discontinuous progression with the most common state being 'no change' at all. This developmental function is not revealed unless frequent measures are taken on individuals. It should be noted that if all of Lampl *et al.*'s data were collapsed across individuals and plotted as a function of monthly age groups, the curve probably would look like Babson and Benda's continuous age function.

**Cohort effects** A serious design problem, which is particularly relevant for studies covering a large age range, involves cohort effects. This is where there are changes across generations in the characteristic one is interested in. Here are a few examples of such effects.

***Height:*** the average height of the Western 20-year-old male has risen from around 5 ft 7 in (1.52 m) in the early 1900s to around 5 ft 10 in (1.78 m) by 2015. This has resulted from gradual improvements in diet and medical care which make foetal life in the womb and post-natal life healthier.

***Attitudes:*** There have been many changes in important psychological characteristics over generations. Consider, for example, current attitudes towards homosexuality – how do you think they have changed over the last 50 years?

***Leisure activities:*** Western children spend much more time in sedentary activities, such as watching television, playing video games, surfing the internet, etc. than their counterparts of 50 or 60 years ago, for whom such activities simply didn't exist.

***Everyday life:*** Huge changes have occurred in everyday life in recent generations which combine to produce substantial intergenerational psychological changes. In addition to changes in leisure activities consider the impact

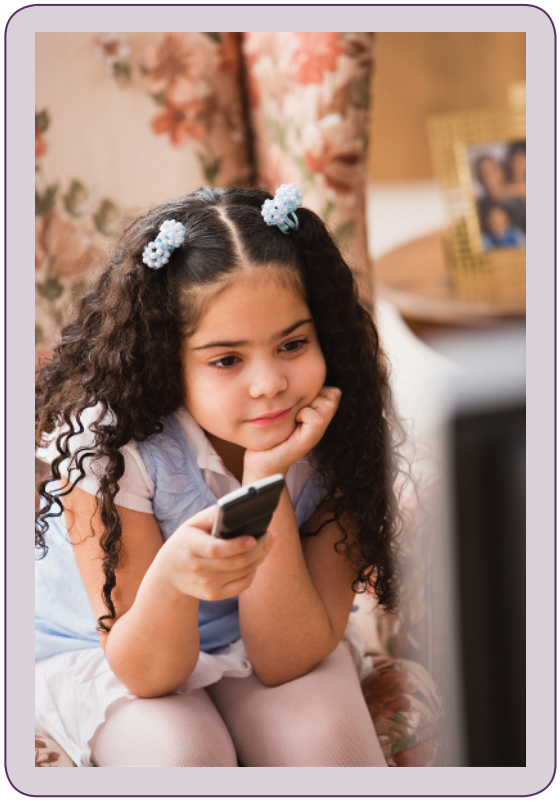

**FIGURE 1.2** *Watching television is now a common leisure activity for Western children.*

*Source:* Blend Images/Shutterstock.

of better, more affordable cars and better transport in general, household appliances such as washing machines and televisions (Figure 1.2), electronic devices such as computers, mobile phones, iPods – the luxuries of yesteryear become today's necessities and, of course, electronic devices were not available a generation ago.

***Intelligence:*** In much the same way that height has increased over generations, so too has measured intelligence (**intelligence quotient** or IQ as measured by **intelligence tests**). This means that the findings from early cross-sectional studies gave a different account of the development of intelligence across the life span than more recent studies – these findings are described in the next section.

## Sequential designs

One possible way of investigating the different findings that might result from longitudinal and cross-sectional designs is with the use of what are called **sequential** or *age/cohort* designs. These studies involve a combination of designs, and are fairly rare (in large part because of the costs and time involved). We will illustrate this design with a schematic drawing of performance on one intelligence test (known as *visualisation performance* – the precise details of the test are not important for our purposes), adapted from Nesselroade *et al.*, 1972, which is shown in Figure 1.3. In this figure, adults in five different age groups (30, 37, 44, 51 and 58 years – the *cross-sectional* aspect of the study) were tested twice (seven years apart – the *longitudinal* part) giving us overlapping age groups.

The results show two effects. There is a *cohort effect*, resulting from testing different adults of different ages at about the same time: this is the lower performance by the older age groups, illustrated by the dotted line connecting the cross-sectional data. There is also a contrasting, *longitudinal effect*, where the same individuals tested at two ages show a slight improvement in performance over age, illustrated by the solid lines connecting each pair of longitudinal points for the five age groups. Thus, IQ scores have been increasing over generations, a phenomenon referred to as the **Flynn effect**.

**intelligence quotient (IQ)** an IQ score gives an indication of an individual's intelligence compared with other individuals of the same *chronological age*.

**intelligence test** Any test that aims to measure an individual's intellectual ability.

**sequential design** a combination of longitudinal and cross-sectional designs that examines the development of individuals from different age *cohorts*.

**Flynn effect** an increase in the average intelligence quotient (IQ) test scores over generations.

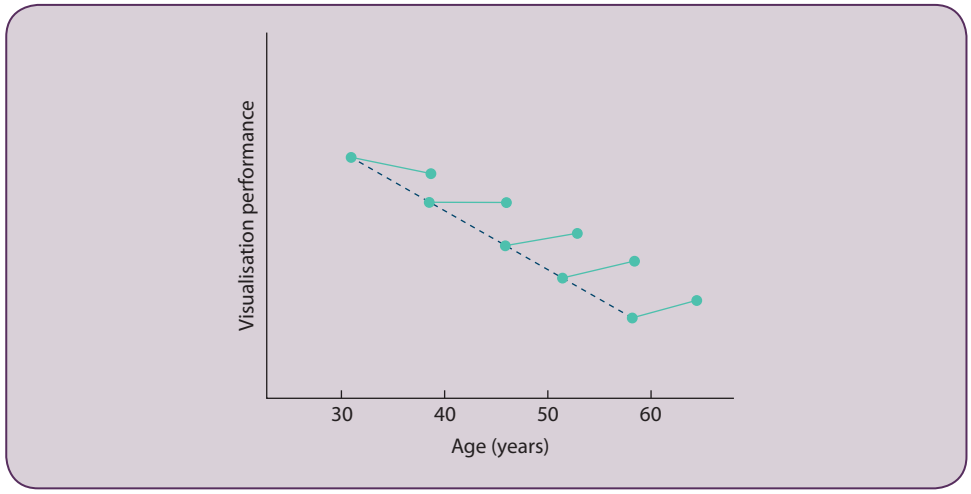


**FIGURE 1.3** *The use of a sequential design with an intelligence test demonstrates that different results can emerge from cross-sectional findings (the cohort effect shown by the downward sloping dotted line) and longitudinal findings (the solid lines).*

However, when the same individuals are tested over time their scores remain relatively static. Thus, intelligence does not decline with age, but the environment has improved over successive generations. The Flynn effect is discussed in more detail later in this chapter, and also in Chapter 16.

Although sequential designs are not used often, when they are used they provide a measure of individual differences and reveal whether or not longitudinal and cross-sectional results agree. We now turn to an account of the different *research methods* which are used to collect data on children's development.

**observational studies** studies in which behaviour is observed and recorded, and the researcher does not attempt to influence the individual's natural behaviour in any way.

**experimental methods** experimental methods control an individual's environment in systematic ways in an attempt to identify which variables influence the behaviour of interest.

**psychological tests** instruments for the quantitative assessment of some psychological attribute or attributes of a person.

**correlational studies** studies that examine whether two variables vary systematically in relation to each other, e.g. as height increases, will weight reliably increase also?

## Research methods

The research designs that we have discussed always incorporate one or more developmental *research methods* in order to investigate development. Developmental psychologists employ a variety of methods, and here we will discuss some of the most important: **observational studies**, **experimental methods**, **psychological testing** and **correlational studies**.

### Observational studies

**Baby biographies** Perhaps the simplest in form is the case study, which involves repeated observations of the same person over time. These observations are usually of infants, and are made by parents or caregivers who are close to the child. These are often called baby

**baby biographies** diaries detailing an infant's development, usually kept by the infant's parents or caregiver. Charles Darwin's biography of his eldest son's development is a well-known example.

diaries, or **baby biographies**, which may either describe several aspects of development, such as Darwin's biography described below, or may focus on a more specific type of development, such as emerging musicality (Forrester, 2010).

Charles Darwin wrote a delightful biographical sketch of the development of his first born son – William Erasmus Darwin (in Slater & Muir, 1999). William Erasmus (nicknamed 'Doddy') was born on 27 December 1839, but Darwin's account of his development was not published until 1877, by which time Charles and his wife Emma had had another nine children, five boys and four girls (Darwin, 1877/1999): thus Darwin was able to compare his eldest child with his others. We will give four extracts from this account in order to illustrate some of the strengths and weaknesses of such biographies:

> ***Seeing:*** 'With respect to vision, – his eyes were fixed on a candle as early as the 9th day, and up to the 45th day nothing else seemed thus to fix them; but on the 49th day his attention was attracted by a brightly coloured tassel . . .'
>
> ***Hearing:*** 'Although so sensitive to sound in a general way, he was not able even when 124 days easily to recognise whence a sound proceeded, so as to direct his eyes to the source.'
>
> ***Anger:*** 'When two years and three months old, he became a great adept at throwing books or sticks, etc., at anyone who offended him; and so it was with some of my other sons. On the other hand, I could never see a trace of such an aptitude in my infant daughters; and *this makes me think that a tendency to throw objects is inherited by boys*.' (italics added)
>
> ***Moral Sense:*** (When 2 years and 7½ months) 'I met him coming out of the dining room with his eyes unnaturally bright, and an odd unnatural or affected manner, so that I went into the room to see who was there, and found that he had been taking pounded sugar, which he had been told not to do. As he had never been in any way punished, his odd manner certainly was not due to fear and I suppose it was pleasurable excitement struggling with conscience. . . . *As this child was educated solely by working on his good feelings, he soon became as truthful, open, and tender, as anyone could desire*.' (italics added)

While such case studies provide a rich source of ideas and insights, they have many obvious weaknesses. Despite the fact that Darwin was one of the finest observers of natural behaviour who has ever lived, we now know that his account of the development of vision and hearing is wrong. As is described in Chapter 5 we know from careful experimentation that although vision at birth is poor it is sufficient for the infant to begin learning about the visual world: for instance, within hours from birth infants will prefer to look at their mother's face when hers is shown paired with that of a female stranger (Bushnell, 2003; see Figure 1.4). We also know that newborn infants can localise sounds at birth, an ability that Darwin was unable to detect in his son, even at 124 days (4 months). We will discuss auditory localisation later (under 'Developmental Functions').

**FIGURE 1.4** *Which one is mother? A few hours after birth newborn infants prefer to look at their mother's face.*
*Source:* Dr. Ian Bushnell. Reproduced with permission of Dr. Ian Bushnell.

We can notice weaknesses in the italicised extracts from 'Anger' and 'Moral Sense': in both of these Darwin is expressing untested theoretical views which are derived either from observations of just a few children or from a 'folk theory of development' of the sort we discussed earlier. With respect to 'Anger', Darwin suggests that there may be inherited gender differences in acts of aggression, and indeed there is clear evidence that the majority of physically aggressive acts are committed by males. With respect to 'Moral Sense', note that Darwin is assuming that children brought up in the absence of physical punishment will display less anti-social behaviour in later life. We will comment on this later, in the section on 'Experimental Methods', but it turns out that Darwin was right: that is, the use of punishment is not a good way of changing behaviour, and children disciplined with the use of physical punishment are more likely to misbehave and become aggressive.

The weaknesses of such accounts include problems of generalisation – one or two children hardly constitute a representative sample of the population. Also, the observations tend to be unsystematic, and in many cases are retrospective – that is, events described long after their occurrence. Baby biographers may have strong theoretical biases which lead them to note anecdotes supporting their own theories.

The strengths of such accounts are primarily twofold: (1) the biographer can give a detailed account of subtle changes in behaviour because of their intimate knowledge of the child; (2) the observations can lead to the production of theories of child development, which can then be given a more systematic (often experimental) test.

## Time and event sampling

**Time sampling** is an observational method in which individuals are studied over a period of time, and at frequent brief intervals during this period a note is made – usually by an observer but sometimes by the individuals themselves – of whether or not certain behaviours of interest are occurring. For example, a researcher might watch a child over a 20-minute play period, noting every 30 seconds for a 5-second interval, whether the child is playing alone, playing with others, not playing, being aggressive, and so on.

**Time sampling** an *observational study* that records an individual's behaviour at frequent intervals of time.

Here is one study to illustrate the use of this method. Lee and Larson (2000) sampled 56 high school seniors (17–18-year-olds) in South Korea and 62 seniors (17-year-olds) in the United States. Each student was studied for one month and was provided with an electronic timer which gave a beep seven times a day at randomly spaced intervals over the period between approximately 7.00 am to 11.30 pm. Every time the beeper sounded the student was asked to note down (a) what they were doing, and (b) their **affect** state (i.e. whether they were happy, sad, etc.) as it was just before the beeper sounded. What they found was that the Korean students recorded many more times spent in schoolwork and much less time in other (e.g. recreational) activities than the American students. We know that academic stress heightens student anxiety levels (Leung *et al.*, 2010) and what Lee and Larson found was that the Korean students experienced many more negative affect states (i.e. they were more depressed) than their American counterparts. This suggests that the Koreans' ordeal of studying in preparation for the competitive college entrance examinations was causing them considerable distress and depression.

**affect** emotional state or feelings. Contrast with behaviour (what one does in a situation) and *cognition* (how one thinks about a situation).

While the greater academic stress experienced by the Korean students clearly has negative consequences, there are positive rewards: in the biggest ever global school rankings published to date, by the Organisation for Economic Cooperation and Development (2015) the top five performers were Asian – Singapore, Hong Kong, South Korea, Japan, Taiwan (the UK and the US were, respectively, 20th and 28th).

The Lee and Larson study, and other time sampling studies, record the participants' behaviour at frequent intervals over a period of time, and simply note what is happening at each recording period. The aim is to get an idea of how frequently different behaviours occur during the total observation period. However, there are two interrelated criticisms of time sampling. One is that the researcher may not get an accurate record of the amount of time spent in different behaviours – quite simply, many naturally occurring behaviours may not be happening when each behaviour sample is taken! The other is that many behaviours of interest may simply not occur, or might be missed, during the period that recording is taking place.

**Event sampling** is an alternative method that avoids these problems. As the name suggests, in this procedure the researchers actively select the type of event that they want to observe. This event is then recorded, usually *throughout* its time period (rather than at intervals as would be the case for time sampling) on a continuous basis – for this reason this type of event sampling is also known as *continuous sampling*, and it is the most common observation method used in child development research. There are innumerable events that are of interest to child psychologists. The following list, while long, is not exhaustive!

**event sampling** an *observational study* which records what happens during particular events. Events studied include playing, bathtime, feeding, and reading.

quarrels, anger episodes, fear episodes, frustration, success episodes, failure episodes, competition episodes, cooperation episodes, problem-solving, prosocial episodes, antisocial times, play with pets, play with others, solitary play, school recitations, toilet-training, discipline periods, first school day, bedtime activities, reading with mother, weaning, feeding, illness, vaccinations, school leisure times, mother–infant social engagements . . .

Although these methods look like longitudinal designs their aim is to accumulate data systematically rather than to investigate change over time. A final point to note is that the baby biographies, referred to earlier, used both time and event sampling procedures, but not in a particularly systematic fashion.

**The clinical method** The greatest developmental psychologist of all time, Jean Piaget, studied the development of his three children during their infancy. He kept very detailed records of their development, but instead of simply recording their development, which is typical of the baby biographers, he would note an interesting behaviour and then, in order to understand it better, he varied the task to note any changes in the infant's response. This technique, which is a combination of observation and loosely structured experimentation, is known as the **clinical method**. He also used this method extensively with other children, and an example of this method with children is given in Chapter 2. Here is a brief extract (Piaget, 1954, pp. 177–178) to illustrate the procedure – Piaget observed his son Laurent (aged 6 months 22 days) when reaching for objects:

**clinical method** research method first used by Piaget whereby natural behaviour is observed and then the individual's environment is changed in order to understand better the behaviour of interest.

> Laurent tries to grasp a box of matches. When he is at the point of reaching it I place it on a book; he immediately withdraws his hand, then grasps the book itself. He remains puzzled until the box slides and thanks to this accident he dissociates it from its support.

Piaget's reasonable interpretation of this observation is that when one object is on top of, and hence touching, another object, his infant did not realise that there were two objects. In fact, it was not until he was 10 months old that he:

> immediately grasps matchboxes, erasers, etc., placed on a notebook or my hand; he therefore readily dissociates the object from the support (p. 178).

## *Experimental methods*

The majority of investigations of child behaviour and development are experimental in nature. Behaviour does not occur, and development does not take place, without a *cause*. The aim of the experimenter is to specify, in as precise a manner as possible, the causal relationships between maturation, experience and learning, and behaviour. The essential aspect of experimental techniques is *control*. A situation is constructed which enables the experimenter to exert control over the causal variables that influence

**independent variable** a factor or variable in a study or experiment which can be systematically controlled and varied by the experimenter to see if there are changes in the child's response. The behaviour that changes is called the *dependent variable*.

the behaviour of interest. One of these factors, which is called the **independent variable**, is varied in a systematic fashion, and objective measurements are made of any changes in the child's behaviour. The behaviour that is measured is called the **dependent variable** since (if all goes well!), changes in this behaviour are dependent upon, that is, caused by, changes in the independent variable. The following is a good example of application of the experimental method to a developmental phenomenon.

**dependent variable** the behaviour that is measured or observed in a study. Changes in the behaviour are dependent on, that is, caused by, changes to the *independent variable*.

**Why do infants grasp pictures of objects?** Judy DeLoache and her colleagues have described one of the errors that children make with objects. This is where children seem to confuse objects with pictures and may try to pick up pictures as if they were the objects they depict.

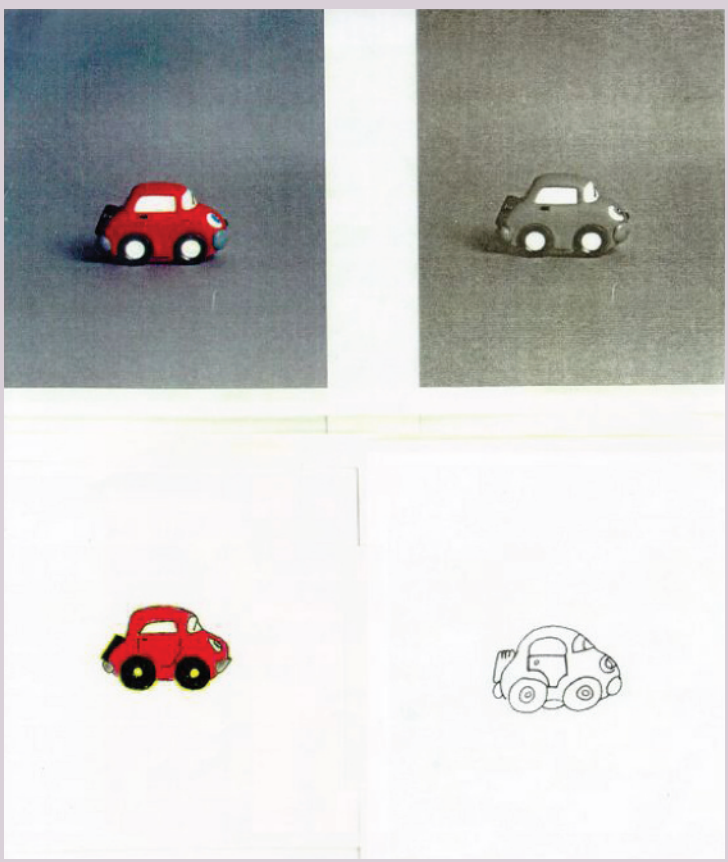

**FIGURE 1.5** *An example of a 3D toy car (top left) and three 2D representations of the car.*

*Source:* Dr. Sophia Pierroutsakos. Reproduced with permission of Dr. Sophia Pierroutsakos.

To illustrate the experimental method we will describe this effect (DeLoache *et al.*, 1998). The famous Belgian experimental psychologist Albert Michotte (1881–1965) discussed the meaning of objects and the way in which a picture of an object represents the real object. Note that adults do not confuse objects with pictures except under special viewing conditions – perhaps looking with one eye, or being given *binocular stereoscopic images* (these are where slightly different images are presented to the two eyes so that they give the illusion of solidity and three-dimensionality). If someone were to ask us to pick up a pictured object we'd think them very strange! However, children often think differently.

DeLoache *et al.* (1998) tested 9-month-old infants and their *independent variable* was the extent to which the objects depicted in pictures looked like the real thing. They had four versions of pictorial representations, which were, in order of realism: (1) a highly realistic coloured photograph of real objects (such as a toy car); (2) a black-and-white photograph; (3) a coloured line drawing of the object; and (4) a black-and-white line drawing. All of the depicted objects measured approximately 3 cm × 3 cm, a size that matches the size of the infants' grasp. An illustration of these is given in Figure 1.5. Their *dependent variable* was the amount of manual investigation of the depicted objects, which included attempts at grasping them. The results are shown in Figure 1.6 and clearly show that the closer the depicted object is to the real object, the greater the amount of manual exploration. Sometimes the pictured object is just too enticing! (Figure 1.7).

Deloache *et al.* had other experimental conditions. Their 1998 paper describes two experimental findings: a *cross-cultural* comparison – 9-month-old infants from two extremely different societies (the United States and the West African republic of the

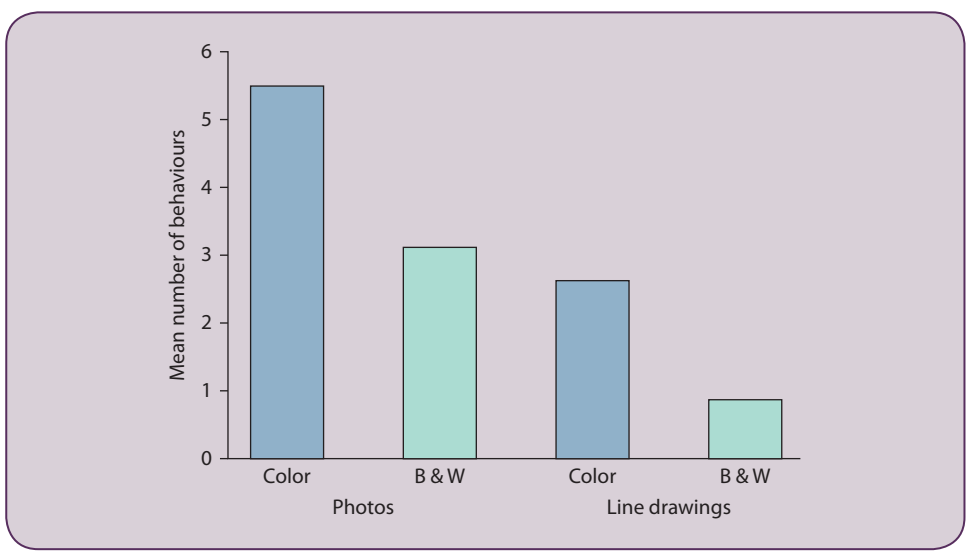


**FIGURE 1.6** *Grasping and reaching behaviours were clearly related to how realistic the pictures were; the more the pictures looked like the real object, the more exploration they evoked.*

**FIGURE 1.7** *A 9-month-old infant as he grasps and mouths a photograph of a baby bottle – the picture is just too enticing!*

*Source:* Dr. Sophia Pierroutsakos. Reproduced with permission of Dr. Sophia Pierroutsakos.

Ivory Coast) produced the same reaching and grasping behaviour; a *cross-sectional* study, where different infants were tested at three different ages (9, 15 and 19 months) – the younger infants reached and grasped, by 15 months this behaviour was rare, and by 19 months of age they merely pointed at the pictures. Note that in this instance the *independent variable* is the age of the infants. In a further experimental condition 9-month-olds were presented with the realistic picture and the real object – in this condition none of the infants reached for the picture! Presumably, under these conditions the real object was clearly seen to be more realistic and graspable than the picture.

Deloache *et al.* interpret their intriguing results as indicating that the younger, 9-month-olds, do not understand the ways in which depicted objects are both similar to and different from real objects: when the real object is not present they treat the pictures as if they were real objects because in many ways they *look* like real objects. As they gain experience the infants develop a more sophisticated understanding of the relationship between the pictures and the objects they depict, and learn that pictures are *representations* of objects.

Deloache *et al.* are able to tell a convincing developmental story of the nature and development of infants' understanding of pictures and objects. In these experiments the independent variables – such as the realism of the pictorial representations and the age of the infants – were systematically varied, and the experimenters then carefully observed the babies' reaching responses. Sometimes this sort of experiment is called a **structured observation**, and there are those who would distinguish between this sort of experiment and those involving more formal or precise measures of the dependent variable. There is clearly an element of observation in many, perhaps most, experimental studies of children's development.

## *Psychological testing*

**structured observation** an *observational study* in which the *independent variable* is systematically controlled and varied, and the investigator then observes the child's behaviour. Similar to an experiment but the degree of control is less precise than in a laboratory setting.

Psychological tests can be defined as *instruments for the quantitative assessment of some psychological attribute or attributes of a person*. The developmental psychologist has available a wide variety of tests for measuring psychological functioning at all ages of childhood. These include tests of motor development, personality development, aptitudes (perhaps mechanical or musical or scholastic achievement), achievement, motivation, self-esteem, reading ability, general intelligence and many others.

Such tests are usually carefully standardised on large samples of children of the appropriate age groups, and norms (i.e. average scores and the range or spread of scores) for various age and gender groups are often available. Researchers, or testers, can compare their sample of children (or individual children) against the appropriate norms. Clear and precise instructions for administering and scoring the test items are usually included with the published test.

**Types of test items** The type of item included in a particular test will depend both on the age group it is intended for and what is being measured. Tests of infant development usually consist of careful observations of the child when confronted with a number of standard situations: Can they stand alone? Can they build a tower of 5 bricks? and so on. Beyond about 2 years of age tests make increasing use of

**FIGURE 1.8** *Building a brick tower – a test of infant development.*

*Source:* Noam Armonn/Shutterstock.com.

children's ability to use language, and the instructions given to the child are typically in a verbal form. Thus, in a test of intelligence the child might be asked to solve problems, to give the meanings of words, to say in what way(s) two or three words are similar in meaning, to trace a pathway through a maze, and so on.

**Can test scores predict later development?** Tests of ability and intelligence become increasingly accurate in predicting later behaviour (for example, school achievement) as children get older (Chapter 16 presents findings on the predictability of IQ scores in adolescence from scores obtained in earlier childhood). However, attempts to predict adult personality from measures of personality in earlier childhood have usually not been very successful. There are a couple of exceptions: children who are shy or bold as infants tend to become adults who are shy or bold; the child who fights with other children a lot is likely to become the adolescent who is judged by peers to be aggressive (see Chapter 15). In fact, aggression shows greater continuity across childhood and adolescence than any other facet of personality.

**personality trait** facet of a person's character that is relatively stable. Examples of personality traits include shyness, *extraversion*, and confidence.

**extraversion** a personality variable. Someone who scores highly on an extraversion scale will typically be an outgoing and confident person.

**introversion** a personality variable. Someone who scores highly on an introversion scale will typically be very quiet and reserved.

However, the term *personality* is extremely difficult to define, and **personality traits** are difficult to measure precisely. One problem with measuring personality is that the most important personality traits – such as **extraversion**, **introversion**, sociability, suggestibility – are *social* in nature and may vary depending on the different types of social settings individuals find themselves in. Thus, although there may be some underlying stability of a shy/bold personality, the child who is sociable and outgoing with their family and friends may be shy and withdrawn in the classroom. Furthermore, changing life experiences alter behaviour and attitudes: an adolescent will be treated differently from a 7-year-old, and this will affect the way the individual behaves and responds.

**Uses of tests** The uses of tests by developmental psychologists are many and varied. Tests are regularly used in *clinical* and *educational assessment*, to gain an understanding of an individual child and to see how they compare with others of the same age and gender.

Another use is to select groups of children for participation in an experiment, and then to evaluate the results of the experiment. Suppose a researcher is interested in evaluating a new scheme for teaching children to read. They may then wish to divide children into two groups of equal reading ability: to select these groups the researcher will give the children a standardised test of reading ability, and will perhaps also administer a test of general intelligence. On the basis of the test scores the children would be matched in terms of ability, usually in pairs. One of the matched pair will then be randomly assigned to the experimental and the other to the control group, resulting in two groups of children who are equated on the two variables of reading ability and intelligence. In this sort of experimental situation the group of children who receive the new reading scheme are often known as the **experimental group** (since they are to be experimented on!), and the other group, which simply receives the

**experimental group** the group of individuals who receive a particular treatment or manipulation. In order to measure the effectiveness of the treatment, their results are compared with those from a *control group* that does not receive the treatment.

**FIGURE 1.9** *Teaching a young child to read.*
*Source:* Tatiana Belova/Shutterstock.

usual, 'old' reading scheme, are the **control group**. When the two groups have had their different reading experiences they would then be assessed again on a standardised reading test: if the children in the experimental group now have higher reading scores than those in the control group we can perhaps conclude that the new reading scheme is a success!

**control group** In order to evaluate the effectiveness of a particular treatment or manipulation, the control group is that group of individuals in an experiment who do not receive the treatment. Their behaviour is then compared with that of the *experimental group*, which does receive the treatment.

## Correlational studies

Let us begin with a definition: a correlation coefficient is a statistic between +1 and –1 which indicates the extent to which two variables tend to be related or to vary together. A value close to +1 is a high positive correlation which tells us that the two variables are closely related. There are many instances of naturally occurring positive correlations: between height and weight (taller people tend to weigh more); between maths and English (students tend to be good, bad or indifferent at both!) There are innumerable instances of correlations that are close to zero (indicating no relationship): height is not correlated with academic performance; IQ is not correlated with sports achievement.

A correlation coefficient close to –1 is a high negative correlation which tells us that two variables are inversely related. There are fewer instances of negative correlations – perhaps amount of time spent watching television and school grades!

There are primarily two types of correlational studies that are of interest to the developmental psychologist, *concurrent* and *predictive*.

**Concurrent studies** A *concurrent* correlational study is where we are interested in the relationship between variables that are measured *at the same time*. An example of such a study would be to find out how similar the IQs of identical twins are. In this study we would give intelligence tests to pairs of identical twins and, if the correlation is high (which it almost certainly would be) this would tell us that if one twin had a high IQ the other one would also be bright; if one had a low IQ we could predict a low IQ for the other twin.

**Predictive studies** A *predictive* correlational study is one where we are interested in finding whether individuals retain their relative standing, or rank order, relative to others, over time. For example, does the bright child at age 5 turn out to be the gifted student at age 20?; does the outgoing child become an extraverted teenager?

Here is one example of a predictive correlational study, asking the question 'can we predict IQ in 3-year-olds from problem-solving in infancy?' This is a study carried out by Peter Willatts, a developmental psychologist at Dundee University, Scotland, UK. It begins with 9-month-old infants who were tested on what is called a *means-end* problem-solving task. Each infant was shown an attractive toy which was placed out of reach on a cloth, and their job was then to grasp the cloth, pull it towards them – the means – in order to take the toy – the end. This doesn't sound too difficult, but babies only begin to string behaviours together to solve means-end tasks around 7 or 8 months – at 9 months many can do it expertly (see Figure 1.10), but others are

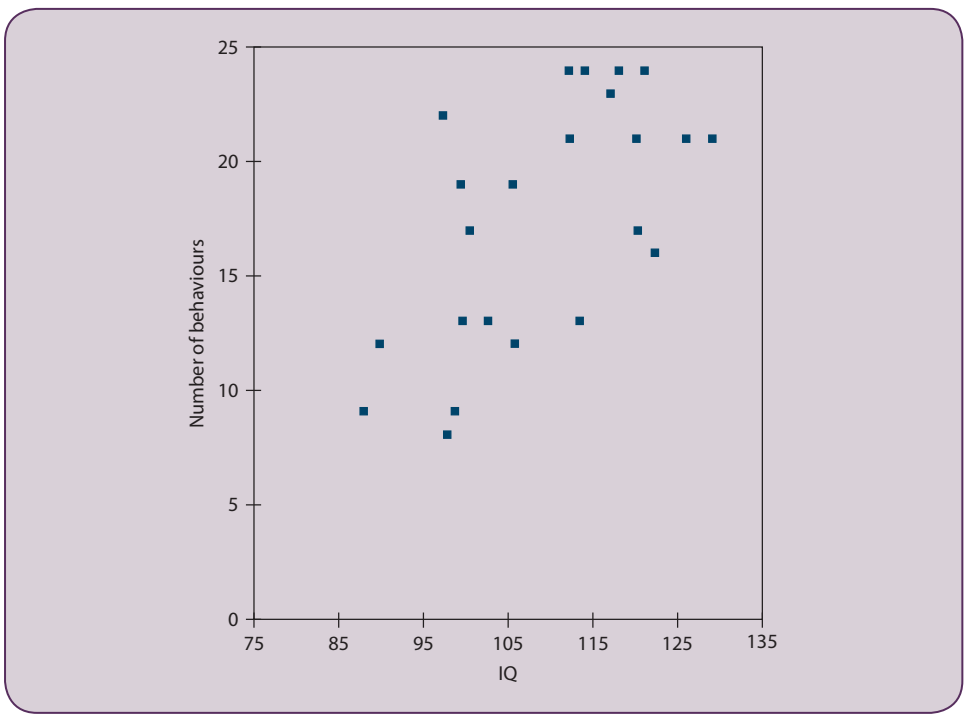


**FIGURE 1.10** *Scattergram to show the relationship between the number of successful reaching behaviours at 9 months (vertical axis) and 3-year IQ (horizontal axis). The most successful infants turned out to be those with the higher IQs.*

*Source:* From Peter Willatts (1997).

lagging behind. Willatts then gave the same infants the British Picture Vocabulary Test (BPVT) when they were 3 years 3 months old (the BPVT is the British version of the well-known American test the Peabody Picture Vocabulary Test, PPVT, which is a test of intelligence).

What Willatts found was that those 9-month-old infants who were best at the means-ends task tended to become the 3-year-olds with the higher IQs. The correlation was 0.64, and the relationship between the infants' scores at 9 months and their scores as children is shown in Figure 1.10. This figure is called a scattergram and is a graphical way of showing a correlation.

Correlational studies are thus important in telling us what sorts of abilities or psychological characteristics tend to go together (concurrent studies) and what abilities and characteristics predict later occurring behaviours (predictive studies).

**Neurodevelopmental studies** A particularly challenging task for developmental psychologists is to understand brain development and its relation to developments in perceptual, cognitive, social and motor skills. This challenge is particularly acute for developmentalists because our subjects of interest – infants and children – can be difficult to test due to a general lack of cooperation or inability to cope with the methods, and also because the brain develops at a rapid pace early in life, making brain–behaviour links difficult to assess. Nevertheless, progress is being made with the judicious use of selective methods.

**Marker tasks** A **marker task** refers to a method designed to elicit a behaviour with a known neural basis. Often the neural basis is discovered through experiments with animals, for which experiments on brain function present fewer ethical hurdles than experiments with humans. For example, much is known about the neural basis of visual function from experiments with monkeys. Visual attention in monkeys has been a subject of much investigation, and the neural underpinnings of different kinds of eye movements is fairly well known. It is thought that the visual system of rhesus macaques, a species of Old World monkeys, has a great deal of similarity to the human visual system, and researchers interested in the development of visual attention in humans have looked to the literature on monkeys for clues. Marker tasks have contributed much to this goal (Johnson, 1990). One prominent example comes from infants' ability to track moving objects using 'smooth pursuit' eye movements in which the point of gaze stays more or less locked on target as an object moves back and forth. Before 1–2 months of age, infants' tracking is jerky and frequently falls behind the object, necessitating numerous attempts to catch up to it. Johnson (1990) proposed that a specific area of the visual system known as the **medial temporal (MT) area** in the monkey has an analogue in the human, and development of this area and its connections with other parts of the visual system is responsible for the onset of smooth pursuit in humans. This is because damage to monkey MT causes deficits in motion tracking.

**marker task** a method designed to elicit a behaviour with a known neural basis.

**medial temporal (MT) area** a specific area of the visual system. The development of this area and its connections with other parts of the visual system is responsible for the onset of smooth pursuit in humans.

## *Imaging methods*

Recording brain activity in any animal poses a host of technical challenges, and no animal presents more of a challenge in this respect than a human child! Nevertheless,

**imaging methods** methods of recording brain activity.

**electroencephalogram (EEG)** a scalp recording done with electrodes that measure electrical activity produced by neurons.

**event-related potential (ERP)** scalp recordings in which brain activity is monitored during the presentation of specific perceptual events.

**positron emission tomography (PET)** an imaging method measuring cortical activity. PET works by measuring blood flow to tissues in the body, including tissues in the brain; blood flow is localised to regions of high activity.

**functional magnetic resonance imaging (fMRI)** an imaging method measuring cortical activity, which works by measuring blood flow, and involves no invasive procedures.

there are several methods available. There are two kinds of **imaging** used commonly with infants and children: those that record brain activity from the scalp, and those that record activity inside the head. Scalp recordings are done with electrodes that measure electrical activity produced by neurons, yielding an **electroencephalogram**, or *EEG*. The EEG is often measured when it is time-locked to a stimulus event, producing an **event-related potential**, or *ERP*. ERPs to different events can be compared to investigate developmental changes or individual differences in response. The EEG and ERP is highly sensitive to the timing of the brain's response to events, but it can be difficult to tap into specific brain regions with this method, because all activity is recorded at the surface. Accessing deep structures, such as those areas involved in memory or emotion, is not yet entirely feasible, but statistical methods are being developed to aid in this goal.

Two imaging methods are better suited to measuring cortical sources: **positron emission tomography**, or *PET*, and **functional magnetic resonance imaging**, or *fMRI*. PET works by measuring blood flow to tissues in the body, including tissues in the brain; blood flow is localised to regions of high activity. PET requires injection of a short-lived radioactive isotope, however, limiting its use to high-risk populations, and as such it is rarely used with infants and children. fMRI also measures blood flow, but involves no invasive procedures, instead recording by means of a strong magnetic field in which the participant is placed, which detects differences in oxygen concentration throughout the brain. fMRI has several disadvantages. It is expensive and it requires the participant to keep very still for lengthy periods, and the magnetic field itself is produced by a device that is very noisy – as loud as 120 dB. As such it is not suitable for widespread use with infants. However, if infants are tested during sleep, movement artifacts become less of an issue, and this allows researchers to gather information about structural aspects of brain function (i.e. its anatomy). Functional aspects of brain activity in infants can be examined if they can be done during sleep, such as tests of speech perception.

## *Choosing the method of study*

It will be apparent that psychologists have available a great many research strategies and methods for observing, classifying, testing and studying children's development. There are no hard and fast rules for determining which method should be used at a particular time, and the decision will depend on a number of considerations: the problem being investigated, the availability of participants, individual preferences of the researcher, and so on. In this section we will present the case for observation and the case for experimentation.

**Observation versus experimentation** As we have seen, observational studies are ideal for discovering questions to ask about various phases and aspects of children's development. Such studies can often lead to answers and theories, and they are often critical in allowing the researcher to generate hypotheses about aspects of

development. We need always to remember that the child has a vast repertoire of behaviours that occur in natural settings. We can conclude that observational studies are ideal in studying children's behaviour and development in its natural context.

A common argument against the use of experimentation is that it often takes place in a highly controlled and unnatural setting: while experimental studies tell us a great deal about behaviour in such settings it sometimes happens that experimental findings have little bearing on real life – that is, it is often claimed that many experimental studies lack **ecological validity**. Typically, however, a great deal can be learned from experimental studies even when the experimental setting seems rather distant from real life. Additionally, it is clear that observational studies are less powerful than experimental studies when it comes to understanding the *causes* of development, or in testing hypotheses. To illustrate this point, we may find that children who are aggressive watch more violence on television. However, we cannot therefore infer that watching TV violence causes violent behaviour – it is possible that the relationship is the other way round, that is, that aggressive children seek out violence. To tease out the real cause–effect relationship we would need careful experimental studies in which the relevant variables were systematically varied.

**ecological validity** the results obtained from a study are ecologically valid if they are meaningful in the real world.

Critical to the research process is the generation of hypotheses which can be systematically tested: hypotheses can be defined as *testable suppositions about the nature of reality*. In an example given above, one of the hypotheses tested by Judy Deloache and her team (1998) was 'infants will grasp more at pictured objects the more they resemble real objects', and this was tested by careful experimentation.

The well-controlled experiment allows relatively precise statements to be made about cause and effect. The degree of control required is often not easily attained in a natural setting, and experiments are often laboratory based, where a laboratory has no essential characteristics other than being a place in which the experimenter can exercise control over the relevant variables more easily than elsewhere. A laboratory may simply be a quiet room in a school or nursery, or it might be a purposely designed suite of rooms equipped with sophisticated equipment for measuring precise aspects of behaviour.

Experimentation allows us to explore avenues of research that could not easily be investigated by the use of observation alone. We have seen that Charles Darwin was quite wrong in his suggestion that the young infant's vision and hearing are extremely poor and our understanding of infants' development has only begun to emerge because of careful experimental findings – an account of some of these findings is given in Chapter 5.

# BEYOND COMMON SENSE: THE IMPORTANCE OF RESEARCH EVIDENCE

Sometimes, when psychologists publish their findings we hear remarks such as 'What a waste of money! Everybody knows people behave like that!' Such comments assume that common observation is an adequate substitute for controlled observation and

experimentation. However, everyday observation of human behaviour and 'folk' theories of development are notoriously unreliable, and in our impressions and interpretations of behaviour we are often unaware of the controlling and causative variables. We should also remember that there are often different and diametrically opposed 'folk' theories of development – see earlier in the chapter – and appropriate research evidence is needed to choose between them, or to show that they are all wrong!

Here are a few examples, some drawn from the accounts given earlier, which serve to convince us that systematic investigations are necessary to help us to understand human behaviour and development.

- We now know that babies can see reasonably well at birth, and that they can hear speech and other sounds even while in the womb. To paraphrase an eminent developmental psychologist, Annette Karmiloff-Smith (1994, p. 133): 'When two heavily pregnant women are talking to each other there are four people listening to the conversation.' Compare our current knowledge with Charles Darwin's assumption (given at the beginning of this chapter) that vision and hearing are almost non-functional at birth.
- Everybody 'knows' that children are more likely to do something for which they have been rewarded than *not* to do something for which they have been punished: we now know, from many experiments both with animals and humans, that punishment is a very ineffective way of controlling behaviour (Mazur, 1990). Contrast this view with the view implied by the expression discussed earlier: 'Spare the rod and spoil the child.' Psychological findings have influenced governments such that physical punishment of children in schools is banned by many states and countries, and some countries have banned parents from smacking their children.
- It has been widely held that a child's aggressive behaviours may be reduced by observing aggression through television programmes, movies and the like. This view has been called the **catharsis hypothesis**, the notion being that aggressive tendencies would be 'drained off' by the vicarious act of observing aggression. However, several decades of carefully designed experiments with children and adolescents have shown that observing aggression is likely to *increase,* rather than decrease, children's tendencies to behave aggressively towards others.

**catharsis hypothesis** the argument that watching aggressive tendencies in others will reduce your own feelings of aggression.

- We all know that tender loving care (TLC) is just as important as good nutrition in promoting favourable child development, but this was not always thought to be the case. In the 1920s and 1930s there was puzzlement as to why it was that children reared in orphanages, with a lack of care and attention, but with adequate nutrition, were 'failing to thrive' and there were high infant mortality rates. We now know that it was lack of affection and interaction with caring adults that resulted in these negative outcomes (see Chapter 6 for emotional development and attachments).
- No-one is surprised that the young child performs rather poorly on many tests of memory when compared with older children. The obvious reasons for the younger children's poorer performance is that they simply have a more

limited memory capacity – that they have fewer 'slots' in which to put new information. Research has shown this view to be false: older children's better performance results from what they *do* to try and remember, and not from an increased memory capacity (Chapter 13 gives a detailed account of memory development).

- In the past it has often been assumed that infants almost exclusively needed their mother's care, and that alternative caregiving (fathers, older siblings or other relatives, child minders, day care) would have adverse effects on their development. We now know that infants' development can proceed normally if they have multiple caregivers, so long as they receive consistent and predictable care. This understanding was only recently established: for example, we know that infants can form multiple attachments, and that the mother is not necessarily the one with whom the infant has its closest bond. Many studies have demonstrated that adequate day care has no damaging effects on development.
- Some 50 years ago it was widely believed that language development began when infants spoke their first meaningful word, around 1 year of age. However, we now know that by this age infants have learned an enormous amount about their native language and, in normally hearing infants, this learning begins prior to birth. An account of language development is given in Chapter 10.

## Social policy implications of child development research

**social policies** actions, rules, and laws aimed at solving social problems or attaining social goals, in particular intended to improve existing conditions.

In the latter part of the 20th century, and with increasing emphasis in the 21st century, developmental researchers have applied their vast store of knowledge to the implementation of **social policies** which are intended to improve children's well-being and to help them achieve their full potential. This is a world-wide endeavour, assisted by such bodies as the international Society for Research in Child Development (SRCD). In the previous section we have seen that child development research has implications for early visual development, discipline procedures, day care and the provision of adequate psychological care.

Other social policy implications abound and include: the implementation, provision and assessment of early intervention schemes (such as the **Head Start** programme in the USA and its counterpart **Sure Start** in the UK – these are schemes aimed at alleviating the worst social and cognitive deficits that result from neglect and poverty in early childhood); programmes to reduce the amount of bullying in the school and its effects on the bullied; early detection and treatment of childhood disorders such as autism, dyslexia and many others; combating the potential negative effects of parental divorce on children; detection and effective intervention in cases of child abuse and neglect; provision of effective health care for pregnant mothers-to-be and for young infants and children.

**Head Start and Sure Start** A federally supported programme in the United States with five components: (1) preschool enrichment education; (2) health screening and referral services; (3) nutrition education and hot meals; (4) social services; and (5) parent education and involvement. Research has indicated that children's cognitive and language development is enhanced during the period that they are participating in a Head Start programme. The British equivalent is called Sure Start.

You will be able to think of many other areas of concern relating to children's development. The essential point is that research into children's development is not simply the accumulation of information: it has a practical purpose, which is to understand better the development of the child in order to provide better attention to the requirements of children and families.

# DEVELOPMENTAL FUNCTIONS: GROWING AND CHANGING

From the data that developmental psychologists collect, analyse and interpret, it is possible to describe a number of **developmental functions**, or developmental trends – that is, the ways in which humans typically grow and change with age. Developmental functions are presented in graphs similar to those in Figure 1.11. Usually, the measure of behaviour (or behavioural change) is represented on the vertical, Y-axis, and age or time is on the horizontal, X-axis. The practical value of such functions is that they allow us to detect unusual developmental patterns (e.g. developmental delays) and to intervene with treatment as and when appropriate. The theoretical value is that the data can be used to evaluate hypotheses derived from various theoretical perspectives by comparing *theoretical* schematic plots such as those in Figure 1.1 with *empirically derived* functions, where the latter are the data that are collected. Human development of course is extremely complex, and different aspects of development grow and change in different ways. Figure 1.11 shows five of the most commonly found functions, and we will give examples of development which match each of them.

**developmental functions** typical trends in development; for example, we typically get more intelligent as we age.

## *Continuous function (a) – increasing ability*

**continuous function – increasing ability** behaviour that improves with age. For example, during the first year of life the precision with which infants reach for objects increases.

Perhaps the most common developmental function found in textbooks is the one shown in Figure 1.11(a) in which we simply get better, or increase in an ability or quantity with age. Examples include the negatively accelerating change in the height and weight of children which increase rapidly during the first few years of life, more gradually during childhood, and level off after adolescence. We should note that although height and weight are typically considered to be *continuous* in their development, research by Lampl *et al.* mentioned earlier (see Figure 1.1) suggests that changes in height might be *discontinuous* at times. Another example with a shorter timescale is the precision in reaching for and grasping an object, which gradually increases during the first year of life as infants practise and receive feedback from their errors. Intelligence is another example – as children grow older they become more intelligent, and this levels off during adolescence. We will return to the development of intelligence (and whether its development is continuous or discontinuous!) when we compare developmental functions.

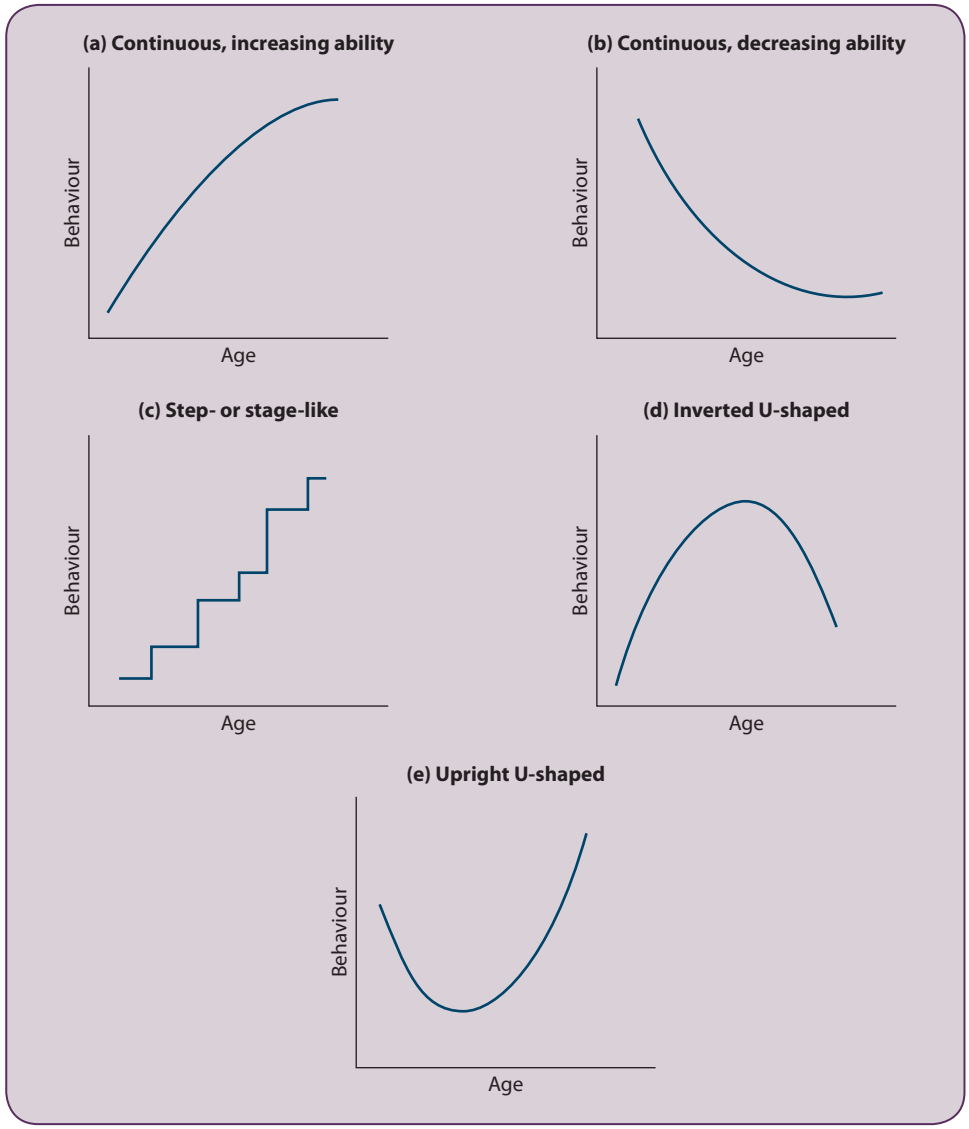


**FIGURE 1.11** *Five of the most common developmental functions, illustrating the ways in which people typically grow and change with age: (a) continuous, increasing ability; (b) continuous, decreasing ability; (c) step- or stage-like; (d) inverted U-shaped; and (e) upright U-shaped. Usually (as here), the measure of behaviour, or changes in behaviour, is represented on the vertical, Y-axis, and age or time is on the horizontal, X-axis.*

## Continuous function (b) – decreasing ability

It seems odd to think of aspects of development where we get *worse* rather than *better* as we grow up! As you can imagine there are few of these developmental functions. The clearest example is found in speech perception in early infancy (language development is discussed in detail in Chapter 10).

**continuous function – decreasing ability** behaviour that gets worse as we age. For example, young infants can initially distinguish non-native speech sounds very easily; however, for many sounds they lose this ability after their first year of life.

Research by Janet Werker and her colleagues has demonstrated that young infants, around 6 months of age, are able to discriminate almost every slight variation in sound (that is, the phonetic contrast between different phones, however similar sounding they seem), but that this broad-based sensitivity declines by the time the infant is around 1 year old (the time babies produce their first meaningful word). That is, as a result of their experience with their native language, and particularly as they begin to utter meaningful words, infants *lose* the ability to make many phonetic discriminations that are not used to differentiate between words in their native language.

For example, both the [k] sound in 'key' and the [k] sound in 'ski' are different phones, but members of the same phoneme in English, and English speakers hear them as the same sound. In contrast, the two [k] sounds are members of different phonemes in Chinese. As a result, speakers of Chinese can readily discriminate between the two sounds. Conversely, the [r] sound as in 'very' and the [l] in 'loud' are different phones in English but not in Chinese or Japanese, so that Chinese and Japanese people from about 1 year of age are unable to discriminate, for example, between 'berry' and 'belly'. Thus, speakers of English and speakers of Chinese differ in terms of their ability to discriminate sounds. As Werker (1989) puts it, infants become exquisitely tuned to the properties of the native language – they are 'becoming a native listener'.

**discontinuous (step) function** where development takes place in a series of stages, where each new stage appears to be *qualitatively* different from the preceding (and following) stages.

## Discontinuous (step) function

A second, common function is where development takes place in a series of stages, where each new stage appears to be *qualitatively* different from the preceding (and following) stages (Figure 1.11(c)). It is easy to describe different major stages in the human lifespan such as infancy, preschool childhood, middle childhood, adolescence, adulthood and old age: thus, infancy is the period 'without language', there are clear biological changes occurring at puberty, and so on. Stages of development are found in many areas of development. Piaget's theory (which is discussed in detail in Chapters 2, 9 and 16) is the most famous example of a stage theory of development. In his theory the child's thinking from one stage to the next involves different structures, and undergoes qualitative change: the young child will believe in Father Christmas, but this belief disappears around age 7; the adolescent, but not the younger child, is capable of abstract thought.

A stage-like progression of specific skills or processes also exists, such as in the development of mobility in the infant. Here the vertical, Y-axis on a graph could be distance travelled by an infant, which suddenly accelerates at different points in time matching the onset of various mobility accomplishments. Infants are relatively immobile during the first few months of life, begin to crawl around 6–8 months of age, stand up and toddle around furniture a few months later, and begin to walk on their own between 12–18 months of age (the time at which parents move all small objects out of the infant's reach!)

The onset of these mobility milestones seems to occur rather abruptly, and each one represents a qualitatively different type of locomotion suggesting a stage-like

progression. Another example is the development of speech – an initial period of no word production is followed by a period of babbling beginning around 9 months of age when infants make speech-like sounds in a flowing 'conversation' which contains no words. Infants begin to use single words around 12 months of age, produce two- to three-word phrases at about 18 months and, finally, produce complex grammatical sentences. These major milestones, which appear to be qualitatively different, also have been conceptualised as stages.

Many other step-like functions have been described, for example in the child's acquisition of a **theory of mind** (Chapter 11), in the **moral judgement stages** (Chapter 15).

**theory of mind** the understanding that different people may have different emotions, feelings, thoughts, and beliefs from one's own.

**moral judgement stages** Piaget described two stages in the development of moral reasoning: heteronomous and autonomous. Kohlberg described five stages: punishment and obedience orientation, instrumental morality, interpersonal normative morality, social system morality, and human rights and social welfare morality.

## U-shaped functions

Two other types of developmental functions are inverted and upright **U-shaped functions**. When we consider development across the lifespan, an *inverted U-shaped developmental function*, illustrated in Figure 1.11(d), is commonly observed. One example is the development of visual acuity which is poor at birth, increases rapidly during the first few months of life, and diminishes during the latter part of the lifespan. Inverted U-shaped functions can also be found during shorter time periods. For example, babbling is not present at birth, emerges around 6 months of age, and disappears without a trace a few months later (see Chapter 10). Of course, some might argue that it does emerge again during adulthood – perhaps during university lectures!

Inverted U-shaped functions are extremely common in development – we improve in the early years, stabilise or level off in adulthood, and get worse as we get older! Biological as well as psychological development often shows this function: thus, we reach our muscular and athletic peak in adolescence and early adulthood, and from about 30 years of age or thereabouts our abilities decline.

**U-shaped functions** behaviour where ability is initially very good, then decreases, and then increases again follows a U-shaped function of development. An inverted U-shaped function follows the opposite trend, initially poor, then getting better, and then becoming poor again.

The other U-shaped function, shown in Figure 1.11(e) involves abilities which may be present early in life and disappear to re-emerge at a later age. One example is the ability of newborn infants to turn their heads and eyes towards sounds. This dramatic auditory localisation response is present at birth, diminishes or disappears at around 6 weeks of age, and reappears again around 4 months of age (Muir *et al.*, 1994). Another example is the common observation that infants will display coordinated alternating step-like movements at birth, if they are supported in an upright position and held so that the soles of their feet are touching a solid surface. This amazing ability seems to disappear when infants are about 2 months old and reappears again when they begin to stand and walk, around 12 months of age.

This 'stepping reflex' gives the impression that the baby is 'walking' (Zelazo, 1983), and it was only a few years ago that some 'experts' were encouraging parents to keep exercising this stepping response in very young infants with the assumption that they would then learn to walk earlier. For a long time it was believed that the

stepping reflex and later walking were qualitatively different, both in the underlying brain systems and in the pattern of muscular coordination, but Thelen and Fisher (1982) offered a more plausible 'heavy legs' interpretation, that the behaviour declined simply because the infants accumulated more fat in their legs making it more difficult for them to produce the stepping response; certainly, under some circumstances the response is easy to elicit in 2-month and older infants (Barbu-Roth *et al.*, 2015).

## Comparing developmental functions

It can be useful to plot more than one developmental function on the same graph. Possible causal relationships may be suggested by doing so. In the case of the U-shaped auditory localisation function, Humphrey *et al.* (1988) compared the developmental functions for auditory localisation responses and orientation to schematic faces, from birth to 5 months of age, shown in Figure 1.12(a). When there is a minimum in the performance of head turning to off-centred sounds (i.e. it is very difficult to elicit), there is a maximum in looking time at the faces. They speculated that competition between the two stimulus–response systems occurred, with the most rapidly changing system, visual attention, predominating.

Uttal and Perlmutter (1989) provide a number of comparisons between developmental functions for older children and adults which illustrate possible causal relationships. One example has to do with the maintenance of typing speed by professional typists as they age. The developmental function tends to be flat over

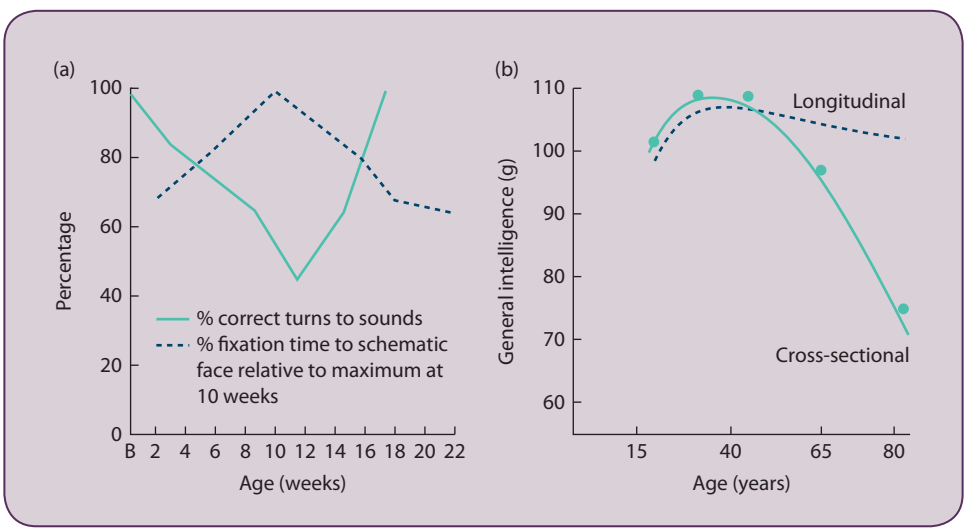


**FIGURE 1.12** *Comparing developmental functions: (a) compares the developmental course of the U-shaped auditory localisation response function with that of the inverted U-shaped function for interest in a schematic face (reported in Humphrey* et al.*, 1988); (b) shows the results from longitudinal (continuous function) and cross-sectional (inverted U-shaped function) studies of intellectual growth across a wide age span.*

*Source:* (a) ©1988, Canadian Psychological Association. Permission granted for use of material.

much of the life span. This is a puzzle because it is well known that as people age they have a slower reaction time, which should therefore slow down the typist's keystroke speed. It turns out that as keystroke speed declines, older typists increase their letter span (the number of words they code as a unit, which are then run off automatically by the fingers). This cognitive skill, which increases with practice, may compensate for the loss of keystroke speed.

We will make one final comparison, to do with the development of intelligence. Sometimes it is useful to think of intelligence as developing in a qualitative, stage-like manner (as in Figure 1.11(c)). However, sometimes it is convenient to think of intelligence as growing in a quantitative manner. This is the assumption that underlies most intelligence tests – as children get older they become able to solve, or answer, more and more of the items in the tests. With this latter assumption we find that children's measured intelligence (the raw scores they obtain on IQ tests) increases until adolescence, and then it levels off or stabilises. And then what happens? In the 1940s and 1950s there were many cross-sectional studies in which people of different ages, from young adults to the very elderly, were given the same intelligence tests. The clear finding was that the development of intelligence followed an inverted-U function (as in Figure 1.11(d)) – people simply got less intelligent as they approached middle- and old-age.

However, during the 1950s and 1960s the findings from longitudinal studies, in which the same people had been tested over many years, began to emerge. These findings were that intelligence did not decrease as people got older, rather scores on intelligence tests have simply been increasing over generations, most likely attributable to a number of factors which include improvements in nutrition, health and education, and smaller family size. As mentioned earlier, this is called the *Flynn effect*, named after James R. Flynn, the psychologist who documented it and described its implications (Flynn, 1998, 2009; Lynn, 2009, and see Chapter 16). An idealised drawing of the findings from this work is shown in Figure 1.12(b), which illustrates the finding that the developmental functions of intellectual performance derived from *cross-sectional studies* decrease with age, while those derived from *longitudinal studies* may show little change with age.

Interestingly, the Flynn effect seems to have reached its peak in Western countries, and is showing a small decline: one possible, disquieting reason for this is given by Holmes (2014, p. 32):

> Most demographers agree that in the past 150 years in Western countries the most highly educated people have been having fewer children than is normal in the general population. The notion that less educated people are outbreeding others is far from new, as is the inference that we are evolving to be less intelligent.

# SUMMARY AND CONCLUSIONS

Human development is extremely complex and multi-faceted. Not surprisingly, therefore, there are many ways of studying development and many different types of developmental functions that emerge from the research as scientists try to understand

the ways in which children grow and change. Sometimes the story that is told gets confusing. For instance we have seen that the development of intelligence can be described as a continuously increasing function (the child simply gets better with age) – this is the assumption underlying intelligence tests. But sometimes it is better to think of the child's thinking as changing in a step-like, qualitative fashion, a view that is central to Piaget's theory of development. We have also seen that early research suggested that intelligence declined with age, but now we think that it doesn't (which is encouraging news for us all!).

As you read the remainder of the book you will find innumerable examples of longitudinal and cross-sectional studies, of the different developmental methods that are used, and of the different developmental functions that are found. It will be helpful to have a clear idea of these different designs, methods and functions. This basic understanding will help you understand better the ways in which researchers are gradually unlocking the secrets of children's development.

## DISCUSSION POINTS

1. Think of the differing views that parents have about rearing their children. Is there scientific evidence for these 'folk' theories?
2. Consider the differences between organismic and mechanistic theories of development. How might these perspectives be helpful in understanding different areas of development?
3. What are the important differences between longitudinal and cross-sectional studies of development?
4. Why is it important to have both observational and experimental studies of development?
5. Think of ways in which the findings of developmental psychology go beyond common sense.
6. Consider the different developmental functions that describe how children grow and change. Why is it important to have these different functions?

## SUGGESTIONS FOR FURTHER READING

Christensen, P., & James, A. (1999). *Research with children*. London: Routledge-Falmer.

Coolican, H. (2009). *Research methods and statistics in psychology* (5th edn). London: Hodder Education.

Greig, A. D., & Taylor, J. (1998). *Doing research with children*. London: Sage.

Harris, M. (2008). *Exploring developmental psychology*. London: Sage.

Haslam, S.A., & McGarty, C. (2003). *Research methods and statistics in psychology*. London and Thousand Oaks, CA: Sage.

McNaughton, G., Rolfe, S., & Siraj-Blatchford, I. (2001). *Doing early childhood research: Theory and practice*. London: Open University Press.

## REFERENCES


Babson, T., & Benda, G. (1976). Growth graphs for the clinical assessment of infants of varying gestational age. *Journal of Pediatrics*, *89*, 814–820.

Barbu-Roth, M. *et al*. (2015). Why does infant stepping disappear and can it be stimulated by optic flow? *Child Development*, *86*, 441–455.

Benoit, D., & Parker, K. (1994). Stability and transmission of attachment across three generations. *Child Development*, *65*, 1444–1456.

Booth-LaForce, C., & Roisman, G.I. (2014). The Adult Attachment Interview: Psychometrics, stability, and change from infancy, and developmental origins. *Monographs of the Society for Research in Child Development, 79* (Serial No. 3).

Boyd, A., & Golding, J. *et al*. (2013). Cohort profile: The 'Children of the 90s' – the index offspring of the Avon Longitudinal Study of Parents and Children. *International Journal of Epidemiology, 47*, 111–127.

Bushnell, I.W.R. (2003). Newborn face recognition. In O. Pascalis & A. Slater (Eds.) *Face: The development of face processing in infancy and early childhood* (pp. 41–53). New York: NOVA Science Publishers.

Darwin, C. (1877/1999). A biographical sketch of an infant. In A. Slater and D. Muir (Eds.), *The Blackwell reader in developmental psychology* (pp. 18–26). Oxford and Massachusetts: Blackwell.

Deloache, J.S., Pierroutsakos, S.L., Uttal, D.H., Rosengren, K.S., & Gottlieb, A. (1998). Grasping the nature of pictures. *Psychological Science*, *9*, 205–210.

Fifer, W. (2010). Prenatal development and risks. In G. Bremner & T. Wachs (Eds.), *The Blackwell handbook of infant development*. Oxford: Wiley/Blackwell.

Flynn, E., Pine, K., & Lewis, C. (2006). The microgenetic method – Time for a change? *The Psychologist*, *19*, 152–155.

Flynn, J.R. (1998). Searching for justice: The discovery of IQ gains over time. *American Psychologist*, *54*, 5–20.

Flynn, J.R. (2009). Requiem for nutrition as the cause of IQ gains: Raven's gains in Britain 1938–2008. *Economics and Human Biology*, *7*, 18–27.

Forrester, M.A. (2010). Emerging musicality during the pre-school years: A case study of one child. *Psychology of Music*, *38*, 131–158.

Geldhof, G.J., Bowers, E.P., Gestsdottir, S., Napolitano, C.M., & Lerner, R.M. (2015). Self-regulation across adolescence: Exploring the structure of selection, optimization, and compensation. *Journal of Research on Adolescence*, 25, 214–228.

Gestsdottir, S., & Lerner, R.M. (2008). Positive development in adolescence: The development and role of intentional self-regulation. *Human Development*, *51*, 202–224.

Hepper, P. (2011). Prenatal development. In A. Slater, M. Lewis, G. Anzures, & K. Lee (Eds.), *Introduction to infant development* (Canadian edn; pp. 36–56). Oxford: Oxford University Press.

Holmes, R. (2014). Stalled. *New Scientist, 223*(2983), 30–33.

Hultsch, D., & Deutsch, F. (1981). *Adult development and aging: A life-span perspective*. New York: McGraw-Hill.

Humphrey, G., Dodwell, P., Muir, D., & Humphrey, D. (1988). Can blind infants and children use sonar sensory aids? *Canadian Journal of Psychology*, *42*, 94–119.

Johnson, M.H. (1990). Cortical maturation and the development of visual attention in early infancy. *Journal of Cognitive Neuroscience*, *2*, 81–95.

Karmiloff-Smith, A. (1994). *Baby it's you*. London: Ebury.

Lampl, M., & Thompson, A.L. (2007). Growth charts do not describe individual growth biology. *American Journal of Human Biology*, *19*, 643–653.

Lampl, M., Veldhuis, J., & Johnson, M. (1992). Saltation and stasis: A model of human growth. *Science*, *258*, 801–803.

Lee, M., & Larson, R. (2000). The Korean 'examination hell': Long hours of studying, distress and depression. *Journal of Youth and Adolescence*, *29*, 249–271.

Lerner, R. (1986). *Concepts and theories of human development* (2nd edn). New York: Random House.

Leung, G.S.M., Yeung, K.C., & Wong, D.F.K. (2010). Academic stressors and anxiety in children: The role of parental support. *Journal of Child and Family Studies*, *19*, 90–100.

Lynn, R. (2009). What has caused the Flynn effect? Secular increases in the Developmental Quotients of children. *Intelligence*, *37*, 16–24.

Mazur, J.E. (1990). *Learning and behavior* (2nd edn). Englewood Cliffs, NJ: Prentice Hall.

Muir, D., Humphrey, D., & Humphrey, K. (1994). Pattern and space perception in young infants. *Spatial Vision*, *8*, 141–165.

Nesselroade, J., Schaie, K., & Baltes, P. (1972). Ontogenetic and generational components of structural and quantitative change in adult behavior. *Journal of Gerontology*, *27*, 222–228.

Piaget, J. (1954). *The construction of reality in the child*. New York: Basic Books.

Sants, J., & Barnes, P. (1985). Childhood. In *Personality, development and learning* (Unit 2) [Open University second level course]. Milton Keynes: The Open University Press.

Shaffer, A., Burt, K.B., Obradovic, J., Herbers, J.E., & Masten, A.S. (2009). Intergenerational continuity in parenting quality: The mediating role of social competence. *Developmental Psychology*, *45*, 1227–1240.

Slater, A., & Muir, D. (Eds) (1999). *The Blackwell reader in developmental psychology*. Oxford: Blackwell.

Thelen, E., & Fisher, D.M. (1982). Newborn stepping: An explanation for a disappearing reflex. *Developmental Psychology*, 18, 760–775.

Uttal, D., & Perlmutter, M. (1989). Toward a broader conceptualization of development: The role of gains and losses across the life span. *Developmental Review*, *9*, 101–132.

Wallace, D.B., Franklin, M.B., & Keegan, R.T. (1994). The observing eye: A century of baby diaries. *Human Development*, *37*, 1–29.

Werker, J.F. (1989). Becoming a native listener. *American Scientist*, *77*, 54–59.

Zelazo, P.R. (1983). The development of walking: New findings and old assumptions. *Journal of Motor Behavior*, *15*, 99–137.