1 What Enables Infants to Acquire Language?

KEY TERMS

• alloparents • artificial language • babbling • collective breeders • communicative intentions • conspecifics • constructions • coordinated interpersonal timing • discourse • Duchenne smiles • dyadic interaction • encephalisation • executive functioning • fundamental frequency • hominin • intersubjectivity • joint attention • Less-Is-More • natural pedagogy • scaffolding • social shaping • still-face effect • terrestrial bipedalism

CHAPTER OUTLINE

Language is a universal human ability. Children at a young age learn to speak and to understand others' speech; they learn to use language to share ideas, negotiate activities, and cooperate with others. They do this in spite of the fact that there is extraordinary complexity and diversity in the sound patterns, word meanings, and grammatical structures of the approximately 7000 human languages that have been catalogued throughout the world (Gordon & Grimes, 2005; Lewis, 2009). All human languages have a degree of complexity that surpasses by far the communication system of any other species. Yet the process of language development seems to be easy, effortless, and does not require specific instruction. So how do children do it?

In this book we will try to understand what language development entails and what lies behind this extraordinary human achievement. Humans have evolved to learn language over an extended period of childhood. Children grow up as members of communities in which language constitutes the primary mechanism by which social activities are coordinated and ideas are exchanged. In this chapter, we will examine the sociocultural context in which language development takes place and begin to explore the social and cognitive abilities that allow human infants to learn language so readily. Among other things, infants show precocious sensitivity to the sound patterns of languages, and in Chapter 2 we will discuss what abilities enable infants to crack the sound code of their native language very early in life. Infants are also able to communicate through gesture at a stage when their ability to use spoken language is still very rudimentary. In Chapter 3 we will show how shared attention and non-verbal communication provide the basis for the development of spoken language. Building on this ability, infants are able to figure out what others mean when they produce specific speech patterns, and in Chapter 4 we will trace how the meanings of words are negotiated in the context of shared activities with others. Once the first words are acquired, infants and toddlers start combining and modifying them. In Chapter 5, we will describe how infants discover the myriad ways in which speakers of their language combine and modify words to create new meanings. Even though language development is a universal aspect of human development, there is variation in the learning trajectories of individual children. In Chapter 6 we will examine the nature of children's language input and what consequences, if any, variability in the quality and quantity of language input has for language development.

Obviously, using language encompasses more than just knowing the meanings of words and how to put them together to create sentences. Children learn to use language in socially appropriate ways, to tease others and make them laugh, to argue, lie and deceive, to tell stories, retrace the past and plan for the future, as well as for many other purposes. These abilities take time to develop, and Chapter 7 traces the acquisition of pragmatic and conversational skills. Chapter 8 returns to the phenomenon of linguistic diversity and explores how specific features of languages and bilingualism influence cognitive development. In many cultures, like our own, language develops further as children learn to read and write. Chapter 9 provides an overview of literacy acquisition and its role in language development.

Despite the fact that most children acquire language with apparent speed and ease, language development is not always a smooth path. Some children have impairments in language learning and processing, and Chapter 10 summarises what is known about

the possible causes of their difficulties. Chapter 11 explores sign language development in deaf children who are not able to perceive the sound patterns of a spoken language. Studying deaf children provides a unique opportunity to observe what happens when exposure to a language (spoken or signed) is delayed during development. To what extent does the brain remain plastic enough to accommodate language learning at ages beyond early childhood? This question is explored further in Chapter 12, which looks at the neural basis of language development.

In describing the trajectory of human language development, this book will try to incorporate evidence from children acquiring different languages in different cultures. As the bulk of research on language development has been carried out with children who are acquiring a few languages spoken in industrialised Western societies, we acknowledge that much is still not known about language development elsewhere. We urge readers to be cautious in their conclusions about what is culturally and linguistically universal in language development.

1.1 WHAT IS THE EVOLUTIONARY CONTEXT OF LANGUAGE DEVELOPMENT?

Over the past two decades there has been growing interest in how humans evolved to have language. Much research in this area has asked what is unique about human language and communication. At some point in human evolutionary history, there emerged a precursor to a symbolic communication system; that is, some sort of a rudimentary proto-language which may have been gesture-based, sound-based, or both. There is considerable debate as to whether humans subsequently evolved special adaptations that are unique to language (Pinker & Bloom, 1990), or whether the features of human languages were shaped by more general social and cognitive abilities, which enabled humans to adapt to a wide variety of different environments through cultural learning (Kirby, Christiansen & Chater, 2009; Tomasello, 2008). In other words, did changes in our genetic make-up provide humans with an innate capacity to acquire and process language, or alternatively, did human languages evolve under selective pressure to fit our ancestors' social and cognitive capabilities and ecological niche (Chater & Christiansen, 2010; Christiansen & Chater, 2008; Levinson & Evans, 2010; Lupyan & Dale, 2010; Nettle, 2007)? Models of gene–culture co-evolution suggest that increased complexity in communication may have pushed genetic evolution in a direction that enhanced the social and cognitive skills needed for language acquisition and processing (Deacon, 1997; Richerson & Boyd, 2010). This debate to some extent informs our understanding of how language development is ultimately tied to children's social and cognitive development.

In this chapter, we set the stage by briefly sketching the evolution of the conditions under which language development takes place. These conditions pertain to (a) the

time course of language development – that is, how long it takes for a person to master a language; (b) the nature of social and communicative engagement between children and others; and (c) the wider social environment that supports language development over the lifespan. We will then take a brief look at the social and cognitive abilities of human infants that support their entry into communities defined by their sociocultural and linguistic practices.

1.1.1 Extended period of immaturity

Many authors emphasise the speed and ease with which human children acquire the basic principles of language (e.g. O'Grady, 1997). By four years of age most sentences uttered by most children will be meaningful and more or less grammatically correct. In comparison to adult language learners, who often attain only limited proficiency in a new language after years of study, the linguistic achievements of children seem quite remarkable indeed. However, it is important to bear in mind that the time course of language development in humans is much more extended in comparison to the relative rapidity with which other species acquire their respective communication systems. Humans acquire language over a relatively long period of social and cognitive immaturity (Konner, 2010), and human language learning extends over the lifespan. How did this extended period of childhood, which is unusual in comparison with other apes (Bruner, 1972; Gould, 1977; Locke & Bogin, 2006), come about, and what might be its consequences for the process of language development?

hominin refers to humans and their ancestors, and includes all the Homo species, all the Australopithecines, and others such as Ardipithecus; this term is more specific and replaces the previous term 'hominid'.

terrestrial bipedalism two-footed walking on the ground.

One idea is that adaptations to bipedalism initiated a series of changes that extended the life history of humans, relative to other apes. At least four million years ago, our **hominin** ancestors shifted from quadramanus (four-handed) climbing to **terrestrial bipedalism** (two-footed walking). This shift in posture most likely came about as an adaptation to changes in habitat and diet (Coppens, 1994; Wrangham, Cheney, Seyfarth, & Sarmiento, 2010). Regardless of the specific causes of bipedalism, an undisputed consequence is that it altered the shape of the hominin pelvis through horizontal realignment, and thereby effectively narrowed the birth canal (Abitbol, 1987; Rosenberg, & Trevarthan, 2002). Pelvic realignment would have generated considerable selective pressure to delay skeletal maturation (Ragir, 2001; Ruff, 1995); that is, to allow a neonate with a softer, less mature skeleton to pass through the constricted birth canal. Over the subsequent course of human evolution, additional adjustments in growth parameters may have occurred as dietary advances (e.g. hunting, cooking, and food preservation) improved year-round access to nutrients and increased the weight of females and the weight and size of their offspring. Increased foetal size would become problematic if the skeleton became too big to successfully deliver through the birth canal (Rosenberg & Trevarthan, 1996). Consequently, each dietary advance may have triggered further maturational delays to ensure successful birth of hominin infants. Altering the rate of skeletal maturation through adjustments to growth parameters would also

have lengthened the time course of neural development. Such adjustments would have increased brain size, because brain size increases proportionally as neural development is prolonged (Finlay, Darlington, & Nicastro, 2001), which would have contributed to the **encephalisation** (increased cranial volume relative to body size) characteristic of modern humans. Crucially, a more slowly maturing brain has greater neural plasticity and behavioural flexibility, thus leaving increased room for learning about the physical and social environment in a rapidly changing world (Chrysikou, Novick, Trueswell, & Thompson-Schill, 2011; Ragir, 1985; Thompson-Schill, Ramscar, & Chrysikou, 2009).

encephalisation increased cranial volume relative to body size (i.e. the amount of brain mass that exceeds what is expected given the animal's body mass).

There is debate about the extent to which neurobiological development after birth obeys a genetically predetermined maturational schedule and whether this controls language acquisition. Although the infant brain appears to be uniquely adapted to learn and process language, humans nevertheless retain considerable neural plasticity throughout childhood and into adulthood to cope with newly encountered languages and to reorganise the brain in response to injury (see Chapter 12). While some aspects of language are acquired in the first year of life (e.g. a language's rhythmic structure and its inventory of speech sounds; see Chapter 2), other aspects are acquired much later in childhood (e.g. story-telling, sarcasm, humour, literacy; see Chapters 7 and 9). In many respects, language learning is a life-long endeavour with vocabulary, grammar, and **discourse** skills continue to grow throughout adolescence and even adulthood.

discourse conversational aspects of language use, which may be applicable to specific social contexts.

The prolonged human childhood is a period of intense learning during which children acquire language as well as many other complex skills, such as mathematical reasoning, cooking, and chess. Irrespective of factors such as bipedalism and diet that may have triggered the uniquely human life history (as described above), it is also possible to view prolonged immaturity as an adaptation to the need to acquire complex skills. Note, however, that slow maturation also occurs in other species, for example, tortoises and elephants; it therefore seems unlikely that prolonged immaturity is an adaptation to the need for complex skill acquisition. But note also that elephants, like humans, are **collective breeders** that pool the resources of group members to care for their offspring (Hrdy, 2009). Collective breeding reinforces early immaturity, and in humans it provides a stable sociocultural context over which there is sufficient time for complex skills like language to develop.

collective breeders certain species of animals (including humans) that pool the resources of group members to care for their offspring.

In the next section, we turn to the role of childcare in language development.

1.1.2 Alloparental care

Prolonged immaturity and nutritional dependency of infants requires prolonged and costly childcare. Human parents have to invest considerable resources into their immature offspring. As if this was not difficult enough, dietary improvements such as the domestication of fire, which helped to preserve food and to reduce parasite load, resulted in increased fertility of hominin females and a reduction of the spacing

Figure 1.1 *Parents recruit the assistance of alloparents (grandparents, friends, teachers, professional caregivers, older siblings, and other kin) to care for their dependent children.*

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between births (Bogin, 1998). This created situations in which mothers had to juggle the needs of a young infant while caring for other semi-dependent children. Because the cost of childcare exceeds what individual mothers are able to provide, hominins have evolved to be cooperative breeders: to ensure child survival, mothers recruit **alloparents** to assist in the care of their children (Hrdy, 1999); see Figure 1.1. Alloparental support is especially important after weaning, when young children have to rely on other members of the community for provisioning.

In humans, the role of alloparents is often taken on by kin – grandmothers, older siblings, aunts, great aunts, and, to a varying degree, fathers. For a range of cultures as diverse as hunter-gatherers, horticulturalists, and peasants, shorter birth intervals and increased child survival are linked to the availability of matrilineal kin, especially maternal grandmothers (Voland, Chasiotis, & Schiefenhoevel, 2004). Similarly, the availability of older sisters has also been linked to child survival rates (Sear, Steel, McGregor, & Mace, 2002).

alloparents individuals besides the parents who engage in the care and provisioning of offspring.

In addition, in many cultures, alloparental care is also provided by non-kin alloparents such as younger women or fellow mothers or, more recently, hired childcare providers such as wet nurses, childminders, au pairs, or nannies. What compels non-kin helpers to engage in caring for other people's children without any direct benefit to their own reproductive success? One suggestion is that young non-kin females benefit from providing childcare because they can hone their own mothering skills (Konner, 2010). Furthermore, many human childcare arrangements may be based on direct reciprocity, such that non-kin take care of each other's children or receive direct remuneration for their services. Human mothers weigh a number of factors, such as the degree of available alloparental support, in deciding whether a particular infant is worth their investment (Hrdy, 1999). Perhaps for this reason, human infants have to play their part in ensuring their own survival by soliciting care from their mothers and other potential caregivers. It is imperative for young infants to use whatever communicative means they have at their disposal to solicit care. Infants who are able to engage their mothers and other caregivers from birth have a better chance of survival than those who do not.

1.1.3 Reciprocal interaction between young infants and caregivers

To solicit care, human infants need to engage in social interactions and to monitor the behaviours of others for signs of commitment. When interacting with their caregivers, infants produce various types of vocalisation, such as grunting, crying, laughter, cooing, and **babbling**. These vocalisations are not intentionally communicative in the earliest stages of development; neonates obviously cannot voluntarily control their bouts of crying. Nevertheless, even the earliest vocalisations of infants provide information about their physical states (health, distress) and needs (food, comfort, sleep). More mature individuals, in turn, are predisposed to respond to infant signs of immaturity and need. This predisposition is not only evident in mothers, but in other adults or even juveniles, who all potentially may serve as alloparents. Indeed, it may have co-evolved with infant immaturity to ease the burden of costly childcare.

babbling obligatory vocalisations of preverbal infants; includes canonical and variegated babbling stages.

In early infancy, vocalisation functions primarily as a means to initiate and maintain rapport with others. Dyadic vocal interactions (see Figure 1.2) between young infants and their caregivers are, for the most part, emotional in nature (Locke, 2001), and only later become referential as caregivers use language to draw their infant's attention to things in the world. The sharing of positive affect through **dyadic interaction** fosters a continuous sense of bonding and connectedness, which plays a crucial role in the establishment of attachment to the caregiver (Bowlby, 1982). Reciprocal face-to-face exchanges between infant and caregiver create mutual awareness

dyadic interaction a communicative interaction between two individuals; here mainly used to describe the face-to-face communicative interactions of infants and their caregivers.

Figure 1.2 *In face-to-face dyadic interaction, caregivers and infants use facial expressions, eye gaze, volcalisation, and touch to convey interest and emotion, and to modulate arousal.*

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of internal states such as pleasure, through the alignment of vocalisation, eye contact, and facial expression. These interactions have a rhythmic structure that approximates the turn-taking and give-and-take of conversation, and in many cultures, caregivers treat infants as worthy conversational partners almost from birth. Early on, infants are capable of coordinating their behaviour with a caregiver in face-to-face interaction by modulating eye contact – establishing eye contact to signal readiness to communicate, and withdrawing eye contact when the social stimulation becomes too intense (Lavelli & Fogel, 2005). In a pioneering study, Haith, Bergman and Moore (1977) reported developmental increases in the amount of time infants fixated on their mother's face from 3 to 11 weeks of age: while infants at 3–5 weeks fixated on faces only 22 per cent of the time, this amount increased to 87.5 per cent of the time for infants at 7 weeks of age. Importantly, child-directed speech increased the amount of face scanning in children at 7 weeks of age and older. **Coordinated interpersonal timing** is evident from at least 6 weeks of age, as infants initiate and maintain eye contact in response to their mothers' vocalisations, and mothers time their vocalisation in response to their infants' gaze behaviour (Crown, Feldstein, Jasnow, Beebe, & Jaffe, 2002). The coordination of infant–caregiver behaviour in dyadic interaction is even more robust at 4 months of age, as infants at this age coordinate their vocalisations with those of strangers as well as their mothers (Jaffe, Beebe, Feldstein, Crown, & Jasnow, 2001).

coordinated interpersonal timing changes in the temporal patterning of one person's behaviour in response to another person's behaviour.

Infants vocalise to engage and maintain closeness with their caregivers, who vocalise in return to reassure, soothe, elicit attention, or make infants smile. Infants produce different qualities of vocalisation depending on whether they are alone or engaged with others, which suggests that they can vary their prelinguistic vocalisations for purposeful communication (Papaeliou & Trevarthan, 2006). Adults, in turn, are highly sensitive to differences in the quality of infants' vocalisation (Bloom & Lo, 1990). The intuitive appeal of certain types of infant vocalisations (e.g. cooing and babbling) in contrast to the negative valence of others (e.g. crying) leads adults to selectively reinforce specific qualities of infant vocalisation over others. For example, when 2- to 4-month-old infants make cooing sounds, adults intuitively perceive them as playful and friendly, and respond favourably towards them (Locke, 2006; Snow, 1977; Watson, 1972). In contrast, excessive crying elicits caregiver stress, frustration, and aggression. The process whereby caregivers respond contingently and positively to their infants' communicative bids is called **social shaping**, and has been shown to increase both the quality and the quantity of babbling in infants (Goldstein, King, & West, 2003; Goldstein & Schwade, 2008). Because cooing and babbling are effective in eliciting adult attention, positive affect, social stimulation, and caretaking, infants readily learn to use vocalisation as a means to establish and maintain positive rapport with others (Goldstein, Schwade, & Bornstein, 2009). Recent neuro-imaging work suggests that close social interaction between individuals leads to the coupling of neural responses, which further reinforces the execution of coordinated, joint behaviours (Hasson, Ghazanfar, Galantucci, Garrod, & Keysers, 2012). Thus, the interplay between infants who are primed to engage their caregivers and caregivers who

social shaping the process whereby a caregiver responds contingently and positively to an infant's communicative bids, and thereby increases the quantity and quality of the infant's speech and gesture.

are primed to respond to their infants' needs drives the development of language and other social and cognitive skills.

1.1.4 Complex social environments

Coincidental with the fossil record indicating changes in growth parameters and encephalisation, there is evidence for changes in the structure of hominin societies. Based on assemblages of stone tools collected at butchering sites, one can be fairly certain that hominins engaged in cooperative hunting of large game from about 1.5 million years ago (Haidle, 2010; but see McPherron et al. [2010] for dating of stone tool use to 3.4 million years ago), and used fires for cooking starting at least about 400,000 years ago (James, 1989; Rolland, 2004; but see Wrangham, Jones, Laden, Pilbeam, & Conklin-Brittain [1999] for dating of control of fire to 2 million years ago). The variety of tool types in the archaeological record (e.g. hammers, choppers, and scrapers) suggests that tools were used for hunting, fishing, and butchering, as well as to manufacture and shape other tools. The existence of these tools implies division of labour, specialised knowledge, fine-motor control, and hierarchical planning of activities – in effect, the presence of the socio-cognitive abilities necessary for language (Ragir, 2000).

Technological advances in cooperative hunting and cooking would have supported directly the growth of larger communities, and the emergence of specialised trades. Domestication of fire for cooking, in particular, probably increased the differentiation of the labour force, as some members of the group stayed at home bases to tend the fire while others engaged in hunting and foraging activities. Moreover, the establishment of home bases around fires might have provided a context for various members of the community to congregate with their young dependents. Larger social groups, engaged in more sophisticated activities, would increase the need for more efficient communication. Furthermore, the increased group size and improved nutrition most likely increased the proportion of infants and semi-dependent children in the groups (McBrearty & Brooks, 2000), thus leaving room for peer interaction and play. In this context, language would have been an important medium for organising joint activities, and for cultural transmission of knowledge.

natural pedagogy the use of ostensive signals to indicate that cultural knowledge is being taught within a communicative interaction.

As tool use and cooking techniques became more sophisticated, the ways in which objects were manufactured and used became more opaque and less self-explanatory. Humans may have adapted to this situation by evolving what Csibra and Gergely (2009, 2011) have termed **natural pedagogy**; see Figure 1.3. Although such ostensive signals may be non-linguistic (e.g. pointing or the use of eye gaze to indicate referential intent), the process of knowledge transmission is greatly enhanced by language, and language learning itself may benefit from the availability of such ostensive signalling. There is controversy about the extent to which human adults engage in direct teaching, as opposed to expecting children to learn from observation, imitation, and overhearing: in many contemporary non-industrial societies there is much less direct teaching and verbal instruction of children in comparison to Western industrialised societies (Lancy, 2009; Rogoff, 1990). Still, natural pedagogy seems to be largely absent in other species, which suggests that there is an important place for language in the transmission of generalisable cultural knowledge.

Figure 1.3 *Humans devote considerable time and effort to teaching their young culturally significant practices. Such natural pedagogy requires the teacher and student to achieve a mutual understanding of what they are doing together and for what reason. Here a grandmother is teaching her grandson how to prepare meat dumplings.*

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Language not only accompanies and facilitates joint activity and information exchange, but is also used to cement social alliances and to share states of mind (Carpendale & Lewis, 2004). In fact, it has been suggested that the need for language arose when human groups became too large to engage in direct mutual grooming (Dunbar, 1993, 1996). Mutual grooming, being both pleasurable and a hygienic necessity, serves to cement social alliances because it implies reciprocity – as in 'You scratch my back and I'll scratch yours'. As group sizes increased, language may have taken over the social function of mutual grooming by allowing individuals to share internal states and important social information through gossip.

Human communication, at a fundamental level, requires cooperation. Recently, it has been suggested that the emergence of language in human evolution is a reflection of our seemingly innate proclivity to engage cooperatively with others (Tomasello, 2008). Coordination of point of view is necessary for any communicative act to be mutually understood. The creation of shared meanings between members of a group requires a mechanism for achieving **intersubjectivity**. Intersubjectivity emerges early in infancy as caregivers and infants share positive rapport through dyadic face-to-face interaction (Stern, 1985; Trevarthen, 2001). If one views human language as a system of arbitrary relationships between linguistic forms and their associated meanings (Bates, Benigni, Bretherton, Camaioni, Volterra, et al. 1979), each pairing of form and meaning had to have emerged through negotiations among community members to achieve mutual understanding (see Chapter 11 for further discussion of the social factors that support language emergence). Every human language reflects the consensus of a community of speakers regarding what is to be understood in the context of language use and community practice. All human languages comprise complex systems of social conventions predicated upon communities of cooperatively interacting speakers (Clark, 1996; Tomasello, 2008; Wittgenstein, 1953). For two individuals to use a human language to communicate with one another, they must adopt the conventional ways of speaking the language, and they must mutually appreciate when communication has been successful. If one

intersubjectivity mutual awareness between two or more people that they are experiencing something together and have a shared understanding of the situation.

fails to cooperate in using the socially agreed upon **constructions** of the language, communication breaks down, and shared understanding has to be re-negotiated. For a child to break into such a system, the child must share a willingness to engage with others in jointly constructed activities, whereby the **communicative intentions** of others are made transparent and mutual understanding is achieved. Under this view, language develops as the child grasps the myriad ways that community members use linguistic utterances to coordinate their perspectives in order to achieve shared goals.

constructions also called syntactic structures; the structural configurations of words in a sentence.

communicative intentions a speaker's goals that motivate an act of communication in a specific context.

1.2 WHAT ARE THE ABILITIES OF LANGUAGE-READY NEWBORNS?

Just why humans evolved widespread tendencies towards cooperation is a hot topic in evolutionary psychology. One explanation is that increased cooperation in hominins was driven by inter-group competition: culture, which requires cooperation, made groups more successful in adapting to changing environments, and thus allowed them to outcompete neighbouring groups (Richerson & Boyd, 2004). Another view is that the necessity of alloparental support for child rearing required a considerable level of trust, cooperation, and mutual understanding between mothers and other group members (Hrdy, 2009): for their infants to survive, mothers must have been able to identify trustworthy others (i.e., extended kin) to care for their young, and infants must have been able to solicit care and provisioning from these trustworthy others. Regardless of the evolutionary scenario, modern human infants come equipped with social and cognitive skills that enable them to coordinate their behaviour with others. In this section we explore the earliest abilities of human infants that provide the basis for their subsequent language development.

1.2.1 Attending to others

Human infants have very limited information-processing capacity, which makes it advantageous for them to be selective in sampling information from the environment. Reid and Striano (2007, 2009) have suggested that the social abilities of human infants allow them to use interactions with other humans to hone in on what is relevant in the environment. From birth, neonates exhibit preferences and proclivities that focus their interests and attention on the social world around them. Infants' abilities encompass a range of components necessary for successful social interactions: infants need to be able to detect and recognise potential social partners, they need to be able to identify the focus of attention of these partners in relation to themselves and to the environment, and, finally, they need to be able to discern a social partner's goals and intentions. There is evidence that most of these components are in place very early in development, as we will discuss below and in Chapter 3.

One important cue for identifying potential social partners is the detection of biological motion: animals and humans move in self-propelled ways that preserve biomechanical integrity and are different from the movement patterns of non-biological entities. This capacity is already apparent in 3-month-olds, who can distinguish moving point-light displays that preserve the biomechanical integrity of the moving parts, from displays that do not (Bertenthal, Profitt, & Kramer, 1987). But of course identifying an animate entity is not sufficient for social interaction; infants must also be able to recognise who is a potential communicative partner and what constitutes a potential social signal. Indeed, infants are very good at identifying their **conspecifics**. From birth, human infants demonstrate a discernible preference for human faces and voices (Farroni, Johnson, Menon, Zulian, Faraguna, & Csibra, 2005; Vouloumanos & Werker, 2007). Not only can infants identify others as human, they also have a preference for familiar partners: shortly after birth infants already show a preference for their mother's face over the faces of female strangers (Bushnell, Sai, & Mullin, 1989).

conspecifics members of one's own species.

Human infants also appear to have specific preferences for human speech. For example, Vouloumanous and Werker (2004) created speech and non-speech sounds that were carefully matched on a range of physical features (**fundamental frequency**, duration, and timing), and found that neonates preferred the speech sounds to the non-speech sounds. There is evidence that some neural circuits are already specialised for speech processing from very early on: Peña and colleagues (2003) played speech forwards and backwards to neonates and found that only forward speech elicited greater activation in specific areas of the left hemisphere involved in language processing. Krentz and Corina (2008) obtained further confirmation that it is the linguistic aspects of the signal that capture infants' attention: they investigated speech signals in another modality – the visual gestures of American Sign Language (ASL) – and demonstrated that 6-month-old hearing infants who had never been exposed to ASL preferred signs that are part of ASL over matched non-linguistic gestures akin to pantomime. It appears, then, that human neonates are predisposed to identify familiar individuals, which is crucial for the establishment of social interactions, and to attend specifically to those stimuli in the environment that are important for language acquisition.

fundamental frequency the lowest of the formants, abbreviated F0; what is perceived as the voice pitch of different speakers.

However, it is not sufficient for infants to be able to identify potential communicative partners; they also must be able to monitor where their partner's attention is focused. The relevant cues for an individual's focus of attention are the orientation of the eyes, the orientation of the face, and the orientation of the whole body. Some of these cues are processed from birth: neonates are able to discriminate faces with the eyes oriented towards them from faces with the eyes oriented away from them (Farroni, Csibra, Simeon, & Johnson, 2002). By the time infants reach 4 months of age, detecting whether someone's gaze is directed towards them or away from them takes only 250ms. At this age infants appreciate whether an adult is providing relevant feedback in a socially contingent or non-contingent way (Striano, Henning, & Stahl, 2005) – that is, they expect adult behaviour in face-to-face interaction to be responsive to their own behaviour (see Section 1.1.3 for a description of the coordinated interpersonal timing of infant–caretaker interactions). Infants from

birth are highly sensitive to the cessation of a social interaction: when an adult's face suddenly freezes, 0- to 4-day-old newborns decrease eye contact and show signs of distress (Nagy, 2008), a phenomenon known as the **still-face effect** (Tronick, Als, Adamson, Wise, & Brazelton, 1978; see Methodology Box 1.1). From early infancy, eye contact plays an important role in calming infants (Zeifman, Delaney, & Blass, 1996). When an adult partner freezes her face and looks away, infants at 6 weeks of age reduce their smiling and gazing and try to re-engage their partner (Bertin & Striano, 2006). Interestingly, infants respond more negatively in the still-face paradigm when the still face is administered by their mother, as opposed

still-face effect infants exhibit distress when an adult suddenly freezes movement of her face in dyadic interaction; an indicator that young infants have social expectations that people will engage responsively and provide contingent feedback during face-to-face interaction.

METHODOLOGY BOX 1.1 THE STILL-FACE PARADIGM

How can we probe infants' early competencies in social interaction? What kind of behaviours do infants expect from their caregivers in interactive situations? In 1978, Tronick and collaborators (Tronick, Als, Adamson, Wise, & Brazelton, 1978) presented observations of infants' reactions towards an unusual and unexpected type of caregiver behaviour: the still face, that is, a sudden unnatural freeze of the caregiver's face, resulting in a flat emotionless expression for a period of up to three minutes. When confronted with this behaviour, infants typically display a complex range of behaviours that indicate distress, such as reducing their smiling, averting their gaze from the caregiver and even crying. They also try to re-engage their communication partner through smiling and cooing. These reactions of distress and social initiative have been observed from birth (Nagy, 2008) and persist until about 9 months, at which age infants become more sophisticated in self-regulation and are able to redirect their attention towards other objects in the environment. The infant behaviours observed in the still-face paradigm are testimony to the amazing early social sophistication of human infants, which is evidenced by the distress experienced from a withdrawal of social interaction, as well as by the wide repertoire of behaviours that infants use to initiate social exchange and to re-engage their communication partners.

To study the still-face effect in the laboratory, mothers or other caregivers are first videotaped while engaging in normal reciprocal communicative exchange with the infant. Caregivers are then instructed to suddenly withdraw communicative interaction by freezing their facial expression. Interestingly, while the still-face effect itself is considered to be quite robust and dramatic (Adamson & Frick, 2003), procedures vary widely across studies from differences in the duration and presentation of the still face (front, profile, etc.) to differences in the coding of infant behaviour. Nonetheless, the still-face paradigm is widely used to probe the developmental trajectory of infant social behaviour; for example, to study gender and ethnic differences in early social competencies as well as the social competencies, of infants with developmental disorders such as Down syndrome or autism spectrum disorder.

to a stranger; this indicates that infants develop strong social expectations early on about how their mother ought to behave in face-to-face interaction (Melinder, Forbes, Tronick, Fikke, & Gredebäck, 2010). Over time, infants develop the ability to sustain attention towards non-social as well as social aspects of the environment, the latter indicated by infants' more prolonged and stable gaze patterns towards their mothers (Messinger, Ekas, Ruvolo, & Fogel, 2012). The abilities of young infants to create rapport and sustain social interaction with their caregivers through reciprocity, shared affect, and imitation provides the foundation for later developments in understanding the intentions of others (Rochat, 2007); see Chapter 3.

For an infant to discover the meanings of words, he or she must be able to discern what others are talking about – in effect, to read their communicative intentions as relevant to the present situation. This fundamentally involves an ability to grasp another person's focus of attention, and in the special case of learning the names of things (e.g. objects, actions, colours), to determine what aspect of the environment the speaker is referring to when producing a particular linguistic expression. The development of the ability to identify the referents of linguistic forms is the topic of Chapter 4, and relies on the infant's ability to engage in episodes of **joint attention**, whereby the infant coordinates their own attention with that of another person (Carpenter, Nagell, & Tomasello, 1998; Eilan, Hoerl, McCormack, & Roessler, 2005; Moore & Dunham, 1995); see Figure 1.4. Infants' developing ability to engage in joint attention with others, and the role of caregivers in **scaffolding** joint attention, will be described at length in Chapter 3. Chapter 3 also describes the role of gaze cues and communicative gestures, such as pointing, in facilitating joint attention between infants and their caregivers. The human ability to engage cooperatively and infer the communicative intentions of others enables individuals to grasp the potentially infinite number of ways that sound patterns of language can link to meaning. The innate biases of infants allow them to overcome their limited attention span by predisposing them to focus on those aspects of the environment that are socially relevant.

joint attention the coordination of the infant's attention with that of another person to some aspect of the world.

scaffolding caregiver behaviour that supports a child's joint activity with others, by taking into consideration the child's developmental status.

1.2.2 Engaging others

From birth, infants are emotionally expressive. At about 1 month of age smiling and laughter appear. As with crying, both the facial expression of smiling and the vocal behaviour of laughter start out as a reflexive response to some internal or external stimulus, such as tickling (Oller, 2000). However, infants gradually come to produce smiles to elicit attention and maintain rapport with their caregivers. In adults, smiles that express genuine enjoyment, called **Duchenne smiles**, can be identified not just by a raising of the corners of the lips but also by a characteristic cheek raise. In contrast, purely social non-Duchenne smiles lack the cheek raise (Ekman & Friesen, 1978) and are qualitatively different from Duchenne smiles. In infants, however, Duchenne and non-Duchenne smiles often appear together such

Duchenne smiles smiles that express genuine enjoyment; can be identified by a raising of the corners of the lips, accompanied by a cheek raise that creates crow's feet around the eyes.

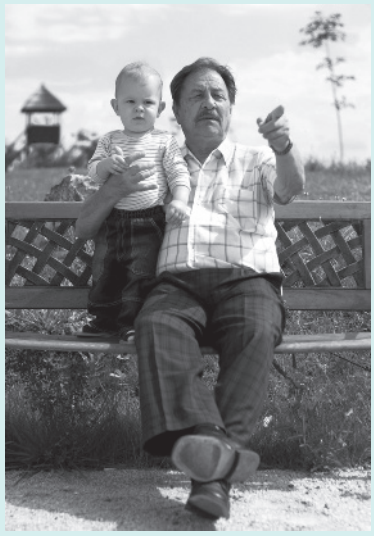

Figure 1.4 *Infants follow their caregivers' direction of eye gaze and pointing gestures to identify objects of interest to others. During periods of joint attention, infants and caregivers are aware of sharing attention to an object of mutual interest. Here a grandfather directs the attention of his grandson.*

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that Duchenne smiles tend to develop out of non-Duchenne smiles within the same interactive episode (Messinger, Fogel, & Dickson, 1999). This suggests that early on, social signalling and expression of internal emotional states may be tightly linked; this fits well with the view that early social interactions between infants and caregivers are primarily emotional in nature, and that infant emotion expressions can serve as important triggers for these interactions.

While engaging with their social partners, infants try to approximate the communicative behaviours of others. One important way of learning culturally important behaviours is through imitation. Meltzoff and Moore (1977), in a seminal study, showed that 12- to 21-day-old neonates were able to imitate facial expressions (tongue or lip protrusions and mouth openings) as well as sequential finger movements (opening a hand one finger at a time). This suggests that neonates already have the ability to map their perceptions of other people's actions onto their own actions. Most importantly, these imitative abilities of infants extend to the vocal domain: 18- to 20-week-old infants can imitate sounds like /a/, /i/, and /u/ (Kuhl & Meltzoff, 1982). (Note that by convention meaning-bearing sounds of a language are placed between forward slashes.)

Amazingly, such vocal imitation can already be detected in neonates. Chen, Striano, and Rakoczy (2004) showed that 1- to 7-day-old infants imitated sounds like /a/ as well as sounds like /m/ by either opening or clutching their mouth, and that they did so even when their eyes were closed. This means that neonates are capable of auditory–oral matching – in effect, they are able to produce the appropriate articulatory gestures based solely on what they hear. While neonates are capable of immediate imitation, older infants are able to defer imitation – to imitate an observed behaviour at a later point in time. How the infant's growing skills in observing and imitating others helps them in learning language and sociocultural skills will be described in Chapter 3.

1.2.3 Neurological and cognitive immaturity

One manifestation of the extended period of childhood in human life history is that the neocortex takes a very long time to mature, resulting in the restricted information-processing abilities of infants and small children. Paradoxically, having restricted

Less-Is-More a proposal that the limited working memory capacity of infants aids language learning by restricting the size of the units they can process.

processing capacity may be of benefit for language learning: Newport (1990) proposed a **Less-Is-More** account which links children's language-learning success to their limited information-processing capacity. According to this account, limited working memory capacity restricts infants to processing only small chunks of input, which, in turn, might help them to notice more fine-grained linguistic details, for example the subtle changes in word endings that mark grammatical functions. The Less-Is-More account, however, still needs to be reconciled with the observation that in, school-aged children and adults, larger processing capacity correlates with better language learning abilities. For example, in many studies with children as young as two years of age, phonological short-term memory (typically measured using a non-word repetition task) has been shown to predict individual differences in vocabulary size (Adams & Gathercole, 1996; Gathercole & Baddeley, 1989, 1990; Gathercole, Hitch, Service, & Martin, 1997; Stokes & Klee, 2009). Furthermore, as will be described in Chapter 10, children with language impairments often show marked deficits in verbal working memory capacity that are predictive of their error rates in sentence comprehension (Marton & Schwartz, 2003; Montgomery, 2000; Montgomery & Evans, 2009; see Montgomery, Magimairaj, & Finney [2010] for a review). In studies of foreign language acquisition, adult learners with larger working memory capacities show greater success in learning the grammatical features of a new language, and better performance on measures of sentence processing and comprehension (Ellis & Sinclair, 1996; Harrington & Sawyer, 1992; Kempe & Brooks, 2008; Miyake & Friedman, 1998; Williams & Lovatt, 2005). To accommodate these findings, the Less-Is-More account must posit that the restricted processing capacity that provides an advantage during infancy becomes a liability with age.

Another perspective on how prolonged cognitive and neurological immaturity might be beneficial for language learning has to do with the development of the prefrontal cortex. Mapping studies of grey matter density have indicated that the cortical areas responsible for **executive functioning** and control of attention mature only around puberty (Gogtay et al., 2004). Consequently, when it comes to solving complex tasks, children exhibit immature executive functioning, which is manifest in problems in which the child must consider several competing response alternatives. In such tasks young children will tend to over-select the most frequent or prepotent response. Adults, in contrast, tend to weigh the different response alternatives according to their probabilities of being correct, and provide responses that reflect those probabilities. So how might the young child's tendency to over-generalise highly frequent responses benefit the process of language learning? As described earlier, language learning is, in essence, the learning of social conventions. Ramscar and colleagues (Ramscar & Gitcho, 2007; Thompson-Schill, Ramscar, & Chrysikou, 2009) have argued that when it comes to learning conventions, cognitive flexibility may actually be a disadvantage. In situations with competing choices, children's lack of flexibility in weighing response alternatives supports learning of just the one alternative that occurs most frequently and is most supported by the context. In essence, immaturity of the prefrontal cortex leaves children at the mercy of the winning cue, whereas

executive functioning a control system, mainly situated in the **frontal lobe** of the neocortex, that manages other cognitive functions; involved in the deliberate control of attention, amongst other functions.

adults are able to override such maximising behaviour to consider the probabilities of the other cues as well. Indeed, comparing **artificial language** learning between children and adults has confirmed that adults tend to reproduce faithfully whatever inconsistencies and irregularities are present in the input, whereas children are more likely to over-regularise irregular patterns (Hudson Kam & Newport, 2005). Given that language learners generally are only ever exposed to a subset of the language they are learning, which leaves them with countless indeterminacies about how linguistic forms may relate to underlying meanings, rampant over-generalising can aid the young language learner in discovering regularity and structure.

artificial language experimental methodology which teaches participants aspects of an artificially created miniature language to control for prior knowledge and to reduce the complexity associated with natural languages.

In sum, prolonged immaturity in humans, in the context of social communities reliant on cooperative practices provides conditions that facilitate learning and make the development of complex social and cognitive skills such as language possible. Language learning benefits from the neural and behavioural plasticity associated with prolonged immaturity. At the same time, language learning builds upon a set of social and cognitive abilities that are linked to the human propensity for cooperation. The social environment that human infants find themselves in promotes the need for communication on the part of the child and the desire to facilitate this process on the part of adults. Language learning is fundamentally a social affair.

SUMMARY

- **Evolutionary constraints associated with bipedalism and dietary improvements due to advanced hunting techniques and domestication of fire resulted in the evolution of delayed maturation, larger brains, and a period of prolonged postnatal immaturity in our hominin ancestors.**
- **Lengthy childhoods provide a substantial period of neural and behavioural flexibility conducive to learning.**
- **Lengthy periods of immaturity necessitate alloparenting by other members of the community. This exerted pressure on human infants to develop communicative behaviours that are effective in soliciting care from others.**
- **Increasing cultural sophistication may have precipitated the emergence of 'natural pedagogy', that is, the use of communicative interaction to teach opaque cultural knowledge. Language development can capitalise on these available channels of information transmission.**
- **Language is based on cooperative abilities because it involves sharing of information and internal states. As a system of social conventions it also constitutes a cooperative endeavour in itself. Thus, social and cognitive abilities for cooperation must be in place for language learning to occur.**

- **Infants possess a range of cognitive and social abilities that constitute prerequisites for language development:**
  - **From birth, infants show preferences for social partners and for social signals.**
  - **Infants learn quickly to attend to others and to determine the focus of joint attention.**
  - **During the first year of life, infants also learn to read others' intentions.**
  - **Infants use emotional signals such as laughter and crying to engage potential communication partners.**
  - **Infants are able to imitate behaviours of their communication partners and to map auditory signals onto simple motor programmes.**
  - **Late maturation of the prefrontal cortex prevents children from considering multiple response alternatives in complex tasks. This results in over-regularisation, which may facilitate the learning of conventions such as language.**

FURTHER READING

Key studies

To better understand the specifics of how language may have evolved to fit the social and cognitive capacities of the human brain, read Kirby, S., Cornish, H. & Smith, K. (2008). Cumulative cultural evolution in the laboratory: An experimental approach to the origins of structure in human language. *Proceedings of the National Academy of Sciences of the USA*, *105*, 10681–10686.

Overview articles

For an accessible treatment of how immaturity of the prefrontal cortex may be beneficial for language learning, read Thompson-Schill, S., Ramscar, M. & Chrysikou, E. (2009). Cognition without control: When a little frontal lobe goes a long way. *Current Directions in Psychological Science*, *18*, 259–263.

Books

For an account of how language development builds on pre-existing cooperative abilities, read Tomasello, M. (2008). *Origins of Human Communication*. Cambridge, MA: MIT Press.