UNDERSTANDING COGNITIVE DEVELOPMENT

CHAPTER 6

THE EMERGENCE OF SPEECH

We now know that infants rapidly progress to speech-like sounds in the second half of their first year. But to speak in words, the infant still needs to be able to connect the sounds it hears with the facial movements it sees when others are talking, and with the sounds it makes itself. We start by reviewing the neuroanatomical structures that make speech – and ultimately language – humanly possible.

THE BRAIN AS AN ORGAN FOR LANGUAGE

Let us consider for a moment what the baby has to master here. She began by making the appropriate mouthing movements to form the rudiments of consonants and vowels. But for these sounds to develop further, she has to connect the movements of mouth and vocal tract with the sounds she hears herself make, and also connect and compare these heard sounds with ones made by those talking to her. Before any of this is invested with adult meaning, the baby will start to build a personal 'lexicon' and know how to produce it at will. These are complex, intermodal and interpersonal connections that require the child's brain to be organised in a very particular way. Let us turn our attention to the anatomical architecture that permits this amazing skill.

LEARNING LANDMARKS

6.1 Brain centres for language: classic models. You should be familiar with the neuroanatomical foundations for language and classical models for how the brain is thought to be specialised for language.

6.2 Brain centres for language: newer models. You should be aware of some of the contemporary re-thinking with regard to the neuroanatomy of language. You should know why mirror neurons might be important in language learning.

6.1 BRAIN CENTRES FOR LANGUAGE: CLASSIC MODELS

It is still not well understood how the many aspects of language are dealt with by the human adult brain, let alone the brain of the developing child. Until quite recently, much of what was believed about the functional anatomy for language came from ideas put forward by nineteenth century clinicians; most notably the French physician, Paul Pierre Broca and the German neurologist, Carl Wernicke. Broca famously carried out a post-mortem study of a brain-damaged patient whose speech production was almost completely impaired apart from the ability to utter the word 'tan'. Broca located the damaged area in the front left hemisphere – a brain region known since as **Broca's area** (Panel 6.1) – and considered to be the area for the motor production of speech sounds in grammatical strings. **Broca's aphasia** is still used today as a clinical term for anyone who speaks effortfully in short phrases with very little grammatical structure. Wernicke, on the other hand, identified another sort of aphasia (meaning an impairment in the production or comprehension of language) in which patients could speak with an apparently normal grammatical pattern and rhythm but with no meaning attached to the speech stream and sometimes with no meaning attached to the words. This is now known as **receptive aphasia**, or **Wernicke's aphasia**, and was thought to be caused by damage to an area in the brain called the **superior temporal gyrus** (STG) that encircles the auditory cortex. Wernicke's area, as it became known, is located on the left STG along a part of the brain known as the **planum temporale**, itself located within the large fissure separating the parietal and temporal lobes, called the **Sylvian fissure** (see Panel 6.1). These two areas are connected via a fibre tract called the **arcuate fasiculus**. The broad conclusions are that **lexical access**, or word meaning, is localised at Wernicke's area and that motor commands to output meaning in sentences are created as motor plans in Broca's area.

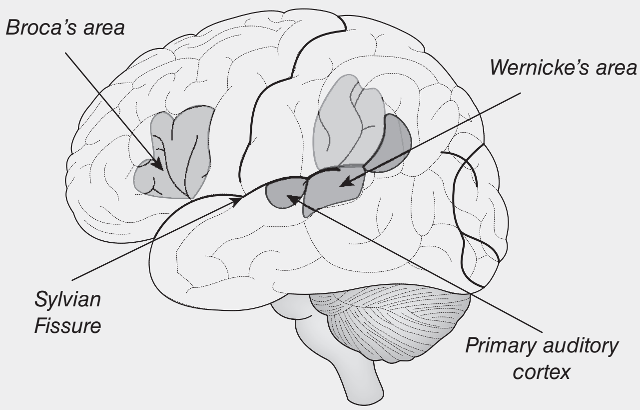
In the middle of the last century, an American neurologist, Norman Geschwind, revived interest in these areas by discovering that the planum temporale was larger in the left than the right hemisphere in most patients. Geschwind popularised the idea that the human language centres are normally located in the left hemisphere of right-handed people (Geschwind & Levitsky, 1968). This idea of a left hemisphere specialised in humans for language has received some support from studies of infants. In a study by Locke et al. (1991), pre-babbling infants (4/5 months) and babbling infants (6–9 months) were given rattles placed in either the right or left hand (see Locke, 1993: 187). A significant increase in right-handed shaking of the rattles was observed in the babbling infants, leading Locke to conclude that the left hemisphere comes to control rhythmic manual movements through a common mechanism that also allows the increased control of the vocal tract.

6.2 BRAIN CENTRES FOR LANGUAGE: NEWER MODELS

New ideas and findings are beginning to modify the classic view of the language 'centres' in the brain. An altogether more complex picture is now emerging, as we gain more detailed information about the different sorts of speech disorder that can occur as a results of brain dysfunction, and as hypotheses about brain localisation become

Panel 6.1 Brain centres for language: classic models

- Language was thought to be processed in the left hemisphere because of certain cases of brain damage
- Two areas were classically identified with language processing
  - *Broca's area*
    - Damage to this area seem to affect the ability to produce speech
      - Broca's apahasia today refers to impairments of producing grammatical language
  - *Wernicke's area*
    - Damage to this area resulting in grammatical utterances that were devoid of meaning
      - Today this is known as Wernicke's aphasia or *receptive aphasia*



(Image by James.mcd.nz; Wikimedia Commons)

- It was thought that Wernicke's area controlled lexical access whilst Broca's area controlled motor output of meaning, but this is now thought to be an over-simplification
- There is still some support for the idea that rhythmic motor output is located in the left hemisphere and it is generally the case that the left hemisphere is dominant in language processing

specifically tested by functional imaging of normal healthy brains. The classic view of biologically localised 'areas' for grammar and for lexical information turns out to be based on a somewhat inaccurate model of how the brain is organised.

First of all, the very concept of left-hemisphere specificity for language has been challenged by striking evidence from patients who have had an entire brain hemisphere surgically removed (usually in order to control epileptic seizures). In a study of 48 child patients who had undergone this surgery (called **hemishperectomy**), Curtiss and de Bode (1999) found that they were actually twice as likely to be seriously language-impaired after removal of the *right* hemisphere than the left. More subtle impairments of language are certainly found in all adult patients undergoing this operation, whichever hemisphere is removed, and it does seem to be true that difficulties in the more complex aspects of grammar are more likely to occur after left-hemisphere removal. But it is also clear that from the fact that some left-hemispherectomised patients suffer no obvious language impairment, that the right hemisphere can sustain a considerable amount of language processing on its own. This is especially true of children, and, in particular, children who are pre-linguistic will make a near normal recovery after damage to the 'classic' left-hemisphere language centres (Bates et al., 2001).

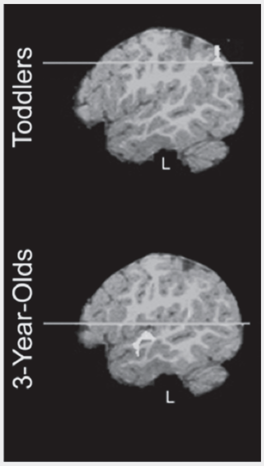
Hemispheric specialisation apart, the idea of two clearly distinct locations for grammatical and lexical function has been challenged by a more complex and fine-grained analysis of language itself (Poeppel & Hickok, 2004). What is actually meant by 'lexical' (word-based) information, for example? It can be both phonological ('pa' versus 'ba') as well as connected to the recognition of meaning ('pad' versus 'bad'). As many are now reporting, moreover, some aphasias can occur after damage to areas outside the classic language-based ones including sub-cortical areas such the deep 'old' part of the brain known as the **basal ganglia** (Lieberman, 2002). And, as Dronkers and Larsen (2001) have reported, patients with damage to Broca's area are not always 'agrammatical', whilst patients with damage to Wernicke's area do not always suffer difficulties with meaning and lexical access – leading them to re-assess whether or not such specific attempts at localisation of function are realistic. Imaging techniques are now shedding light on the complex interconnectivity between different areas involved in language listening and language production such as the auditory and motor cortices.

In children who are learning to speak, however, you may wonder when these areas become functionally connected. This is hard to answer as imaging techniques are not normally used with young healthy children. However, a study by Redcay et al. (2008) compared fMRI activity in toddlers of around two years olds with that of speaking children about one year older during natural sleep, in the course of which they were exposed to speech played both forwards and backwards. The children showed diffuse activation to forwards speech involving frontal cerebellar and occipital regions, but only the older children also showed activation in the temporal areas associated with speech processing in adults (see Panel 6.2). Although this is a preliminary finding, it points to how different brain regions become recruited in language learning and how the brain has become functionally re-organised for speech perception by the age of three.

Returning to our young infant imitating and exploring speech sounds, the general phonetic structure of vocalisation is rapidly becoming like that of the adults, but lexical and motor access to real words is still a very long way off. Are there any brain mechanisms that help the child towards the speech it is hearing around him?

Panel 6.2 Brain centres for language: newer models

- There is growing evidence that the right hemisphere can play an important role in language processing
    - In brain-damaged patients (especially young children) it can take over the left hemisphere's function
- Modern imaging techniques have identified a greater role for the right hemisphere and have helped reveal the interconnections involved in different aspects of language use
- They also show how the brain starts to become functionally re-organised for language at around 3 years



Only 3 year olds showed significantly increased activation (white areas) in the superior temporal region of the brain when listening to forwards as opposed to backwards speech (Adapted from Redcay et al, 2008, with permission)

- Many issues still remain – such as whether there are auditory 'mirror neurons' that allow children to imitate sounds

Mirror neurons and speech

If you remember from Chapter 5, there is a hypothesised brain mechanism in humans that allows visually perceived behaviours to be imitated. This is the mirror system, in which certain motor regions of the brain fire when actions of others are passively observed. The idea that this may be related to language has been largely fuelled by the fact that one of the active regions that fires during different sorts of observed actions is one of the 'classic' language centres – Broca's area, provoking various theories suggesting that human language has evolved from an older centre in the primate brain for coding action. A reasonable speculation arising from this is that there may be a common neural substrate for coding the sound of another's voice and the motor movements that are required to make that sound oneself, just as there seems to be a common substrate for perceiving and carrying out an action with hand or limb. Are there 'auditory' mirror neurons that allow us to copy sounds? No one knows at present. And even if there are, they are unlikely to work in isolation, as speech perception – the foundation for speech production – is multimodal – depending on sight as well as sound. A connection has to be made between the heard sound and the (visible) motor act required to produce it. Even if there is a mirror system that supports this, anatomical readiness alone cannot propel the child forward. The brain has to learn this connection, and this has to be done not only in terms of connecting sight with sound but also by building on the auditory match and mismatch between what is produced and what is heard from others through active learning.

LEARNING MECHANISMS FOR SPEECH

LEARNING LANDMARKS

6.3 Learning from others. You should be aware of the multimodal nature of speech learning and know the extent to which direct reinforcement can help in early speech production.

6.4 Learning through self-regulation. You should understand why the main spur for making word-like sounds seems to be through the child's self-regulation of its own output.

6.3 LEARNING FROM OTHERS

There is growing behavioural evidence regarding how infants make connections between what they hear and what they see when watching someone talk. As you know, visual imitation based on lip and mouth occurs very early but this type of visual imitation seems to disappear after the first two months. Certainly, looking at someone's mouth is not an ideal way to start learning phonology, not least because many of the first uttered and copied sounds are made at the back of the mouth with very little observable effect on the lips. We also know that vocal imitation takes over from visual imitation from the second month. Recently, moreover, it has been recognised that visual attention seems to shift from the eyes back to the mouth between 4 and 8 months and then, at about 1 year, there is a shift of the infant's attention back to eyes when watching someone talk. This is only true if the adult is speaking in the child's native tongue, suggesting that they now have the attentional capacity to pick up social cues, if the phonology is familiar (Lewkowicz & Hansen-Tift, 2012). This is a more complex speech learning mechanism than one based on auditory imitation alone, and indeed looking at the mouth continues to be an important factor in adult speech perception. Adult humans can famously be influenced by what they see the mouth do when they watch someone speak, as demonstrated by the dramatic **McGurk effect.**

Learning from adult feedback

Despite their growing attention to the sight and sound of others, babies take a long time to make sounds an adult can recognise as a word. Does specific feedback from the speaking adult play a part? Adults do not punish or admonish babies for not being able to speak properly in the way that the same adult might scold a puppy for making a mess on the living-room carpet. But just as the adult will lavish praise on the puppy for appropriate toilet behaviour, so the adult provides a huge amount of positive reinforcement during their dialogue with the baby. But can we be sure that this produces specific learning of actual vocal content by the child? In an early study by Routh (1967), the vocalisations made by babies between 2 and 7 months old were recorded and then, over a period of days, the researchers selectively reinforced the baby's own particular consonant-like sounds or, conversely, its own particular vowel-like sounds. They did this by smiles, sounds and stroking when the baby made one or other of these vocalisations. This significantly enhanced the frequency of production of the particular sound type that had been reinforced. Equally, in a somewhat unethical experiment by Wahler (1969), a mother was asked not to reinforce her baby's vocalisations but to 'freeze' on hearing, e.g., cooing or babbling when these first appeared. This reduced the emission of these sounds by the baby, but fortunately, he recovered when her normal behaviour was restored.

The implication from these studies is that deliberate reinforcement by Mum increases the frequency of the sounds the child was experimenting with anyway. This has been supported by a study carried out by Uzgiris et al. (1989), in which it was found that the mother's imitation of her infant increased significantly at about 8 months. Although babies do not imitate their mothers as much as the other way around, there was nevertheless an increase observed in their sample of 80 mother–baby pairs at around 8 months in the extent to which the baby would repeat the vocalisation that had just been imitated by the mother. Social reinforcement clearly acts not just as a stimulus to self-exploration with sound but also as a stimulus for the baby to repeat particular sounds that the mother recognised as speech-like.

Panel 6.3 Learning from others

- Speech is learned by a complex imitative process that involves looking at the mouth and eyes of someone speaking
  - Very young babies tend to focus on the eyes
  - Between 4 and 8 months, they focus more on the mouth
  - By 12 months, they focus back on the eyes if the speaker is talking in their native language
- There is some evidence that babies learn to make speech-like sounds by direct reinforcement from the mother
  - They can be conditioned in the lab to selectively repeat either consonant or vowel sounds if these are reinforced with smiles and tickles
- Imitation by the mother of the baby's vocalisation also acts as a reinforcer
  - This shows an increase at around the babbling stage
- In the main, most learning seems to derive from the mother imitating and reinforcing sounds that the baby was already experimenting with

6.4 LEARNING THROUGH SELF-REGULATION

Unlike dogs that can be (sometimes!) be trained to say 'sausages', language learning in children is no one-off learning achievement. The sheer number and precision of speech sounds that a child will learn in its first year suggests that the child's lexicon is constantly updated by an internal feedback mechanism – or as Gleason (2005: 79) puts it, 'a way of assessing his own performance'. But even this concept requires clarification. How do you assess your performance when trying out your French pronunciation on holiday in France? Is it only when corrected by the native French speakers you meet? Or are you guided at least as much in terms of your own criterion of failure, i.e. when what you hear yourself say doesn't come out the way you intended? In infants it appears that the latter type of experience is crucial. Whilst there is considerable evidence, as we have seen, that babies are led in certain directions through imitative exchanges with the mother, there is very little evidence that discoveries at the babbling stage are acquired by being directly 'corrected' by others. This is a little surprising is it not? For you now know that imitative acts by the mother contain expansions and embellishments of what the baby has just uttered, giving ample opportunity for the baby to learn directly from her 'corrective' input – just as you may adjust your French pronunciation by hearing your words corrected by a French speaker. Yet the numerous studies of language learning during the babbling period have found no evidence that this actually occurs. In fact, Locke (1993) cites at least 10 empirical studies from 1968 to 1990

Panel 6.4 Learning through self-regulation

- Mothers embellish and expand on the speech-like sounds of babies
- Whilst this suggests that babies might learn to adjust their speech by being directly corrected during imitative exchanges, there is no evidence for this
- The growth of the vocal tract, increased articulatory exploration and matching against perceived sound is the main promoter of coherent word production

showing that the developmental literature is actually 'replete with failures' (p. 167) to show how children actively learn from corrective feedback from adults, suggesting that the feedback that drives the learning must be largely internally monitored.

This has been supported by measurements of how the growth of the vocal tract between 4 and 7 months together with increased exploration of sounds can by itself give rise to advanced babbling. Serkhane et al. (2007) constructed a detailed model showing how articulatory development through the growth of the vocal tract is tightly related to acoustic output between 4 and 7 months. It is highly likely that this same process will continue to help the babbling turn into recognisable 'words'. In fact, the relationship between the fine tuning of speech motor control in relation to auditory feedback continues on into adulthood (Shiller & Rochon, 2014).

In the early stages of word production, therefore, the baby really needs to learn about his own voice and how he can modify it in relation to what he hears. Although it is socially reinforced, it seems this is a largely self-propelled voyage of discovery. But its ultimate purpose is to communicate meaning and be understood. The communicative elements of language become increasingly evident in the second half of the first year as we see next.

SPEECH AS COMMUNICATION

LEARNING LANDMARKS

6.5 The beginnings of intentional communication. You should know what is meant by conversational or variegated babbling.

6.6 Joint attention and linguistic reference by the adult. You should know what deictic pointing refers to, and what is meant by dyadic interaction. You should be able to cite at least one study correlating dyadic interaction with language onset.

6.5 THE BEGINNINGS OF INTENTIONAL COMMUNICATION

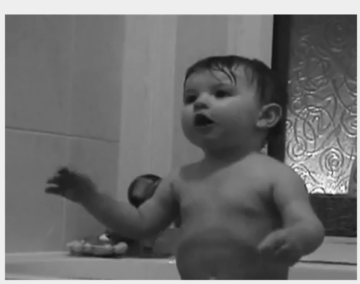
In the realm of direct perception, meaning is a 'given', whether it is about a looming object or a disappearing toy. Human speech is curiously different in that it starts off without meaning and, as we have seen, can advance in pre-speech form for nearly a year without it. What it does need, however, is a communicative purpose if it is ever to be used as a way of expressing and sharing meaning with another. The foundations for this desire to share and interact are in place well before speech begins and they form the platform from which it will finally emerge.

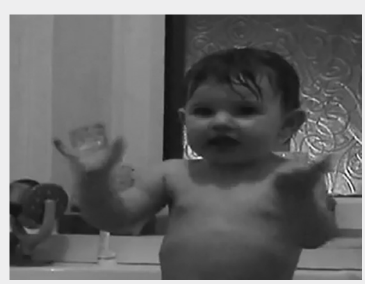
Conveying meaning non-vocally

When expressing meaning in face-to-face adult dialogue, we very rarely rely completely on sound. How many of us are able to talk without waving our arms in the air and making signs and gestures with our hands? There is considerable debate amongst evolutionary biologists as to whether language has evolved directly from such signing – especially

Panel 6.5 The beginnings of intentional communication

- The stage between babbling and meaningful speech shows the intention to convey meaning with sound
- By 12 months, the baby will have more vowels and consonants in its repertoire and be capable of re-duplicated babbling using strings of syllables with varied pitch and intonation. This is called:
    - *variegated babbling* or
    - *conversational babbling*
- It is accompanied by eye-contact and gestures that indicate that the baby intends to refer to something





(Image Ava O'Hara; copyright Kevin O'Hara) given the possibility that there is an action mirroring system in Broca's area. And whilst it is usually fully a year before the child makes a sound that is definitely a meaningful word, the ability and desire to convey and share meaning are evident in the child's gestural behaviour much earlier. In fact, a key landmark phase in the development of vocalisation is called **conversational babble** – vocalisations that are accompanied by clear non-vocal attempts to communicate, using gestures.

Conversational babble

This is an important transition stage between standard or canonical babble and true speech. Also referred to as jargon or **modulated** or **variegated babble**, it starts at about 10 months and overlaps with the appearance of first words. By this stage, babbling has taken on a more complex character with strings of syllables uttered with stress and intonation that sounds very like speech. Variegated babbles are syllables strings, but with varying rather than repeated consonants and vowels such as 'daba' and 'bagidabu'. Variegated babbling predominates over reduplicated babbling after 12 months and overlaps with the production of the first true words.

The qualifying criterion for conversational babble is that it occurs along with eye contact with the listener and/or gestural behaviours such as the newly acquired skills of pointing and looking towards a desired object. In other words, it is as if the baby now knows that these sounds should help make his intentions clearer. This is a crucial development, for it is through eye contact and mutual gaze that the mother can start to establish a shared meaning for the sounds the baby makes. In this coming together of communication, gesture and sound, then, the central discovery an infant makes is that certain sounds *have* meaning, a crucial precondition for learning what those meanings are.

6.6 JOINT ATTENTION AND LINGUISTIC REFERENCE BY THE ADULT

In Chapter 5, you saw how children can start to use pointing and eye gaze by about 14 months to single out an object for joint attention. These pointing behaviours are called **deictic** (from the noun **deixis**). That is, the point has a meaning that can be understood by the broader context in which it appears. Confusingly, they are likely to occur in a situation often referred to as **dyadic** – a pairwise interaction between two people. Deixis brings a particular common context into this interaction; for example, a child extending a finger towards an object whilst looking from the object to the mother and back again. Pointing at this stage is likely to be accompanied not just by glances to the mother but also by vocalisation (Leung & Rheingold, 1981). This gives the mother a valuable clue about what interests the baby, and she can use this to help build the use of naming. Murphy (1978) reported that mothers would name an object that the baby pointed out during storybook reading significantly more often than chance, and Masur (1982a) reported a similar finding for objects in the general visual field pointed at by the baby. Of course the mother doesn't simply name the item, but normally engages in what Bruner (1983) has described as **naming rituals**. She will say for example 'look – what's that's – it's a teddy'. Whilst the baby will not understand the actual words 'look' 'what's that?', etc., Bruner argued that phrases such as these, uttered in the context of joint attention, make the baby aware that a naming event is going on and that the baby understands the naming process as part and parcel of a 'conversation' about a thing. Baldwin and Markman (1989) found that such naming by mother then increased subsequent attention to the named item. This implies that it is more effective for the mother to pick up on the child's natural interest than to try to direct his attention. Tomasello and Farrar (1986) found higher levels of name comprehension by 17-month-old children following four short training sessions in which objects were named *after* the child had already indicated interest rather than at the time when their interest was being directed by the adult.

But how do we know for certain that children really intend to share meaning with an adult? After all, pointing is quite an ambiguous gesture – it can denote an interest for self as much as a desire to share interest. Tomasello and colleagues at the Max Planck Institute in Leipzig have investigated this by disrupting the normal exchange between a child and adult, such that instead of a child's point and vocalisation being followed by a typical elaboration by (usually) the mother ('yes that's a nice green ball isn't it?'), the mother departs from her normal behaviour. Instead of looking to the object, for example, she goes on looking at her book or directly at the infant. They found that if the mother is looking at the child but refuses to look where he or she is pointing (i.e. the mother's attention is 'available'), then the child is twice as likely to repeat the point than in the case of a normal interaction where the mother looks immediately to the source of interest. Such repeat points are less likely, however, when the mother's attention is unavailable – e.g. reading a book (Liszkowski et al., 2008).

Whilst results such as these are open to more than one interpretation of what the child understands about his mother's mental state (Gomez, 2007), there is no doubt that the active involvement of the child in an act of referral helps the mother to latch onto the child's intended meaning, and there is considerable evidence that dyadic interactions (involving deixis) do contribute substantially to early language acquisition. Masur (1982b) found that children with larger vocabularies had been exposed to more frequent object-of-interest naming by their mothers. Tomasello and Todd (1983) found a positive correlation between degree of social interaction at 12 months, measured by length of joint attention episodes, and vocabulary size at 18 months. The degree of deictic pointing by the child was found by Bates (1979) to be correlated with first word onset.

Whilst we might expect the word learning process to be child-led in this way, it would be very maladaptive if children only absorbed meaning in connection with their own ongoing interest. Part of the dynamics of conversation is for the listener to be attuned to the fact that it is the speaker's object of interest that determines the meaning of the words being spoken. Indeed young infants are not immune to the attempts by the mother to direct their attention to something new. Baldwin (1991) found that 16-month-old children showed comprehension of object names that were labelled by the experimenter despite the fact that the child was actually showing interest in another object, confirming Bruner's contention that there

Panel 6.6 Joint attention and linguistic reference by the adult

- Pointing and looking to an object to direct the attention of another starts at around 13 months and is known as *deictic pointing*

- This is increasingly used by the mother to start building on the child's interests in her conversations with her baby
  - These are called *dyadic interactions*
- It is more effective for language learning for the mother to build on the child's interest (by naming an object they have pointed to) than to try to direct attention to something herself
- However, children of 1 year old can also learn by being asked to point out the referent on hearing the word

- The extent and quality of deictic exchanges involving naming around 12 months predicts vocabulary size at 18 months

is some genuine mutuality in the interaction between child and adult at this stage. Bannard and Tomasello (2012) have confirmed this recently by showing that new words are acquired by 1 year olds during a learning context in which they have to point out the referent to the experimenter.

From all of this we can see that from around the child's first birthday, joint attention is not only setting up the conditions both for comprehending new words but also setting up the conditions for the child to do the naming himself.

THE ACQUISITION OF FIRST WORDS

With communicative and articulatory mechanisms in place, the infant now progresses to true speech. It is important to note at this point that the timing and duration of this phase varies considerably across individual children. For example, some children may have a 'silent' phase between babbling and speech; for some babbling may co-exist for some with speech, and the age of onset of speech itself can be highly variable. However, in what follows, you will learn about what is generally true of the emergence of real speech during (usually) the second year of life.

LEARNING LANDMARKS

6.7 Protowords and word pronunciation. You should know what protowords are, and some of the pronunciation constraints that children encounter.

6.8 The vocabulary spurt. You should know what this refers to and the rough age at which it happens.

6.9 Word learning in deaf children. You should know the similarities and differences between hearing and non-hearing children in this phase of early language acquisition.

6.7 PROTOWORDS AND WORD PRONUNCIATION

Protowords

When children start to consistently refer to an object or event with a particular sound, this is the start of naming. Initially, however, the child's attempt to name may be so far from any known word that it has to be described as a **protoword**. It qualifies as word-like in that it will be used recurrently in a context appropriate way. A common example is the name given to a favourite toy or comforter, perhaps 'wa-wa' or 'mooly', recognised by parents, caregivers and family members ('he wants his mooly') but not by a visiting stranger.

Word pronunciation

Sounds acquired during the babbling stage eventually have to conform to precise phonological rules, and this simply takes time to practice. In a way, this is the child's first real brush with cultural constraints. They may choose for themselves what sounds they like to play with during babbling, but now they have to contend with specific voicing and stop rules – and many of them. To deal with this, children seem to impose certain phonological constraints on their own pronunciation; in other words, they will conform to some rules but systematically ignore or alter others. This makes the learning more manageable but it can also make progress seem quite bizarre and bumpy. Here are some of the typical constraints that occur in children's first attempts at speech.

Constraints against consonant clusters

In babbling, children will have used consonants to start a sound. To start many words, however, consonants often have to be run together, whist voiced separately: 'bread', 'cross', 'drink', 'flag', 'green', 'play', 'stick', 'try', for example. Worse still, sometimes, three consonants will start a word: 'scratch', 'scream', 'splash', etc. One simplifying rule employed by many children when dealing with these is to simply omit the first sound, especially when it is the relatively late-appearing fricative sound 's', producing 'tick' for stick or 'cool' for school, for example. However, when the first consonant is the easier labial sound 'b', another common rule is to omit the second consonant (e.g. 'bed' for bread; 'coss' for cross, 'dink' for drink) or to replace it with the bilabial glide 'w' which requires less vocal tract constriction than the liquid consonant 'r' and unlike 'r' does not require the tongue to touch the palette. This produces words such as 'bwed' for bread, 'cwoss' for cross and

Panel 6.7 Protowords and word pronunciation

- A child's first words may be his own invention, such as 'mooly' for a favourite toy
  - These are called *protowords*
- Real words can be hard if they use consonants that require fine-tuned motor control, such as the 'r' sound where the tongue must touch the palette
- Words are even harder if consonants have to be run together, such as 'bread'
  - Here children will omit or replace the difficult consonants, producing 'bed' or 'bwed'
- Omissions will also occur when the child tries to pronounce a multi-syllable word, such as umbrella or elephant
  - Here it is often the unstressed syllable that is left out, producing 'bwella' or 'efant'
- Pronunciation difficulties do not imply that the child has mis-heard or mis-remembered a word
  - The child may say 'fis' for 'fish' but reject that mis-pronunciation from an adult

'dwink' for drink – so common in child language that in the stories of William Brown by Richmal Crompton, William's younger acquaintance, Violet Elizabeth, famously taunted him with her threat to 'scweam and scweam until I'm thick'!

Constraints against multisyllable words

It is difficult enough for children to get their tongues round single syllable words; worse still when the words are made up of different syllables. Most words have what is known as a stress pattern – some syllables are stressed, others unstressed. In English, it is very common to stress the first syllable, *Eng*lish; *buck*et, *car*pet, for example. When learning a word that starts with an unstressed syllable like tomato, children will often begin by omitting this syllable altogether: 'mato' for tomato, 'tato' for potato, 'bwella' for umbrella and so on. If the word has three syllables, the unstressed syllable is again likely to be omitted, especially when it appears in the middle of the word: 'efant' for elephant, 'pifore' for pinafore, etc.

Constraints on production rather than comprehension

When the child can only say 'bwella' or 'soo' for shoe, etc., he is struggling to approximate to a word that he is well aware of in its adult form. This can produce some amusing interchanges between child and adult – and would certainly caution against patronising a young word learner! For example, Berko and Brown (1960) report the following exchange in connection with a child's plastic fish – pronounced 'fis' by the child:

> Adult (imitating the child): "This your fis?"
>
> Child: "No – my fis!"

Child continues to reject adult's pronunciation until

> Adult: "This is your fish?"
>
> Child: "Yes – my fis"

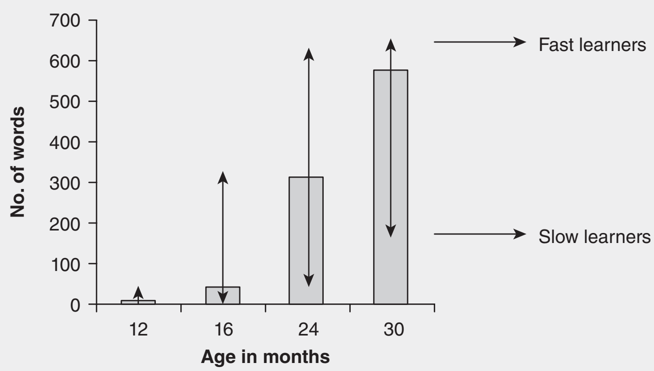
Similarly when children appear to fail to distinguish between two different names in their attempts at pronunciation, such as 'guck' for jug and duck, or 'mouth' for 'mouse', they can clearly differentiate the items when asked to draw or fetch the objects in question (Smith, 1973).

6.8 THE VOCABULARY SPURT

In their second year of life, children will use about as many 'real' words as non-words, but when they have vocabulary size of 50 words or so (very roughly at an average age of 1 year 9 months) real words will dominate non-words in a ratio of 3 to 1. At this stage, most children will show what is known as a **vocabulary spurt** – a sudden and rapid

Panel 6.8 The vocabulary spurt

- There is a very rapid increase in vocabulary size at around the child's second birthday
- However, there is huge individual variation in the actual number of words children will have at this age



The median number of words in a child's vocabulary between 1 and 2½ years of age – also showing the range of variability across slow and fast learners

(Data from Fenson et al., 1994)

- Some think that the spurt is due to better motor control; others think that children suddenly have an 'insight' into the fact that words have meanings and are eager to acquire them
    - Both of these are likely to be true

expansion of their lexicon. Because of the very large variability in degree and rate of speech development, it is not possible to tie this down to a typical pattern, but some idea can be gained from data collected by Fenson et al. (1994), who distinguished between slow, fast and median learners. The vocabulary spurts for the groups are depicted in the graph in Panel 6.8. Researchers disagree about the cause of this spurt; for some, the acceleration in speech is symptomatic of a general improvement of motor control (Kent, 1993), whilst others argue that children gain an 'insight' into the principles of naming (Dore, 1978; McShane, 1980). It is hard to define what such an insight might be, but it is roughly along the lines that 'things have names'. A third argument is that children learn about words – their stress and intonation patterns – and so become able to categorise words into types, making it easier to add on a new exemplar: 'bucket', 'ticket', 'racket', etc.; whilst others have tied it into the growing ability to classify objects themselves (Gopnik & Meltzoff, 1987). It is possible that all these are factors that contribute in some way to the rapid expansion of vocabulary in the second year of life, which could explain why it is so difficult to identify a clear age at which this 'spurt' appears (Ganger & Brent, 2004).

Vocabulary size apart, children will continue to struggle with the pronunciation of some words until they are about 3 years old. By this age, a typically developing child will have mastered all the vowel and consonant sounds in her native language. Difficult sounds, however, can continue to give trouble up to around the age of 5; in particular, the liquid consonants 'r' and 'l' producing confusions such as 'lip' for 'rip', and fricatives such as 'th' producing confusions such as 'fin' for thin. Correct pronunciation of all common sounds, including the difficult consonant clusters at the start of words (like 'snip' and 'scrape'), is usually in place by about the age of 7.

Difficulties notwithstanding, the 1-year-old child is beginning to acquire the elements of an articulated language. Before we move on to how these sounds are mapped onto meaning, we should pause for a moment to consider what it means for the young child who lacks hearing – the crucial sense that enables many of the developments of language that we have reviewed thus far.

6.9 WORD LEARNING IN DEAF CHILDREN

The element common to the hearing and deaf child's early experience is the use of non-vocal gestures such as pointing and gaze; deictic gestures are as common in deaf children as they are in hearing children. But, by the onset of such gestures, typically developing children will have moved towards speech-like sounds, whilst deaf children will not. Furthermore, when hearing children start to string two elements together, they will do so with words, not gestures. Nevertheless, deaf children develop gestures spontaneously and when they start to combine them (a point and gesture for 'hat', for example), they will do so at the same age as hearing children start to combine words. To approach a true language, however, there has to be a substitute for those arbitrary re-usable elements that we call words. Substitutes for sounds are signs. Like words, signs are part of a culturally transmitted system for sharing meaning, and like words, signs have to be used in a consistent and intelligible way. Deaf children may be taught a sign language but, in the first two years, they may be unlikely to be exposed to signing unless one or both parents are also deaf. How easy is it for a deaf child to move from gesture to sign and start to use signs in a language-like way?

Much of the research on this topic has been carried out with children taught American Sign Language (ASL). ASL and BSL, the British equivalent, has nouns and verbs, but unlike English, sentences are unlikely to use the subject explicitly. In Britain, deaf children may be taught manually coded English instead (MCE), which is somewhat different and with a greater focus on the grammatical structure of English. As the age at which children are introduced to ASL (or MCE) is widely variable – depending on the extent of their hearing loss and age of diagnosis – it is hard to draw firm parallels from such sign languages to speech-based language development. Nevertheless, research on deaf children with both hearing and deaf parents is helping to show how the path to language differs for deaf children.

In dyadic interactions, it seems that hearing mothers of deaf babies latch on to the infant's focus of attention and vocalise about it at the same time. This sometimes results in a failure to catch her child's attention and develop some mutual interaction with regard to the object of interest. Research at Bristol University found that deaf mothers, by contrast, would catch the child's attention first, then sign or say the word for the referent before using a sweeping gesture to direct the child back to the object (Woll & Kyle, 1989). By the age of 2 years, deaf children with deaf mothers were found to be 30% more communicatively interactive than deaf children with hearing mothers (Gregory & Barlow, 1989). And so, although they are deprived of the advantage of hearing speech, deaf infants can still develop effective communication with their parents using signing. For many children, this will soon be supplemented with speech reading (silent lip-reading), so that they too will be able to share to some extent in the phonological words of the hearing community.

Panel 6.9 Word learning in deaf children

- Children who can't hear will develop deictic communicative gestures just like hearing children
    - Deaf mothers of deaf babies are more effective at deictic communications
- They are likely to combine gestures at the same age as hearing children combine words
- Sign-language is a formal language system that can be taught to children from a young age. The commonest in English are
    - *American Sign Language* (ASL)
    - *Manually Coded English* (MCE)

CHAPTER SUMMARY

Children learn to speak through visual and auditory imitation. The process of learning how to articulate vowel and consonant sounds leads to babbling, which is coupled with a clear intention to communicate with others. Imitation and feedback from mothers and carers is important, but the process is also highly self-motivated and self-regulated. Mutual interest in objects shared between child and adult gives rise to naming rituals that will eventually lead to the child understanding and producing its first words.

LOOKING AHEAD TO CHAPTER 7

We have seen how interactions with adults enable babbling to turn into recognisable speech. But there is much more going on in these interactions than the learning of articulation. At all times, the adult is using the shared articulatory code to inculcate the infant into a world of shared meaning. There is every sign that children want to convey this meaning themselves. This requires a very special dynamic to operate between child and adult, as we see in the next chapter.