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# Language development in genetic disorders

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## 26.1 Introduction

The study of language in developmental disorders is an important endeavour for several reasons. First, it is essential to identify areas of relative strength and weakness in order to gain a profile of the disorder, so that we may best support and facilitate the development of language and communication skills in these individuals. Second, such research allows us the opportunity to gain an insight into questions about the process of normal language development. For example: to what extent do biological factors influence language development? Does language learning rely on general cognitive processes, or processes that are specific to language? In this chapter, we focus on the process of language development in two contrasting developmental disorders: (i) Williams syndrome and (ii) Down syndrome. This chapter will describe what has been learned about normal language development through the study of these disorders and discuss unresolved issues that still exist in this field.

Both Williams syndrome (WS) and Down syndrome (DS) are genetically defined disorders. WS is caused through the deletion of approximately 28 genes from one copy of chromosome 7.[1] The incidence of WS is rare, occurring in approximately 1 in 20,000 live births (Morris *et al.* 1998). DS is more common by comparison, affecting approximately 14 in 10,000 live births (Roberts *et al.* 2007) and is the result of three copies (referred to as 'trisomy') of chromosome 21 (Tassabehji 2003). In normal individuals, there are only two copies of chromosome 21 – one from each parent. Both disorders result in some degree of learning disability or learning

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[1] The length of missing DNA is well understood while the functional role of the relevant base pairs is a topic of active research.

difficulties, with IQ in WS typically falling between 51 and 70 (Donnai & Karmiloff-Smith 2000, Mervis & Becerra 2007), and in DS ranging from 35 to 70 (Chapman & Hesketh 2000). Both disorders are also accompanied by a series of clearly distinguishable physical characteristics. For example, individuals with WS and DS frequently suffer from co-occurring heart problems and growth deficiency; individuals with DS may also suffer from respiratory problems. A prominent feature of both disorders is that they are also typically frequently accompanied by a distinctive facial appearance (Morris 2006, Roizen & Patterson 2003).

The profile of verbal and nonverbal skills differs between disorders. In WS, overall IQ measures mask areas of relative strength and weakness in mental abilities, such as language, problem-solving ability and visuo-spatial processing, resulting in an uneven *cognitive* profile. Language in WS is frequently hailed as being a particularly strong skill. Notably, compared to overall mental age individuals with WS tend to develop extensive vocabularies that exceed expectations when compared to typically developing children with the same mental age (Bellugi *et al.* 1988). Children with WS also have a relatively good auditory rote memory processing, having a longer forward and backward digit span than normally developing individuals matched for both chronological age and mental age, as well as individuals with DS (Klein & Mervis 1999). By contrast, visuo-spatial skills in WS are particularly poor, for example as measured through the use of drawing and pattern construction tasks (Mervis *et al.* 2000, Udwin & Yule 1991, Wang & Bellugi 1994). WS is also characterized by a distinctive personality profile, which is described as hypersociable or 'over-friendly'. However, individuals with WS are also prone to suffering from anxiety, particularly when in unfamiliar surroundings, or faced with a new set of circumstances (Klein-Tasman & Mervis 2003).

In terms of the profile of strengths and weaknesses in DS, visuo-spatial and visuo-motor skills are considered to be relatively good compared to overall mental age (Klein & Mervis 1999). However, in DS spoken language can be problematic. In part this is due to differences in facial musculature and oral structure (such as a larger tongue and smaller palette) that can limit the speed and range of motion in mouth movements making articulation more difficult, and resulting in poor clarity of speech (Dodd & Thompson 2001, Miller & Leddy 1998). Moreover, cranial facial differences and narrow auditory canals, in conjunction with a slight deficiency of the immune system, results in a susceptibility to Otitis media – inflammation or infection of the middle ear. This can lead to fluctuations in clarity of hearing or even hearing loss, which occurs in approximately two thirds of children with DS (American Academy of Paediatrics 2004, Roberts *et al.* 2004a, Roizen 2002). These additional factors make it more difficult for individuals with DS to develop clear well-articulated spoken language. Nevertheless, children with DS are still capable of effective communication through the support of nonverbal methods, and are socially motivated, affectionate and engaging (Moore *et al.* 2002).

In the following section, we consider the similarities and differences in the process of early language development in WS and DS in comparison to normally developing children, indicating how the initial characteristics of these disorders shape language learning from the very beginning of the acquisition process.

## 26.2 Early communicative development

The initial development of communication skills begins in infancy, with the use of nonverbal elements, such as gestures and eye gaze. This communication takes place between the infant and caregiver (dyadic interactions), and subsequently between the infant, caregiver and object or toy (triadic interactions). It is these initial patterns of interaction that underpin the development of *conceptual knowledge* – learning how objects are used and in what context; and *vocabulary* – learning what objects are called. In this section, we take a look at these early stages of language development in WS and DS, where initial differences from normally developing infants may be clearly identified.

### 26.2.1 Early communicative development in WS

The strong desire for social interaction that characterizes individuals with WS is apparent in infancy through a keen interest in faces. However, this results in infants with WS preferring to look at the face of their caregiver, as opposed to engaging in gaze-following behaviour, which is typically seen in normally developing infants (Bellugi *et al*. 1992). This initial reluctance makes more complex interactions between the infant, caregiver and an object or toy problematic. This is because toddlers with WS have difficulty switching their attention from the caregiver to an object being referred to in communication (via pointing, looking and naming).

During the early stages of communication development, normally developing children use deictic gestures such as pointing, as well as eye gaze, to direct the attention of their caregiver to objects. This behaviour facilitates the child in learning the terms of reference for objects and events. Since shared attention to newly named objects is one of the main routes into the development of vocabulary knowledge (see Tomasello Ch. 5, Carpenter *et al.* 1998), difficulty in triadic interactions places toddlers with WS at a disadvantage in vocabulary development. Indeed, difficulty in triadic interactions is considered to be a major source of the delay in the development of vocabulary knowledge in WS (Laing *et al.* 2002, Mervis *et al.* 2003). Mervis and Bertrand (1997) found that in WS the use of pointing behaviour emerges after these children start to use verbal labels. This finding was confirmed by Laing *et al.* (2002), and could not be attributed to any

*deficit* (difficulty in performance below normal level) in fine motor skills that could potentially impede the development of pointing behaviour. Thus the development of early nonverbal communication skills in WS deviates from that found in normal development.

However, the development of productive vocabulary in WS usually matches, or sometimes even extends beyond, mental-age expectations. In WS, growth in vocabulary is remarkably rapid, equalling or even extending beyond that of children with the same mental age. This rapid growth has been attributed to the high attentional value placed on verbal input and increased auditory memory for words found in WS, rather than the early use of *semantic* knowledge to support vocabulary growth (Mervis & Bertrand 1997, Singer-Harris *et al.* 1997). Indeed, there is preliminary evidence that compared to typically developing children, those with WS show a reduced comprehension vocabulary in comparison to their production vocabulary (Paterson 2000), implying that these children have a poorer understanding of word knowledge than their use of vocabulary suggests.

### 26.2.2 Early communicative development in DS

Like infants with WS, infants with DS also encounter difficulties that result in a delay in establishing early nonverbal communication skills. Specifically, infants with DS usually have difficulty in establishing mutual eye contact with the caregiver, which makes the development of patterns of interaction more challenging (Berger & Cunningham 1981, Jansow *et al.* 1988). Moreover, once this initial problem is resolved, infants with DS prefer to continue to focus on the eyes of their caregiver, rather than the facial features, as young infants typically do (Berger & Cunningham 1981). This can subsequently lead to further difficulties in establishing more complex nonverbal exchanges, such as in triadic interactions. There is also usually delay in the onset of babbling, which is in part attributed to the articulatory difficulties that can occur in conjunction with this disorder (Miller *et al.* 1992).

Young children with DS also differ in their use of nonverbal communicative gestures, producing more gestures than those seen in normal development (and more than observed in WS). It is postulated that this additional use of gesture may be a method of compensating for the delay in the onset of developing spoken language due to frequently occurring articulatory difficulties (Singer-Harris *et al.* 1997). Recent research has investigated the types of gesture used in DS in comparison to normally developing children. Children with DS produce deictic gestures (pointing, giving, showing) and iconic gestures (depicting the use of an object – such as gesturing the use of a spoon) more than normally developing children, and use a particularly large number of iconic gestures in their communication (Stefanini *et al.* 2007). The use of iconic gestures, in

particular, implies that these children have conceptual knowledge and are extracting meaning from their environment, which is not necessarily evident through their use of language production.

However, not all children with DS suffer from such profound articulatory difficulties that spoken language becomes insurmountable. Although vocabulary development is delayed, with some children with DS taking over 3 years to produce their first words (Berglund *et al.* 2001), once this process begins the subsequent rate of development is comparable to that seen in normally developing children of the same mental age MA (Tager-Flusberg & Sullivan 1998). Upon reaching the two-word stage, the progress of productive language development in DS varies – as some children do not extend beyond this stage until 4 years of age, or even as late as 5 or 6 years (Fowler 1998). Moving beyond the two-word stage, the use of grammatical knowledge develops.

### 26.2.3 Summary

Overall, early communication development in WS and DS may be summarized in terms of two main characteristics. First, there is a delay in the onset of language development in both disorders. Second, when language development does get underway, there is an imbalance between productive vocabulary and actual word knowledge. In children with WS, the development of productive vocabulary is rapid and indeed exceeds expectations based on mental age, whereas the development of intelligible speech in DS is frequently hampered by articulatory difficulties. However, children with DS do demonstrate conceptual knowledge of their environment through the use of gesture, whereas the rapid development of productive vocabulary in WS is not necessarily met with a corresponding level of understanding.

## 26.3 Patterns of language development

The development of language is heavily dependent upon the extent of the learning difficulties of the individual. Although there are cases of children who show exceptional language proficiency despite low IQ (Cromer 1994), it is usually expected that language ability in a child with learning difficulties will not surpass that of their mental age (Miller *et al.* 1978). For example, children with DS with a low IQ (below 50) may never develop complex structured language (Miller 1988). Furthermore, in order to succeed in acquiring language, children must also be socially motivated with the desire to communicate, and have some ability to understand the thoughts and intentions of others. In conjunction, these factors are crucial to the level of overall proficiency attained.

In the following section, we consider different aspects of language development in WS and DS, and discuss how these children differ from the typically developing population.

### 26.3.1 Later language learning in WS

Although the main feature of language development in WS is delay (Brock 2007, Thomas *et al.* 2001, 2006), the eventual outcome is relatively successful in that in most cases children with WS become proficient users of language. However, this is not to say that language in these individuals is normal; indeed, there is disparity between different aspects of language that results in an *atypical* profile (differing from normal development). Moreover, there is also variability in terms of the relative strengths and weaknesses found in both linguistic and cognitive skills (Porter & Coltheart 2005). Children with WS usually develop an extensive vocabulary and complex syntax – though their vocabulary skills generally exceed their syntactic ability in terms of mental age (Karmiloff-Smith *et al.* 1997). This profile of language skills contrasts with that found in children with specific language impairment (SLI), who have a particular difficulty in processing grammatical constructions (see Leonard Ch. 24, Tomblin Ch. 23 for discussion). In typically developing children there is a relationship between the length of utterance and the complexity of grammatical structure – this relationship also holds in WS (Mervis *et al.* 1999).

Children with WS make more errors in morphology than in syntax, that is, in verb tense and agreement and personal pronouns (Karmiloff-Smith *et al.* 1997, Volterrra *et al.* 1996). Also, French-speaking children with WS find grammatical gender particularly difficult (Karmiloff-Smith *et al.* 1997). Whilst the cognitive profiles of children with WS have been studies across many different languages, current work reflects a similar profile to that found in English-speaking children with WS (Levy & Bechar 2003). Although syntactic complexity is higher than expected upon the basis of non-linguistic skills, such as visuo-spatial construction or reasoning, they are nevertheless lower than expectations based upon levels of receptive vocabulary ability or auditory short-term memory (Mervis *et al.* 1999). A close inspection of grammatical abilities was carried out by Mervis *et al.* using the Test of Receptive Grammar (TROG: Bishop 1983), which assesses the ability to understand different types of sentence constructions of varying levels of complexity. This study was carried out with a large sample of 77 individuals between the ages of 5 and 52 years. Only 18 per cent of the participants (22 per cent of the adults) passed the test block that assessed right branching relative clauses (e.g. *The girl chases the dog that is jumping*) and only 5 per cent (9 per cent of the adults) passed the block assessing centre-embedded relative clauses (e.g. *The duck the ball is on is yellow*).

In terms of the development of semantic knowledge, children with WS exhibit a relative strength in category concepts (e.g. the distinctions

between animals, tools, clothing, furniture). This contrasts with problems understanding semantic relational concepts. For example, children with WS have difficulty in understanding sentences containing spatial terms of reference (such as: *The bottle is in the boat* – Phillips *et al.* 2004). Within category concepts, recent evidence has indicated differential naming problems across categories, such as animals being named better than foods (Temple *et al.* 2002, Thomas *et al.* 2006). On the basis of such evidence it has been argued that the *lexicon* is an area of specific anomalies in WS (Clahsen & Almazan 1998, Rossen *et al.* 1996, Temple *et al.* 2002). Fractionation such as this also appears in other areas of the WS language system (Thomas 2006). For example, in the area of pragmatics children with WS have relatively good social sensitivity (e.g. making dyadic eye contact, sensitivity to nonverbal cues) but exhibit problems in areas such as greeting behaviours, topic maintenance and answering questions (Semel & Rosner 2003).

Thomas and Karmiloff-Smith (2003) recently characterized two types of hypotheses regarding the developmental profile of WS: (i) a series of 'imbalance' hypotheses, which account for the profile shown in WS in terms of an imbalance in the integration of phonological and semantic processing, and (ii) a 'conservative hypothesis', which proposes that language development in WS is delayed but not fundamentally altered. In the latter case, any anomalies in the language profile of children with WS would be accounted for by non-linguistic characteristics of the disorder – such as a strong desire for social interaction and poor visuo-spatial skills (Brock 2007).

### 26.3.2 Later language learning in DS

There are limitations in the overall level of complexity of language attained in DS. Moreover, the production of intelligible speech can be particularly challenging. Phonological development is delayed, proceeding at a slower rate in terms of mental age expectations and is associated with more error-prone production (Bleile & Schwartz 1984, Roberts *et al.* 2005, Stoel-Gammon 1980). The development of vocabulary knowledge in DS is also slow, but there is some consistency with those patterns observed in normal development. For example, some children with DS experience a vocabulary spurt (Berglund *et al.* 2001, Klein & Mervis 1999); however, this tends to occur at a more advanced age than seen in typically developing children. On the other hand, the development of receptive vocabulary is more consistent with mental age expectations, and is greatly enhanced throughout adolescence and adulthood, through life experience (Chapman 2006, Miller 1999).

Grammatical development varies widely in DS, and can only be partially explained in terms of IQ differences. For individuals with DS whose language development does progress beyond the use of two-word utterances,

utterances tend to be shorter in comparison to normally developing children (as measured by mean length of utterance) and are of lower syntactic complexity (Mervis *et al.* 1999). Also, like children with SLI there are difficulties in grammatical morphology. Children with DS are also more imitative than normally developing children in their use of language (Tager-Flusberg & Sullivan 1998). However, the development of syntax in DS has a prolonged developmental span, with increases in syntactic complexity and utterance length being known to continue throughout adolescence and into early adulthood (Chapman *et al.* 2002).

In terms of pragmatics abilities, children with DS are socially motivated in their use of language, and display the same range of communicative interests and interactions as typically developing children. However, the strength of these pragmatic abilities seems to be closely tied to mental age (Fowler 1998). This may in part contribute to some of the inconsistencies reported in the literature concerning the range of pragmatic abilities reported in DS such as, for example, taking into account the needs of the listener during conversation (Roberts *et al.* 2007). However, overall it is clear that individuals with DS are capable of holding and maintaining conversations in a similar way to typically developing children.

### 26.3.3 Summary

In later language learning, disparities between the normally developing population and WS and DS become more obvious. This is not only due to the limitations placed on language ability by learning difficulties, but also in terms of the differential profile of strengths and weaknesses shown both within and across different aspects of language skill (phonology, grammar, semantics and pragmatics). Language in WS appears to be strong at surface level, and is characterized by its particular use in social engagement. However, in spite of the development of an extensive vocabulary and complex syntax, there are elements of grammar, receptive vocabulary and semantic knowledge that do not match this proficiency. By comparison, language development in DS appears to asymptote at a lower level of complexity and the development of spoken language can be hindered by articulatory difficulties. However, the receptive abilities of those with DS exceed those of productive language, and individuals with DS display sensitivity to the thoughts and intentions of others and enjoy social interaction through conversation.

## 26.4 What can WS and DS tell us about language development?

The differing profiles of linguistic and non-linguistic skills in WS and DS illustrate the ways in which the normal developmental process may be

deflected. The comparison of language skills across syndromes is particularly informative in terms of establishing what skills are crucial to successful language acquisition. In general, the contrasting language skills of those with WS and DS indicate that general cognitive ability cannot be considered to be a reliable indicator of all aspects of language function in children with learning difficulties. Comparisons carried out both in early development (Tager-Flusberg & Sullivan 1998) and later childhood (Fowler 1998) suggest that pragmatics and semantics are more closely linked to overall mental age across different disorders, while phonology and syntax can dissociate. McDonald (1997) compared language acquisition across different disorder groups (including WS and DS) who exhibited varying degrees of success and concluded that good representations of speech sounds (phonology) are a critical requirement to the successful development of language. However, Morton (2004) argues that successful language acquisition is dependent upon multiple cognitive components, and that impairment in any one of these can potentially result in the system failing to develop normally. Therefore, under Morton's view, good phonological skills may be a necessary but not sufficient requirement for successful language acquisition.

Consideration of what components of language are critical to successful acquisition raises key questions about how these components emerge as a process of development and what happens when something goes wrong. In current developmental theory, there are two potential interpretations. The first takes as its starting point the functional organization of normal adult cognitive processes. The field of neuropsychology has identified case studies of healthy adults who exhibit specific deficits in particular aspects of language processing following brain damage. From these dissociations, the language system is inferred to be organized into specific processing components or 'modules'. As applied to developmental disorders, a specific difficulty or strength in a given aspect of language processing is viewed as reflecting the under-development or over-development of that specific component of the language system (Clahsen & Temple 2003).

This framework provides a comfortable fit between the results of standardized language tests and atypical functional structure. Assuming we have tests that give an indication of the integrity of individual modules (e.g. tests of vocabulary, tests of grammar, tests of phonological processing), scores in the normal range of performance on a given test can be interpreted as reflecting a normally developed component. By contrast scores above or below the normal range can be read as reflecting an (atypically) over- or under-developed component. This mapping of test results to modular structure in developmental disorders rests on one of two assumptions. Either the modular system identified in the adult is also present in the infant, so that language development can commence with an initially selective anomaly in one or more components; or the modular structure emerges through development in such a way that when things

go wrong, some parts emerge with atypical functionality while the rest nevertheless manage to emerge displaying their normal functionality. Together, these alternatives constitute the assumption of 'residual normality' (Thomas & Karmiloff-Smith 2002). Formally, the assumption is that the rest of the system can develop normally irrespective of the selective difficulty in one processing component.

The second, contrasting explanatory framework argues that development must play some role in shaping the profile of any given developmental disorder. This approach, known as 'neuroconstructivism', is based on the premise that components of the adult cognitive system are a *product* of the process of development and not initially present in infancy (Mareschal *et al.* 2007). This view is strongly motivated by data from developmental cognitive neuroscience (Elman *et al.* 1996, Karmiloff-Smith 1998). It calls into question a key assumption made by the modular view, that performance within the normal range on a given test of cognitive ability is an indicator of normal functional structure. Instead, neuroconstructivism argues that performance within the normal range may be achieved through atypical means, and that the underlying mechanisms that give rise to the same level of performance may be fundamentally different. The debate between these two explanations of uneven linguistic profiles has at times become polarized. On the one hand, there are strong claims that for given developmental disorders, certain cognitive structures must have developed normally, given behaviour in the normal range (sometimes these are referred to as *intact* or *spared* systems). On the other hand, there are counter claims that since the developmental processes we know about could not have produced such an uneven modular outcome, the relevant behaviour must be produced by structures that are qualitatively different and atypical.

At the neurological level, brain-imaging techniques have been applied to the study of brain development in developmental disorders such as WS and DS. These studies look at a range of aspects of brain development, such as exploring anatomical differences between brain structures. For example, they look for differences in overall size or in the volume of a specific brain structure (in terms of amount of grey or white matter), or differences in patterns of brain symmetry (between left and right hemispheres) or connectivity, known as 'structural' differences. In WS, structural techniques have identified regions of reduced grey matter volume in the intraparietal sulcus and the orbitofrontal cortex (Meyer-Lindenberg *et al.* 2006). Abnormalities in the folds of the cerebral cortex have also been identified (Gaser *et al.* 2006, Kippenhan *et al.* 2005, Van Essen *et al.* 2006). In children with DS, brain regions such as the hippocampus, prefrontal cortex and cerebellum have been found to have a low volume (Nadel 2003). Exactly how these differences in brain structure affect brain 'function' is as yet unclear, and raises further questions. To what extent can we expect normal brain function in a system with structural differences?

As the different constraints placed on the system in developmental disorders put these children at a disadvantage, it is likely that their cognitive systems will attempt to overcome the challenges they face through the process of 'compensation' (Thomas 2005a, 2005b). The process of compensation within the context of developmental disorders is frequently incomplete, as evidenced by children failing to deliver levels of performance within the range of normally developing children. This may be because the process of compensation has resulted in the atypical system utilizing a secondary, less efficient route to task success, or the system has a reduced capacity or less efficient processing resources (i.e. Bishop 1994). However, children are renowned for the adaptive capacity, which is generally attributed to a property known as 'plasticity' – the flexibility of the learning system to adapt and alter in order to incorporate new information from the environment. This property of the learning system is generally considered to decrease over age (Uylings 2006), and may offer only a short window of opportunity for optimal adaptive change (known as a 'sensitive period', M. Johnson 2005). In conjunction, these factors play an important role in shaping the language systems of children with developmental disorders (Fowler 1998).

Finally, we shift our focus to consider the role of the environment in shaping the course of developmental disorders. In terms of environmental influences, there are two main points for consideration. The first of these is the extent to which differences in the internal cognitive system result in differences in the way in which the environment is perceived. We know that the neurology of the cognitive system in children differs from that of normally developing children, which may in turn result in differences in which the external environment is perceived by children with developmental disorders. Autism is a particularly good example of this (Happé & Frith 1996). Thus, although the external environment may not have been altered in any explicit manner, it may be fundamentally different from that of a normally developing child. In addition, children with developmental disorders display different initial preferences as to what they find interesting in their external environment (such as a keen interest in faces in WS). This means that the way they manipulate their external environment in order to participate in exchanges they perceive as rewarding may result in a subtly altered role for the environment in shaping the course of development. The second environmental influence and one of the most important motivating factors for the study of developmental disorders, is how we might support and facilitate effective development through a process of intervention. The degree and type of intervention appropriate may depend upon a number of factors. These include the profile of the individual child and the level of intervention services that may be accessed. Interventional methods seek to manipulate the environment and in doing so attempt to influence the course of development for those with disorders in a positive way. Somewhat counterintuitively, it may

often be useful to interfere and further bolster an area of relative strength (such as language in WS) so that this ability can be used strategically to aid areas of weakness (such as visuo-spatial skills: Semel & Rosner 2003). For example, a series of memorized verbal cues may be one way to improve picture drawing or tying of shoe laces.

In sum, development is a process of change – in developmental disorders it is vital that we understand what changes are occurring and when, in order to establish the similarities and differences in children with disorders and typically developing children. Exploring the nature of these transitions not only enhances our understanding of developmental disorders but also provides us with an insight into cognitive processes in general, in terms of the emergence of modularity and expertise, and the scale and flexibility of cognitive processes during learning. In exploring the mechanisms of development, understanding the impact of the environment is also crucial. In this respect, the environment should not be viewed as a static influence; the environment can be changed externally, and may also undergo internal changes as the child's ability to interpret the environment or gain knowledge from it alters over time.

## 26.5 Unanswered questions and future challenges

In this chapter, we have explored the profiles of language development in WS and DS. We did so first to gain an insight into the relative patterns of strengths and weaknesses that characterize these disorders, and second to understand how the course of typical language development may be altered. However, a range of unanswered questions remains, which pose challenges for future research. Specifically, how does the functional organization of the language system emerge, and to what extent is this constrained by the processing properties of our neurology? These key questions are important to modular theorists and neuroconstructivists alike.

Within the context of developmental disorders, we need to be able to answer questions such as: does deficiency in one component (say, phonology) affect the development of another (say, syntax)? And, what level of disruption is necessary to produce a developmental disorder? Moreover, understanding the processing capabilities of different neural substrates in both in typical development and developmental disorders is an important step towards understanding what kinds of differences result in a disorder. In short, we need to understand the parameters that affect the course of development and the different paths that development may take when faced with adverse circumstances. In this respect methods such as brain-imaging and computational modelling of language development may help in characterizing typical and atypical developmental processes (Thomas & Karmiloff-Smith 2003).

## Suggestions for further reading

The following reviews provide a useful summary of language and communication skills in DS and WS:

Mervis, C., & Becerra, A. (2007). Language and communication development in Williams syndrome, *Mental Retardation and Developmental Disabilities Research Reviews*, 13, 3–15.

Roberts, J., Price, J., & Malkin, C. (2007). Language and communication development in Down syndrome. *Mental Retardation and Developmental Disabilities Research Reviews*, 13, 26–35

For more information on cross-syndrome comparisons see the following useful chapters:

Bellugi, U., Bihrle, A., Neville, H., Jernigan, T., & Doherty, S. (1992). Language, cognition, and brain organization in a neurodevelopmental disorder. In M. R. Gunnar & C. A. Nelson (Eds.), *Developmental Behavioral Neuroscience* (pp. 201–232). Hillsdale, NJ: Lawrence Erlbaum Associates.

Tager-Flusberg, H., & Sullivan, K. (1998). Early language development in children with mental retardation. In J. A. Burack, R. M. Hodapp & E. Zigler (Eds.), *Handbook of Mental Retardation and Development* (pp. 208–239). Cambridge: Cambridge University Press.

For further reading into how the study of developmental disorders can provide an insight into the process of language development, see:

Thomas, M., & Karmiloff-Smith, A. (2005). Can developmental disorders reveal the component parts of the human language faculty? *Language Learning and Development*, 1, 65–92.

For further reading into the development of cognitive processes, see:

Mareschal, D., Johnson, M., Sirios, S., Spratling, M., & Thomas, M. (2007). *Neuroconstructivism: How the Brain Constructs Cognition*. Oxford: Oxford University Press.