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9 Language and Communication in Autism Spectrum Disorders

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Points of Interest

- Unique clinical features of language in ASD include stereotyped speech patterns, pronoun reversal, echolalia, and idiosyncratic words and phrases.
- There are universal impairments in pragmatic aspects of language: the use of language in social contexts, which are closely linked to deficits in theory of mind.
- Language skills, including articulation, vocabulary, and grammar, are quite heterogeneous. Different subtypes have been identified within the ASD population that may be associated with differences in etiology and neurobiological factors.
- Brain areas associated with language are often reduced in size in ASD. There are differences in brain organization, with less reliance on the left hemisphere for processing language and reduced connectivity between different brain regions that are critical for language perception and production.
- Atypical developmental trajectories within and across different domains of language are found. These may be grounded in infancy, and associated with impairments in prelinguistic developments in social engagement, gesture, imitation, and vocal productions.

When Leo Kanner (1943) first introduced his newly discovered syndrome, autistic disorder, impairments in language and communication were not listed among the core diagnostic features. The same held for Hans Asperger's (1944/1991) presentation of what is now referred to as Asperger's syndrome. Nevertheless, the detailed descriptions of the children by these pioneers included numerous examples of unusual speech and communication patterns that were evident in all their cases, and it is now recognized that, at least for autistic disorder, deficits in language and communication are defining criteria for diagnosis. Furthermore, most clinicians and researchers acknowledge the presence of aberrant communication among highly verbal people with Asperger's syndrome (Paul, Orlovski, Marcinko, & Volkmar, 2009; Tager-Flusberg, 2003).

By the end of the first year of life, most children are babbling, using gesture and vocalization to communicate with others, responding appropriately to words and simple phrases, and even speaking a few words that at least their parents understand. When these milestones are not met as expected, this can be an early warning sign that something may be awry. Indeed, surveys of parents whose children were later diagnosed with autism indicated that the most common causes for initial concern were delays in language and social-communicative abilities (Chawarska, Paul, Klin, Hannigen, Dichtel, & Volkmar, 2007; De Giacomo & Fombonne, 1998; Siklos & Kerns, 2007). Infants later diagnosed with autism spectrum disorder (ASD) show less joint attention behavior and produce fewer gestures and consonants (Landa, Holman, & Garrett-Mayer, 2007), all of which are key precursors to the acquisition of language (Luyster, Kadlec, Carter, & Tager-Flusberg, 2008). Given the critical role of language functioning in predicting outcomes in children with autism (Bennett et al., 2008; Billstedt, Gillberg, & Gillberg, 2007; Szatmari, Bryson, Boyle, Streiner, & Duku, 2003), there is now heightened interest in investigating this domain, with particular focus on targeting language and communication skills in early intervention programs (Dawson, 2008). In this chapter we provide an overview of the key features of atypical language and communication in ASD from a developmental perspective and then discuss some neurocognitive models that have been proposed as explanations for these impairments in ASD.

Defining the Language and Communication Impairment in ASD

Description of Language

Language is a multifaceted, hierarchically organized system that can be analyzed into specific components, each of which

has expected patterns of development. The smallest linguistic unit is the *phoneme*, defined as a sound that can be discriminated from others within a language. For example, by changing a /b/ to a /p/, English has two words with different meanings, *bat* and *pat*. Phonology describes the way phonemes can be combined and used. It also encompasses nonspeech *suprasegmental* aspects, defined as those vocal patterns that are at a higher level than the phoneme, such as prosody, rhythm and melody that serve linguistic functions.

The smallest meaningful units of speech are called *morphemes*. These can be unbound, able to stand alone as lexical words (e.g., "walk"), or can be bound, requiring another morpheme for their usage, for example the past tense ending added to verbs -ed, or the negative morpheme un- that can be added to nouns, verbs, and other parts of speech. Morphemes can be combined to form words with new meanings, which in turn can be linked together to form sentences following predictable patterns of combinations, referred to as *syntax*. Within linguistics, morphology and syntax describe the rules governing each of these processes, and together form the *grammar* of a particular language. Sounds and rules cover the basic structure of a language, but these are all in service of expressing meaning, or *semantics*, in words and sentences. The semantic level of language connects most closely to world knowledge. For words, this includes both *intension*, the definition of a word, and *extension*, the range of exemplars to which that word refers. Sentential meaning is derived from the combination of words and grammatical rules.

Together, phonology, morphology, syntax, and semantics form our core linguistic knowledge. The domain of *pragmatics* refers to how context contributes to the interpretation of the meaning of language as it is used in social situations. It includes the functions served by utterances, also called *speech acts* (e.g., statements, requests), the rules of effective communication in discourse (e.g., conversation, narrative), and inferences about the intentions of the speaker, covering literal and nonliteral expressions (e.g., lies, sarcasm). Interpreting language in social contexts often goes beyond the spoken word, relying also on nonverbal cues such as gesture, facial and vocal expressions of affect, and body language.

Language is a highly complex system that is dependent on the interaction of multiple factors over the course of development. These include the input provided to the child that may vary in both quantitative and qualitative ways, and child-specific variables such as the motivation, cognitive, or neurological status of the individual. It is therefore not surprising that in ASD, core social and other neurocognitive impairments contribute significantly to the delays and deficits that are seen in the acquisition of language.

Deficits in Language and Communication

According to the *Diagnostic and Statistical Manual of Psychiatric Disorders* (DSM-IV-TR: American Psychiatric Association, 2000) autistic disorder is defined on the basis of at least one qualitative impairment in the domain of communicative abilities. These include: delay in, or total lack of, the development of spoken language; in individuals with adequate speech, marked impairment in the ability to initiate or sustain a conversation with others; stereotyped and repetitive use of language or idiosyncratic language; or lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level. These criteria are now viewed as reflecting distinct underlying mechanisms. Delays and deficits in language are associated with nonuniversal comorbid impairments in language processing (Bishop & Norbury, 2002; Rapin & Dunn, 2003, Tager-Flusberg, 2004); conversational problems reflect difficulties in theory of mind (Paul, Orlowski, Marcinko, & Volkmar, 2009; Tager-Flusberg, 2000); stereotyped language is an example of repetitive behavior (Bodfish, Symons, Parker, & Lewis, 2000; Gabriels, Cuccaro, Hill, Ivers, & Goldson, 2005); and the absence of play is a reflection of deficits in socialization and symbolic capacity (Naber et al., 2008).

Certain features of the language spoken by children with ASD are relatively unique and specific to this syndrome. One salient symptom of autism is the presence of odd or stereotyped speech patterns. Kanner (1943, 1946) noted several verbal rituals in his early observations of children with autism. Children with autism may quote scripts from favorite television shows or movies, engage in verbal rituals, or echo the speech of others (Rydell & Mirenda, 1994). Other children might use odd phrasing, perhaps incorporating vocabulary that is not age-appropriate (Ghaziuddin & Gerstein, 1996). Another striking feature of autistic children's use of language is their reversal of pronouns—referring to themselves as "you" and their conversational partner as "I." Although reversing personal pronouns is not unique to autism, it does occur more frequently in this group than in any other population (Lee, Hobson, & Chiat, 1994). Odd vocal patterns were noted in many early descriptions of autistic children's language both in echolalic and nonecholalic speech (Pronovost, Wakstein, & Wakstein, 1966). Kanner (1946) also commented on the autistic child's tendency to use words with special or unique meanings, not shared by others. The use of idiosyncratic lexical terms, or "neologisms," has been found even in higher functioning children and adults with autism (Volden & Lord, 1991).

Across the ASD population, including people with Asperger's syndrome, certain aspects of language are universally impaired. One example is the domain of pragmatics, as individuals with ASD have difficulty with the social aspects of language use, including turn-taking (Eales, 1993), conversational discourse (Paul et al., 2009; Tager-Flusberg & Anderson, 1991), processing contextually and socially appropriate comments (Eales, 1993; Loukusa et al., 2007), and understanding nonliteral language such as irony, sarcasm, and metaphor (Happé, 1995; MacKay & Shaw, 2004; Martin & McDonald, 2004). Another problem area is the appropriate use of prosody, or intonation patterns, when speaking. Individuals with ASD can produce grammatically correct sentences, but they may come across as sounding flat, robotic, or otherwise odd (Peppé, McCann, Gibbon, O'Hare, & Rutherford, 2007; Shriberg, Paul, McSweeny, Klin, Cohen, & Volkmar, 2001). They may also have trouble decoding the meaning of an utterance based on its stress patterns (Peppé et al., 2007) or miss

affective content encoded in the voice (Korpilahti et al., 2007; Rutherford, Baron-Cohen, & Wheelwright, 2002).

In contrast to the universal nature of pragmatic deficits in autism spectrum disorders, other language skills vary on a broad continuum from intact linguistic abilities to failure to acquire any language (Diehl, Bennetto, Watson, Gunlogson, & McDonough, 2008; Kjelgaard & Tager-Flusberg, 2001; Lewis, Murdoch, & Woodyatt, 2007). One study of 9-year-old children found that, while a quarter of the children were able to speak fluently using complex sentences, another quarter were still effectively nonverbal (Anderson et al., 2007). Longitudinal studies suggest that variability in language skills increases with time, possibly due to mixed results of interventions (Charman, Taylor, Drew, Cockerill, Brown, & Baird, 2005).

Development of Language and Communication in ASD

Preverbal Period (0–12 Months)

From the moment they are born, infants come prepared to acquire language with a suite of mechanisms that include general learning systems, a bias toward attending to social stimuli in their environment including faces and voices, as well as domain-specific speech processing systems. Within a few short years they have mastered one of the most complex challenges they face, with seemingly little effort or explicit tuition. For children with ASD, the developmental pathway is affected, even before the acquisition of first words, and difficulties continue throughout childhood. Early in life most children communicate with their social partners. They begin to smile reciprocally, vocalize in response to other people, and engage in simple social routines. These early-appearing behaviors form an important foundation for the development of language. Children later diagnosed with ASD have been shown to have deficits in these reciprocal social communication skills within the first year of life. Early impairments have been noted in eye contact, imitation, social interest, shared positive affect, play skills, and joint engagement (Baranek, 1999; Bryson et al., 2007; Landa, Holman, & Garrett-Mayer, 2007; Zwaigenbaum et al., 2005).

Toward the end of the first year, infants typically exhibit a variety of communicative behaviors that are not usually seen in autism. These nonverbal communicative gestures express the same intentions for which words will be used in the coming months, such as requesting objects, rejecting offered actions, calling attention to objects or events, and commenting on their appearance. Gestural ability has been shown to be a strong predictor of later language in typically developing children (Rowe, Özçalişkan, & Goldin-Meadow, 2008; Watt et al., 2006) as well as children with developmental disabilities (Brady, Marquis, Fleming, & McLean, 2004) and ASD (Charman, Baron-Cohen, Swettenham, Baird, Drew, & Cox, 2003; Luyster, Kadlec, Carter, & Tager-Flusberg, 2008).

Parallel to these impairments in social communication during infancy, are early abnormalities in speech perception and preference. Typically developing children, when given a choice of listening to a nonspeech analog or infant-directed speech, consistently prefer to listen to the latter (Kuhl, 2004). This preference is viewed as instrumental in language development, in that the child is motivated to "tune in" to the sounds of their caregiver's speech. Infant-directed speech, moreover, is characterized by exaggerated phonetic and prosodic features that facilitate the emergence of early language. Young children identified with ASD do not show a preference for infant-directed speech, choosing instead to listen to the nonspeech analog (Kuhl, Coffey-Corina, Padden, & Dawson, 2005) or to other environmental sounds (Klin, 1991). There are important early language implications for these observations in ASD: A stronger preference for nonspeech sounds is associated with a greater degree of impairment in early expressive language (Kuhl et al., 2005).

By late infancy, these early disturbances in communication and speech development result in language differences for children later diagnosed with ASD. The majority show delays in the attainment of early milestones, in the production of babbling and first words, gestural communication, as well as in language comprehension (Colgan et al., 2006; Landa & Garrett-Mayer, 2006; Mitchell et al., 2006; Zwaigenbaum et al., 2005).

Early Language (12–30 Months)

The toddler years are characterized by language impairments for most children on the autism spectrum. Delays are evident in both receptive and expressive language. The receptive language deficits are quite striking and not usually seen in children with other language disorders, but these show up more on standardized testing than in parental reports of early language in ASD (Luyster et al., 2008), and are most likely related to the children's overall lack of social responsiveness.

Other atypical patterns may also be observed in the trajectory of language development. A significant minority (estimates usually ranging from about 15 to 40%) of children with ASD experience a loss (or *regression*) of verbal and nonverbal communication skills sometime in the second year of life (Goldberg et al., 2003; Hansen et al., 2008; Lord, Shulman, & DiLavore, 2004; Luyster et al., 2005). Several studies have found that these children show undetected symptoms of ASD within their first year of life, but they also often attain important early milestones in social and communication development. These early gains are followed by a loss of skill, usually some time between 16 and 21 months of age (Goldberg et al., 2003; Lord, Shulman et al., 2004; Luyster et al., 2005; Meilleur & Fombonne, 2009). Historically, these losses were defined strictly on the deterioration of language skills. Typically, children had mastered single words but not yet progressed to phrases, and then lost a substantial number of words

during the regression. Recent conceptualizations of regression have included documentation of social-communication losses as well, particularly in the realm of social interest and reciprocity (Goldberg et al., 2003; Hansen et al., 2008; Luyster et al., 2005). Importantly, children who experience a regression generally do regain the lost skills, although the implications for later outcome remain unclear (Bernabei, Cerquiglini, Cortesi, & D'Ardia, 2007; Hansen et al., 2008; Ozonoff, Williams, & Landa, 2005; Richler et al., 2006; Werner, Dawson, Munson, & Osterling, 2005).

The close connection between language and social-communicative development is also evident when examining early predictors of language development in ASD. Just as the two domains are linked in the loss of skills, they are also linked in the mastery of skills. Language emergence is associated with a number of other symbolic and social-communicative skills. Joint attention (Adamson, Bakeman, Deckner, & Romski, 2009; Carpenter, Pennington, & Rogers, 2002; Charman et al., 2003; Dawson et al., 2004; Mundy, Sigman, & Kasari, 1990; Mundy, Sigman, Ungerer, & Sherman, 1987; Sigman & McGovern, 2005), imitation (Carpenter et al., 2002; Charman et al., 2003; Stone, Ousley, & Littleford 1997; Stone & Yoder 2001), gesture (Luyster et al., 2008), and play (Mundy et al., 1987; Sigman & McGovern, 2005) have all been found to be associated with language ability both concurrently and longitudinally. In addition to social-communicative factors, other child factors including general cognitive skills are highly correlated with language outcomes in children with ASD (Luyster et al., 2008; Thurm et al., 2007), and recent work by Sigman and her colleagues has highlighted the significance of parental responsiveness to the child's focus of attention and play as predictors of later language abilities, independent of the IQ or initial language skills of the child (Siller & Sigman, 2008).

During this period, children acquire a rich and varied vocabulary. By the age of 18 months, typically developing children show an exponential growth curve, learning several words each day. They do so by "fast-mapping" meaning to new words using a number of cues present in the environment. Several studies of children with ASD have found that they are able to exploit some, but not all, of these cues for learning the meanings of nouns, which may partially account for the slower growth and in certain cases, idiosyncratic meanings attached to some words. One cue that children with ASD are capable of using involves the inference that different objects are labeled with different words—the principle of "mutual exclusivity" (Preissler & Carey, 2005). In contrast, children with ASD are less able to use some social cues, such as the direction of a speaker's eye gaze (Baron-Cohen, Baldwin, & Crowson, 1997; Preissler & Carey, 2005), though if the objects are especially interesting and the speaker adds gestural or touch cues, children with ASD can rapidly learn the meanings of new words (McDuffie, Yoder, & Stone, 2006; Parish-Morris, Hennon, Hirsh-Pasek, Golinkoff, & Tager-Flusberg, 2007). At the heart of their difficulty is the use of combinations of social cues (eye gaze, facial expressions, etc.) that signal the speaker's intention, rather than simply a failure to attend to their social partner (Parish-Morris et al., 2007).

Caregivers also notice that their child's pragmatic uses of language are quite restricted. Whereas children with ASD may proficiently use language to meet their needs and wants (e.g., "More cookies"), they are less likely to use language in prosocial ways—directing someone's attention to an object or event of interest (e.g., "A doggie!"), or to use language to engage in a reciprocal exchange of thoughts or experiences (e.g., "Baby went night-night") (Loveland, Landry, Hughes, Hall, & McEvoy, 1988; Wetherby, Watt, Morgan, & Shumway, 2007). The speech acts missing among young children with ASD all involve social, rather than regulatory functions (Wetherby, 1986).

Later Language (30–48 Months)

During the preschool years, children acquire the morphosyntax of their language, continue to add new words to their vocabulary, and develop basic conversation skills. There are few longitudinal studies of grammatical development in ASD. Tager-Flusberg and her colleagues recruited a small group of preschoolers and found that they followed the same developmental path as typically developing children and children with Down syndrome (Tager-Flusberg et al., 1990). The children with autism and Down syndrome showed similar growth curves in the length of their utterances (MLU - Mean Length of Utterance), which is usually taken as a hallmark measure of grammatical development. In a follow-up study using the same language samples, Scarborough et al. (1991) compared the relationship between MLU and scores on a different index of grammatical development, which charts the emergence of a wide range of grammatical constructions: The IPSyn (Index of Productive Syntax). The main findings were that at higher MLU levels, MLU overestimated IPSyn scores for the children with ASD, because they used a narrower range of constructions and asked fewer questions, which accounts for a significant portion of the IPSyn score. These findings have been replicated in a cross-sectional study of preschoolers with ASD (Eigsti, Bennetto, & Dadlani, 2007).

Several studies of English-speaking children with ASD investigated the acquisition of grammatical morphology, using data from spontaneous speech samples. For example, Bartolucci, Pierce, & Streiner (1980) found that children with ASD were more likely to omit certain morphemes, particularly articles (*a, the*), auxiliary and copula verbs, past tense, third-person present tense, and present progressive. Tager-Flusberg (1989) also found that children with ASD were significantly less likely to mark past tense than were matched controls with Down syndrome. Similar findings were obtained on elicited production tasks of grammatical tense in children with lower overall levels of language (e.g., Bartolucci & Albers, 1974; Roberts, Rice, & Tager-Flusberg, 2004) as well as on grammaticality judgment tasks (Eigsti & Bennetto, 2009).

In comparison to grammatical development, lexical knowledge is an area of strength for children with ASD (Eigsti et al., 2007; Tager-Flusberg, Lord, & Paul, 2005). High-functioning children often score well on standardized vocabulary tests (Jarrold, Boucher, & Russell, 1997; Kjelgaard & Tager-Flusberg, 2001), they extend or generalize words they know to a broad range of exemplars, and their lexicons are organized in hierarchical semantic groups as in typically developing children (Boucher, 1988; Tager-Flusberg, 1985; Walenski, Mostofsky, Gidley-Larson, & Ullman, 2008). At the same time, certain classes of words may be underrepresented in the vocabularies of children with ASD. Tager-Flusberg (1992) found that children with ASD rarely used mental-state terms, particularly terms for cognitive states (e.g., *know, think, remember*) when conversing with their mothers. Other studies suggest that children with ASD have particular difficulties understanding social-emotional terms as measured on vocabulary tests such as the Peabody Picture Vocabulary Test (Eskes, Bryson, & McCormick, 1990; Hobson & Lee, 1989; van Lancker, Cornelius, & Needleman, 1991). Thus, while overall lexical knowledge is a relative strength in autism, acquiring words that map onto mental-state concepts may be specifically impaired.

In contrast to their typically developing peers who are successfully mastering early conversational skills, young children with ASD show difficulties in reciprocal and flexible dialogue. At a basic level, question-asking and question-answering may be diminished. More complex abilities such as introducing new topics of discussion, offering additional information, or providing clarification to ongoing discourse topics are also significantly affected (Capps, Kehres, & Sigman, 1998; Tager-Flusberg & Anderson, 1991). These difficulties emerge in early childhood (Hale & Tager-Flusberg, 2005a; Lord, Rutter, DiLavore, & Risi, 1999) and persist throughout the lifespan (de Villiers, Fine, Ginsberg, Vaccarella, & Szatmari, 2007; Dobbinson, Perkins, & Boucher, 1998; Volden, 2004).

Language in Older Children

For many children with ASD, the school years are characterized by continued growth of core language skills (Anderson et al., 2007). However, along with increased skills come new language difficulties that have particular impact on their social interactions with peers and to their academic success. Even for children who have optimal outcomes, losing their diagnosis of ASD and becoming fully integrated into academic settings, subtle impairments remain in the domains of semantics and pragmatics (Kelley, Paul, Fein, & Naigles, 2006).

Complex aspects of language prove to be particularly challenging for individuals with ASD. One example of this is language used in a nonliteral manner. Understanding irony (Kaland et al., 2005; Martin & McDonald, 2004), humor (Emerich, Creaghead, Grether, Murray, & Grasha, 2003; Lyons & Fitzgerald, 2004), idioms (Kerbel & Grunwell, 1998; Norbury, 2004), and metaphor (Happé, 1995) is often impaired in children with ASD, because they tend to interpret words or utterances in a literal or concrete way, rather than the intended meaning, which is often dependent on the context or delivery of the language through a combination of verbal and nonverbal signals.

This difficulty of interpreting intended meaning is especially salient in conversational discourse (Mitchell, Saltmarsh, & Russell, 1997) and reflects the fact that pragmatic deficits in language are more often found in unstructured social contexts than in structured tasks. These deficits, which are found in both Asperger's syndrome and high-functioning autism, take different forms including overly formal or pedantic speech, lack of reciprocal exchanges, problems with topic management, or handling breakdowns and repairs in conversation (Paul et al., 2009). But not all aspects of social language usage are impaired in ASD. For example, older children are quite able at judging and producing requests at different levels of politeness, depending on the status of their discourse partner (Volden & Sorenson, 2009). Sparing of these kinds of skills may be related to their intact knowledge of social stereotypes such as gender and race (Hirschfeld, Bartmess, White, & Frith, 2007).

Another area of deficit is in the production of narratives, which has implications for their ability to perform well in language arts and social studies classes in school. Children with ASD generally produce less coherent and complex stories (Diehl, Bennetto, & Young, 2006; Losh & Capps, 2003), they tend not to be able to flexibly use different referring expressions such as pronouns (Arnold, Bennetto, & Diehl, 2009), they are less likely to take the perspective of another person in a story (Garcia-Perez, Hobson, & Lee, 2008), and they often ignore the motivations of characters or causal connections in a plot line (Tager-Flusberg, 1995). Their personal narratives also tend to focus more on facts than in providing a meaningful interpretation of autobiographical events (Goldman, 2008).

Processing nonverbal aspects of communication continues to be an area of significant impairment for children and adults with ASD, which may partially explain their strong preference for communicating with others through the Internet. One example is in the use of prosody. Difficulties arise both in using prosody to clarify linguistic ambiguity (Diehl, Bennetto, Watson, Gunlogson, & McDonough, 2008) and in understanding its social significance (see McCann & Peppé, 2003,for a review; McCann, Peppé, Gibbon, O'Hare, & Rutherford, 2007), though these deficits in prosody are more apparent at the level of sentences rather than single words (Järvinen-Pasley, Peppé, King-Smith, & Heaton, 2008). Other nonlinguistic communicative cues, such as gestures, continue to show impairment through childhood into adolescence and beyond. For instance, individuals with ASD are less likely to use "beat gestures" while speaking (Lord et al., 1999), employ nonverbal cues of reciprocity such as nodding their head when a conversational partner is speaking (Garcia-Perez, Lee, & Hobson, 2007), respond to such cues in their conversational partner, or modulate eye contact (Paul et al., 2009). Thus, it is clear that even when structural aspects of language are

acquired, people with ASD continue to experience significant problems in communicating effectively and appropriately in everyday social contexts.

Neurocognitive Models of Language and Communication in ASD

Variability in the Language Phenotypes

A hallmark feature of ASD is heterogeneity in etiology, neurobiological substrate, behavioral characteristics, developmental trajectory, and comorbidity. In an effort to distill some of the essential features that have both clinical and theoretical relevance, our review of the language characteristics and their development in ASD glosses over the fundamental variability that is seen in every study. Within language, heterogeneity takes on particular significance, in part because language itself is multifaceted, composed of intersecting systems of knowledge—sounds, words, morphosyntax, meaning—serving a full range of social-communicative functions. In ASD, any one or all of these systems can be affected. In recent years, considerable effort has been made to explore this heterogeneity to advance understanding about the mechanisms that may underlie the different phenotypes that are observed.

At a superficial level, three primary subtypes can be distinguished. At one end are the verbally fluent individuals who acquire a full and rich system of linguistic knowledge at the structural level (phonology, morphosyntax, vocabulary) that is indistinguishable from nonautistic individuals. For this group, language deficits are primarily limited to the domain of pragmatics. Interestingly, studies have shown that some proportion of older children who fit within this group experienced early delays in language, however once they reached initial milestones, the rate of acquisition was normal or even accelerated and by the end of the preschool period they were indistinguishable from children who experienced no delays in the early timing of language development (Bennett et al., 2008). At the other end are nonverbal individuals who fail to acquire the ability to speak (or communicate via other systems) beyond a rudimentary level of single words or short phrases. In general, the prognosis for acquiring useful speech is very poor for children who have not done so by age 5, however there are a number of cases in the literature of children who do achieve some success after this age if they continue to receive highly intensive behavioral treatment programs (Pickett, Pullara, O'Grady, & Gordon, 2009). The majority of children fall into a third group: They acquire language, albeit later, at a slower rate, and without fully catching up to age expectations. As more children with ASD receive early diagnoses and interventions, the proportion of children who acquire some degree of functional spoken language is increasing (Tager-Flusberg et al., 2005).

A diagnosis of ASD, even classic autism, does not require that a child has impaired language; conversational impairments are sufficient to meet criteria. Thus, the children who have linguistic deficits may be viewed as forming subtypes within the spectrum. Several researchers have proposed that children who are verbal but with impairments in phonology and morphosyntax (in addition to pragmatics) have a comorbid disorder of specific language impairment (SLI), because of the parallel deficits that are seen in these children (e.g., Bishop & Norbury, 2002; Tager-Flusberg, 2006). Clinical characteristics of SLI include lower overall language scores on standardized tests, impaired phonological processing as measured by repetition of nonsense words, and for English-speakers, morphosyntactic problems, particularly in the omission of tense markers and other grammatical features (Tager-Flusberg & Cooper, 1999). Like ASD, SLI is a heterogeneous disorder. For example, some children with SLI have articulation deficits, others do not; some have both receptive and expressive impairments, others only expressive; some have comorbid dyslexia, others do not (Tomblin & Zhang, 1999). A range of similar language deficits are seen in children with ASD (Rapin, Dunn, Allen, Stevens, & Fein, 2009; Tager-Flusberg, 2006; Tager-Flusberg et al. 2005; Whitehouse, Barry, & Bishop, 2008), though the added triad of autism-specific impairments contributes to how these are uniquely expressed in ASD on both structured tasks and in everyday language use. There is very little language research on the children at the nonverbal end of the continuum. These children are likely to have more severe autism-specific impairments, are more likely to be intellectually disabled (Luyster et al., 2008), and there is evidence that oral-motor impairments may explain why some children with ASD fail to acquire spoken language (Gernsbacher, Sauer, Geye, Schweigert, & Goldsmith, 2008). These children may have a comorbid dyspraxia, though this is a poorly understood developmental language disorder.

Given these different subtypes (or comorbidities), it is clear that no single etiology, neurological deficit, or theoretical framework can be developed to explain the language phenotypes associated with ASD. Instead, in recent years, researchers have attempted to exploit the variability in language to parse the population for genetic (e.g., Alarcon, Cantor, Liu, Gilliam, & Geschwind, 2002; Alarcon et al., 2008; Bradford et al., 2001), neurobiological (de Fossé et al., 2004), and cognitive (e.g., Norbury, Brock, Cragg, Einav, Griffiths, & Nation, 2009) studies with considerable success.

Neurobiology of Language in ASD

The classic language network is composed of Broca's area (regions in the inferior frontal gyrus) and Wernicke's area (regions in the posterior superior temporal gyrus and planum temporale). These areas are connected by a series of dorsal and ventral pathways, the most significant of which is the arcuate fasciculus, and they are supplemented by other cortical and subcortical regions, including the basal ganglia,

thalamus, and cerebellum (for a recent review, see Friederici, 2009). Typically, portions of Broca's and Wernicke's areas (particularly in the pars triangularis and planum temporale) are asymmetric, larger in the left hemisphere; and functionally, the left hemisphere assumes a primary role in processing phonological, semantic, and grammatical aspects of language, although findings across studies using different methods are not consistent, and there is greater variability among females and non–right handed individuals (Keller, Crow, Foundas, Amunts, & Roberts, 2009; Wallentin, 2009). Developmental studies have found that with age, there is continued developmental growth in the structure and asymmetry of language-related cortices into early adulthood (Gogtay, et al., 2004; Sowell, Thompson, Leonard, Welcome, Kan, & Toga, 2004).

In children with developmental language disorders such as SLI and dyslexia, both structural and functional differences have been found in studies using magnetic resonance imaging. In general, these children have reduced volumes in the primary cortical language areas, reduced asymmetry in the frontal areas, and are functionally less left-lateralized (Tager-Flusberg, Lindgren, & Mody, 2008). In ASD, similar atypical structural patterns have been found, although findings across different studies vary, depending on the methods used (e.g., manual or automatic) and the age and characteristics of the participants. The majority of studies, which primarily have included only boys with ASD, report reduced volume of the pars triangularis and posterior language regions (e.g., McAlonan et al., 2005; Rojas, Camou, Reite, & Rogers, 2005; but see also, Knaus et al., 2009). Interestingly, a recent study suggested that reduced volumes in these regions may be associated with later onset of language (McAlonan et al., 2008). Reductions in left hemisphere asymmetry of frontal language regions has also been found in several studies and is associated with greater impairment in language abilities, or comorbid SLI (Herbert et al., 2002; Herbert et al., 2005; de Fossé et al., 2004). Several studies have found exaggerated left hemisphere asymmetry in the planum temporale, again associated with comorbid SLI (Herbert et al., 2002; de Fossé et al., 2004; but for different findings see Knaus et al., 2009; Rojas et al., 2005). Only one MRI study, conducted by Munson and his colleagues (Munson et al., 2006) included very young children with ASD to explore the relationship between brain structure and developmental trajectories in communication development, as measured by the Vineland Adaptive Behavior Scales (Sparrow, Balla, & Cicchetti, 1984). Interestingly, they found a significant inverse relationship between the size of the right amygdala and growth in communication scores, which may be taken as evidence for the role of atypical development of subcortical structures associated with social functioning in the acquisition of language use in young children with ASD.

Functional imaging studies of language have found atypical patterns of activation in children and adults with ASD. Several studies have found reduced activation in frontal areas in adults with ASD, but increased activation in posterior regions, on both syntactic (Just et al., 2004) and semantic processing tasks (Harris et al., 2006). However, this pattern was not found in adolescents with ASD, who demonstrated increased activation, relative to controls in both frontal and posterior language areas (Knaus et al., 2008). The most consistent findings across studies is reduced asymmetry of language processing, especially in Broca's area, and reduced correlations in activation patterns across language regions (Just et al., 2004; Harris et al., 2006; Kleinhans et al., 2008; Knaus et al., 2008; Muller et al., 1999), which is consistent with other work suggesting impaired connectivity in the brains of people with ASD (e.g., Courchesne & Pierce, 2005). A recent study found atypical activation to speech in toddlers with ASD (Redcay & Courchesne, 2008). In contrast to the control children, who activated the left hemisphere language network, toddlers with ASD primarily activated corresponding regions in the right hemisphere, confirming that these atypical patterns begin early in development. It is not known, however, the extent to which these differences in functional organization of language in ASD are related to fundamental differences in neuroanatomy that are present at birth, to behavioral language skills, or to compensatory mechanisms. Finally, it is surprising to note that, to date, there are no published studies of the neural processing of pragmatic aspects of language in individuals with ASD.

Mechanisms Associated with Language and Communication Impairments in ASD

Most researchers argue that more than one set of mechanisms is needed to explain the full range of language impairments that is seen across the different language phenotypes in ASD. Given the complexity of the language system itself, as well as its interactions with perceptual (visual, auditory), motor (articulation), memory, social, executive, and general cognitive capacities we are still many years from having anything close to a complete theoretical account that is grounded in a dynamic, developmental framework. Still, some progress has been made in specifying the neurocognitive mechanisms associated with the universal pragmatic impairments as well as with the linguistic deficits that characterize some portion of the population.

Pragmatic aspects of language typically entail an appreciation of the intentions, knowledge, and other mental states of a discourse partner (Sperber & Wilson, 1986). Such mental state understanding, or "theory of mind" skills, are important for the interpretation of intended meaning, nonliteral language, and conversational and narrative skills, all of which are impaired in individuals with ASD. According to this view, the pragmatic deficits in ASD are explained on the basis of deficits in theory of mind, and thus, are closely linked to aspects of the core social symptoms (Baron-Cohen, Tager-Flusberg, & Cohen, 2000). Studies have found significant relationships between performance on theory of mind tasks and conversational impairments (Hale & Tager-Flusberg, 2005b) as well as

in understanding nonliteral meaning (Happé, 1993, 1994) that are independent of general cognitive and language skills. Thus, according to this model, impairments in theory of mind mechanisms underlie the pragmatic language problems that are found across most individuals with ASD (Paul et al., 2009; Tager-Flusberg, 2000).

There is less agreement on what might underlie the deficits in other language skills. At a neurobiological level, the evidence suggests that these deficits are associated with altered asymmetry, structural and functional impairments in inferior frontal regions in the left hemisphere, and reduced connectivity between frontal and temporal language regions.

These atypical neuroanatomical and functional patterns are also found in individuals with other developmental and acquired language disorders, and one theory that has been proposed as a unifying explanation for phonological and grammatical impairments across a range of disorders, including ASD, is the procedural deficit hypothesis, which claims that these impairments are related to neurocognitive abnormalities in the procedural memory system (Ullman, 2001; Walenski, Tager-Flusberg, & Ullman, 2006). The procedural memory system is involved in the learning and maintenance of cognitive and motor skills, particularly those that involve sequences, such as rule-governed combinations in phonology and grammar. This system is based on networks of interconnected brain regions, particularly in the left hemisphere, including frontal-basal ganglia, and frontal-cerebellar circuits (Ullman, 2001). The procedural deficit hypothesis proposes that the language impairments in ASD (and related disorders such as SLI; Ullman & Pierpont, 2005) are rooted in this neurocognitive system, and are thus associated with impairments in other functions (e.g., temporal processing, motor skills) that also depend on this network of structures. Because of the complexity of the neural bases of the procedural memory system, it is predicted that there will be significant individual variation in the specific nature and extent of the language (and other) impairments, that reflect the specific structures and connections that have been affected, as well as the compensatory systems that may be activated, such as the declarative memory system (Walenski et al., 2006). The nature of the deficits found among language-impaired individuals with ASD is consistent with this theoretical model, however, no studies have yet related language deficits to structural or functional abnormalities in the basal ganglia or cerebellum, both of which are central components of the procedural memory system.

Conclusions

Considerable progress has been made in advancing knowledge about the development and neurobiological bases of language and communication in ASD. For the majority of children with ASD, impairments in this domain involve fundamental alterations in the onset and rate of acquisition of major language milestones (Tager-Flusberg et al., 2005). Hallmark characteristics of the profile of language development involve dissociations in the developmental trajectory for different components of language. One example is the dissociation seen between form and function—or between structural and pragmatic aspects of language development (Tager-Flusberg, 1994). Other examples include relative dissociations between expressive and receptive processing systems and between lexical and phonological development (see Paul, Chawarska, Cicchetti, & Volkmar, 2008). These dissociations reveal differences in developmental timing that influence the interactions among language components, and between these components and other aspects of cognition.

Atypical developmental trajectories within and across domains of language and social cognition are grounded in atypical patterns of brain organization for language and associated functions, particularly hemispheric specializations that are typically present early in development (Flagg, Cardy, Roberts, & Roberts, 2005; Kuhl et al., 2005; Redcay & Courchesne, 2008). Infants are born biased to attend to human speech. Toward the end of the first year, infants' speech processing skills are rapidly changing as they are molded to their native language, resulting in an increase in cortical specialization for language (Kuhl, 2007). All experience is now deeply embedded in a social and cultural environment; infants no longer discriminate speech sounds that are not part of their everyday world. These developmental changes, which reflect advances in linguistic development, are crucially dependent on socially grounded experience (Kuhl, 2007). Indeed, change in speech perception and early language development are dependent on interactions with people, referred to as the "social gating" model (Kuhl, 2007). One possibility is that these early stages of development, between 6 and 12 months, mark the beginning of the atypical developmental pathways that can lead to ASD, including core language and communicative impairments. Failures to attend fully to socially mediated learning opportunities for language acquisition may have profound developmental consequences (Meltzoff, Kuhl, Movellan, & Sejnowski, 2009). This view is consistent with the developmental timing of changes in head size in some infants with ASD as reported in retrospective studies (e.g., Redcay & Courchesne, 2005) as well as in the genetic mechanisms relating to synaptic plasticity that have been implicated in recent studies (cf. Morrow et al., 2008). Even during this early period, there is likely to be heterogeneity, both in the mechanisms crucial for responding to the social environment, and in the mechanisms crucial for linguistic development (including perceptual, motor, and learning systems). Future research will investigate these very early developmental patterns using prospective longitudinal approaches (cf. Zwaigenbaum et al., 2007). In turn, these studies may shed light on the mechanisms that underlie the profound impairments seen in some children with ASD who fail to acquire any spoken language.

This review of the research on language and communicative impairments in ASD has a number of important clinical implications. First, it is now clear based on several studies that

a history of delay in early language is not nearly as important from a diagnostic perspective as is a comprehensive evaluation of current language skills (e.g., Bennett et al., 2008). Second, we know that early intervention can jumpstart and significantly accelerate the rate of language acquisition in young children with ASD (Dawson, 2008). Finally, we should also be optimistic that since language skills continue to develop in older children (e.g., vocabulary, discourse and narrative abilities) and the neural substrates for language do not reach full maturity until the end of adolescence, ongoing treatment may also lead to continued growth in children with ASD throughout this period.

Challenges and Future Directions

- Little is known about the neurocognitive mechanisms associated with the failure to acquire language in some children with ASD. Methodological challenges of obtaining valid behavioral data and in acquiring measures of brain structure and function have slowed research into these important issues.
- Given the pervasive and lifelong impairments in pragmatic aspects of language that are universally found in individuals with ASD, an important priority for future research will be advancing our understanding of the neurobiology of these deficits.
- Evidence-based treatments for older children and adults with ASD, including interventions for pragmatic aspects of language and nonverbal communication skills need to be developed and implemented in the community.

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