Language Disorders

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Introduction

A glance at the literatures addressing childhood and adult language disorders might lead to a logical conclusion that these disciplines are cataloging two entirely different species. Nevertheless, there are commonalities that unite the study of language disorders across the lifespan. This article will outline principles that yield a broad frame of reference for conceptualizing the lexicon of language disorders.

What is language?

Many non-human animals use complex forms of communication to convey information about distance, direction, threat, and emotional states (Hesse & Potter, 2004; Mangum, 2010; Pepperberg, 1999; Pepperberg, 2013; Tschudin, Call, Dunbar, Harris, & van der Elst, 2001). Some non-human animals (e.g., great apes, dolphins) have demonstrated remarkable inter-specifies communication abilities by associating signs and symbols (e.g., manual signs, vocalizations) with objects and ideas. Alex, the famed African Gray parrot, had an expressive vocabulary estimated at 100 words, with intelligence comparable to a five-year old human (Pepperberg, 2004). Likewise, chimpanzees and bonabos such as Kanzi, have captured the public's fascination by conveying novel ideas through the use of basic combinatorial rules (Savage-Rumbaugh, 1986; Savage-Rumbaugh, Shanker, & Taylor, 1998; Wynne, 2007). Although it is clear that non-human animals routinely communicate, many linguists hold a strong distinction between communication and language. Humans perceive and produce language in ways that other species apparently do not (Fitch, Hauser, & Chomsky, 2005; Hauser, Chomsky, & Fitch, 2002; Pinker & Jackendoff, 2005). For instance, In everyday conversation, humans routinely transcend the immediate present by referencing the past and the future (e.g., remember your prom date?). We also use abstract words (e.g., *justice*) and are adept at symbolic reasoning and symbol manipulation. Finally, we employ rules for combining the building blocks of language into a potentially infinite series of recursive utterances. These unique properties of human expression (e.g., recursion, syntactic competence, temporal flexibility, abstraction) comprise formal criteria for *language*. Within the backdrop of this operational definition of language, one might begin to understand some of the common elements of language breakdown.

A language disorder can arise from impairment(s) at many distinct levels of a processing hierarchy composed nominally of input, output, and word meaning. For example, failure to name an object (i.e., anomia) might result from perceptual deficits in visual object identification (i.e., agnosia), degradation of the core concept that underlies object meaning (i.e., semantic impairment), or failure to accurately link a word form to a target concept (i.e., lexical retrieval deficits). One way of isolating the particular cause of a language disorder is to first pursue a broad, psycholinguistic modeling approach. Figure 1 represents a highly stylized model of some of the key systems that support language, and the discussion to follow will focus on the selective vulnerability of these components.

-Figure 1-

Language as a complex system

Most language researchers acknowledge the existence of separate but highly interactive pathways that access word meaning (Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Levelt, 1999; Magnuson, Dixon, Tanenhaus, & Aslin, 2007; Monaghan & Christiansen, 2010; Nelson, McEvoy, & Pointer, 2003; Nygaard, Cook, & Namy, 2009; Pinker, 1995; Saffran, 2003; Saffran & Thiessen, 2003). Language input arrives from a variety of representational modalities including orthography (i.e., text), manual gesture (i.e., signs), speech, and non-verbal means (e.g., facial expression). This incoming detail reverberates through language pathways to engage a vast repository of stored word forms known as the *mental lexicon* (Coltheart, 2004; Levelt, Praamstra, Meyer, Helenius, & Salmelin, 1998). Many psycholinguists believe that these lexical representations subsequently engage a more central pool dedicated to word meaning (i.e., semantic memory) (Foygel & Dell, 2000; Kellenbach, Brett, & Patterson, 2003; Reilly, Cross, Troiani, & Grossman, 2007; Reilly & Peelle, 2008; Rogers et al., 2004). If the input processing pathway functions successfully to this point, a person has now comprehended a single word. Language expression proceeds by selecting an appropriate target word (e.g., lexical selection) and subsequently encoding its phonological, orthographic, or gestural properties. Finally, during the act of overt speech, our bodies (lips, tongue, palate, diaphragm) execute a precise series of motor programs that shape acoustic detail into intelligible speech output.[1]

Figure 1 represents a primitive starting point for understanding single word production. The limitation of this box-and-arrow modeling approach is that language involves far more than single word production. Language also demands syntactic competence to impose structure upon running discourse. Moreover, we are sensitive variations in pitch, amplitude, and duration (i.e., prosody) that convey information about emotional states and grammatical class. In addition, social pragmatic abilities and theory of mind are supra-linguistic elements of communication that are critical for maintaining the flow of conversational narrative and adapting messages to the unique needs of a conversation partner. Language competence compels us to integrate all of these components in rapid-fire succession and with great precision. It is a marvel that we accomplish this feat with such little effort. Yet, the complexity of this dynamic system offers numerous potential points of breakdown.

Language disorders

Most researchers and clinicians approach language disorders by reducing global impairments into a set of receptive and expressive components. Deficits in receptive language impact comprehension by compromising the input pathway illustrated on the left side of figure 1. In contrast, expressive language deficits emerge in the context of impairment to one or more output processes illustrated on the right side of figure 1. This expressive-receptive language dichotomy often serves as an anchor point for assessment and intervention of language disorders. Standardized tests of language functioning typically assess receptive and expressive abilities through a range of unique subtests. Composite scores on such assessments tend to be relatively uninformative in

[1] Most researchers draw a sharp divide between language and motor speech production. Consequently, speech and language disorders are typically regarded as unique entities. In reality, this distinction is often murky. Parents, for example, often report speech delays when in fact their child is experiencing delayed expressive language.

isolation. To follow, we discuss some of the primary loci of receptive and expressive language disorders.

Phonology & Orthography

Most spoken languages represent concepts through arbitrarily symbolic associations with strings of sounds. Phonemes are defined as the smallest units of sound that are capable of changing word meaning within a given language or dialect (Ladefoged, 1993). In English, for example, the phonemes /l/ and /r/ mark the words *lap* and *rap* as distinct, whereas Japanese phonology does not mark this distinction. Standard American English is composed of approximately 42 phonemes but only 26 letters.[2] This discrepancy arises because English has an opaque (or deep) orthography that is characterized by irregular mapping of letters to sound. In contrast, languages such as Spanish and Italian are considered to have transparent (or shallow) orthographies where each letter consistently maps to one phoneme, a property that might contribute to variable rates of dyslexia (i.e., reading impairment) and dysgraphia (i.e., writing and/or spelling impairment) across language boundaries, with higher rates of dyslexia among opaque languages (Friedmann & Gvion, 2012; Hornickel & Kraus, 2013; Landerl et al., 2013; Ziegler et al., 2010).

As very young infants, through listening exposure we implicitly learn phonemic distinctions within our native language. We also gain rapid proficiency with regularities and rules that govern the ways that phonemes combine (i.e., phonotactic probability), and during typical language development, infants make active use of this knowledge to parse incoming speech into chunks of discrete words (Saffran, 2001, 2003; Saffran, Aslin, & Newport, 1996; Saffran, Johnson, Aslin, & Newport, 1999; Saffran & Thiessen, 2003; Thiessen & Saffran, 2003). Thus, early acquisition of the sound system or an alternate mode of input (e.g., manual sign) is crucial for early word learning. A variety of language disorders are associated with deficits that impact early stages of acoustic and phonological input processing. Various forms of hearing loss (e.g., congenital deafness, transient middle ear infections) reflect input deprivation. Other conditions impact more central cognitive abilities. Examples of related language disorders include central auditory processing disorder and specific language impairment (SLI). Among these conditions, the associated phonological impairments are not attributable to peripheral hearing loss. People with SLI, for example, often have no trouble detecting tones or discriminating between two spoken words. Yet, SLI is also characterized by difficulties with “meta-tasks” that demand phonological awareness and/or explicit knowledge of phonological rules in addition to working memory (e.g., rhyme judgments, explicitly segmenting phonemes or syllables) (Bortolini & Leonard, 2000; Joanisse, 2004; Joanisse & Seidenberg, 2003; Leonard, Davis, & Deevy, 2007; Storkel, 2011).

In addition to receptive phonological disorders, there exist a range of expressive phonological impairments. Adult patients with nonfluent forms of aphasia commonly produce phonemic paraphasias, that are characterized by the production of unintended, distorted, or omitted syllables (e.g., umbwellug for umbrella) (Berg, 2005; Buckingham, 1992). These errors are not typically related to speech motor deficits or peripheral coordination of the tongue or lips. Expressive phonological deficits are also apparent as

[2] This number is in fact highly debated among sociolinguists. There exists great variability among the many unique dialects that comprise English, especially with respect to vowels.

children learn difficult phonemic transitions (e.g., moving rapidly between sounds made in the front of the mouth relative to the back). Many such expressive phonological problems often involve processes or patterns of sound production deficits (e.g., fronting of sounds that should be made in the back of the mouth) rather than isolated difficulties producing particular phonemes (e.g., /s/).

Word Meaning: Semantic Memory

Much of our ability to understand and express language relies on a unique system of human memory. Semantic memory comprises our multi-modal knowledge of word and object meaning. Such conceptual knowledge is essential for naming and understanding spoken words in addition to nonverbal interactions. Thus, semantic memory forms a substrate for language. Deficits in semantic memory tend to produce profound language impairments (Lambon Ralph, Graham, Ellis, & Hodges, 1998; Lambon Ralph, Patterson, & Hodges, 1997; Warrington, 1975). The most compelling evidence for this relation between language and memory is seen in neurodegenerative conditions such as Alzheimer's Disease and the semantic variant of primary progressive aphasia (Gorno-Tempini et al., 2011; Hodges, Patterson, Graham, & Dawson, 1996; Hodges, Salmon, & Butters, 1992; Reilly, Peelle, Antonucci, & Grossman, 2011; Reilly, Rodriguez, Peelle, & Grossman, 2011). Patients with these conditions typically have great difficulties with both expressive and receptive language, producing narratives that are empty (uninformative). Language disorders with a basis in degraded semantic memory typically present with comparable deficits in language and many other nonverbal modalities In contrast, semantic access disorders (e.g., aphasia, agnosia) often reflect impairment of one or more unique pathways either to or from semantic memory (see figure 1).

Morphology

Morphemes are the smallest meaningful units within a particular language. Free morphemes can stand alone as independent words (e.g., love), whereas bound morphemes (-ing, -tion, -s) constitute affixes. Thus, all words are nominally composed of at least one morpheme. Yet, not all morphemes are words. Morphology serves many grammatical and semantic functions in everyday language. We routinely use inflectional morphemes to mark verb tense and noun quantity (e.g., dog – dogs). We also use derivational morphology to change the meanings of words (e.g., friend – unfriendly).

Relatively little is known about the nature of focal language impairments that impact morphology. Specific language impairment (SLI) appears to impact morphological development during childhood; for example, people with SLI have trouble acquiring verb tense and irregular constructions (e.g., run – ran) (Leonard, Deevy, et al., 2007; Owen & Leonard, 2006; Rice & Blossom, 2013; Verhoeven, Steenge, & van Balkom, 2011). Morphological deficits are also present in the production of adults with nonfluent aphasia who show telegraphic speech, a condition characterized by clipped utterances and the deletion of bound morphemes (Stark, 2010; Tesak & Dittmann, 1991).

Syntax

Language is not simply a succession of single words. We combine words and morphemes into discourse using a set of grammatical rules (i.e., syntax). Natural languages vary in their syntactic structures, and one of the great challenges for linguistics has involved uncovering deep structure, or universal grammar, that is common to all languages (Chomsky, 1965). Many language disorders are characterized by deficits in comprehending or producing complex syntax. Broad deficits in syntactic competence, termed agrammatism, are strikingly evident in a form of left frontal lobe stroke known as Broca's Aphasia. People with this form of aphasia often produce only very short, canonical (subject-verb-object) sentence structures devoid of morphology and function words (e.g., Mary go store).

During language acquisition, early syntactic competence is a key component of language learning from which children "bootstrap" more complex linguistic skills (e.g., understanding noncanonical sentence structures such as passives) (Gerken, Jusczyk, & Mandel, 1994; Gleitman & Gleitman, 1992; Kelly, 2004; Pinker & MacWhinney, 1987; Saffran & Thiessen, 2003).

Pragmatics

Have you ever interacted with a 'close talker' or answered a phone call only to have your conversation partner behave as if you called him? Situations like these are uncomfortable because they violate social-pragmatic norms. Pragmatics generally refers to the collective set of behaviors that govern appropriate and effective language use in a particular environment. Pragmatic competence demands that we fluidly adjust our linguistic registers and other non-verbal aspects of language (e.g., posture, height) during a conversation. For example, many people adopt more formal discourse when speaking with a judge then with a close friend. Many pragmatic skills are inextricably linked with theory of mind (TOM) in that "good" conversation requires that we intuit and attend to the needs of our listener and adjust our communication accordingly. Grice identified several 'maxims' related to aspects such as quantity (e.g., are we saying too much or too little?) and the quality (e.g., are we paying proper deference to the social status of our listener?) of our delivery, along with shared assumptions of truthfulness and relevance (Grice, 1975).

Numerous language disorders, both acquired and congenital, impact pragmatic language skills. Children with autism often have great difficulty mastering pragmatic aspects of language (e.g., turntaking in conversation, maintaining eye contact) (Barnes & Baron-Cohen, 2011; Kissine, 2012). During adulthood, traumatic brain injuries and right hemisphere neurological damage also compromise many aspects of pragmatics, including response inhibition and apparent apathy. The treatment of pragmatic language deficits remains notoriously difficult to execute, and much remains to be learned about effective means of promoting generalization of treatment gains to naturalistic interactions.

Prosody

The semantic and phonological content of speech is often only marginally informative of the true meaning of a statement. As listeners, we routinely rely on variations in pitch, frequency, and duration of incoming speech to suffuse words with a speaker's higher-level emotional intent. For example, statement such as, "*I just love*

Florida" uttered with a falling or flat intonation conveys sarcasm. Yet, the same utterance produced with rising intonation and amplitude (intensity) typically conveys enthusiasm and sincerity. In this example, it is impossible to discern a speaker's true intent by simply reading the printed words. Prosody is the rhythm, stress, and intonation of speech and is critical for adjudicating the true meaning of this statement and more broadly for appreciating humor, sarcasm, and many subtle aspects of emotional communication.

Prosody, like most elements of language, has receptive and expressive components. In addition, prosody can serve either linguistic or emotional purposes. Prosody can mark grammatical distinctions (e.g., verb/noun) through segmental (syllabic) stress patterns. When we read a word such as *content* in isolation, it is impossible to know the intended meaning (i.e., happy or material). Yet, when we hear the spoken word, syllable stress instantly clarifies the intended meaning.

Expressive and receptive prosody appear to be dissociable (i.e., vulnerable to selective impairment). Further lending complexity to the expressive-receptive distinction is the fact that prosodic deficits (i.e., aprosodia) fractionate along emotional vs. syntactic lines (Heilman, Bowers, Speedie, & Coslett, 1984). Expressive prosodic deficits often perceived as flat, monotonic speech are a common consequence of people who experience a right hemisphere stroke . In contrast, people with Parkinson's Disease sometimes have difficulties matching the emotional content conveyed by prosody to an appropriate situation (Pell, 1996; Pell, Cheang, & Leonard, 2006; Pell & Leonard, 2003). It is believed that children who show difficulties with linguistic prosody have difficulty acquiring grammatical distinctions (nouns vs. verbs) later on. (Gerken et al., 1994).

Language and other cognitive processes

Language competence relies on a strong supporting cast of other cognitive processes such as working memory, attention, inhibitory control…. Working memory helps offset the rapid decay of information. We also require attention and inhibitory control to select intended targets and suppress competing alternatives. Moreover, functional sensory channels (vision, audition) allow us to name and monitor our own production. Some language disorders reflect focal impairment of the language system proper (e.g., syntax, phonology), whereas others reflect downstream effects of these other cognitive deficits (Martin & Reilly, 2012). Patients with Alzheimer's Disease, for example, often have great difficulties understanding sentence-level material, and these deficits are exacerbated with increased sentence length and syntactic complexity (e.g., passive versus active voice) (Altmann, 2004; Caplan & Waters, 1999). One lingering question regards whether these deficits reflect a true language disorder or more generalized limitations in working memory. Although debatable, consensus points toward memory as a primary etiology. Alzheimer's Disease yields just one example of a literature that is rife with cases where a domain-general cognitive deficit might masquerade as a focal language disorder.

Conclusion

The study of language disorders represents a nexus among many disciplines, both theoretical and applied. The development of effective treatments for language disorders requires a mechanistic understanding of the problem(s) at hand. Thus,

applied clinical disciplines that address language disorders often dovetail with classically theoretical fields such as developmental psychology, cognitive psychology, and linguistics. More recently, the study of language disorders has also fallen under the purview of biological psychology, cognitive neuroscience and neurobiology. Thus, the contemporary study of language disorders is highly multidisciplinary with psychological methods and psycholinguistic theories offering prominent and essential contributions.

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Figure 1. A simple interactive model of single word processing