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The Assessment and Treatment of Prosodic Disorders and Neurological Theories of Prosody

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Abstract

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Introduction

Peppé (2009) provides a detailed discussion of the critical issues concerning the ways in which atypical prosody is identified and characterized in clinical settings. The article delineates specific forms and functions of prosody, reviews literature on the neurological bases of prosodic disorders, discusses nosological issues, and offers suggestions for assessment and treatment. In our response, we will provide comment on these issues. First, we discuss the major limitations of the assessment of prosodic disorder with currently available tools and offer a methodological framework for designing measuring tools with clinical utility. Second, we expand on Peppé's discussion of the state of prosodic intervention programs for children. Finally, we focus on neurological theories regarding how prosody is processed in the brain. In particular, we argue that current theories of prosody processing are moving away from modularity of function and toward theories in which cortical communication is the crucial component. The goal of this response is to expand the discussion of these important issues.

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Assessment

Current instruments for assessing prosodic deficits are decades behind those that are used for clinical assessment of other aspects of language. The primary cause of this state of affairs is the fact that there are few, if any, psychometrically sound measurement standards and tools in the area of typical prosodic development. The last forty years have produced a wealth of data on the typical development of vocabulary, syntax, phonology, and pragmatics, as well as on disordered development of these areas. A plethora of standardized instruments, as well as criterion-referenced methods such as language sample analyses procedures, have been presented and evaluated in the literature. In prosody, however, there are no analogous data on the typical developmental sequence of the acquisition of prosodic ability; nor are there commonly used metrics, derived from studies of spontaneous language use, analogous to mean length of utterance for syntax (Brown, 1973), Type-Token Ratio (Templin, 1957) for semantics, or Percent Consonants Correct (Shriberg & Kwiatkowski, 1982) for phonology. In addition, there are no analogs to the kinds of standardized language assessments—such as the Clinical Evaluation of Language Fundamentals (CELF-IV; Semel, Wiig, & Secord, 2003) and the Peabody Picture Vocabulary Test (PPVT-IV; Dunn & Dunn, 2007) that are used to evaluate other areas of language—in the area of prosody. In this section, we examine current instruments in the context of other well-established methods of assessing language in order to establish a methodological framework for future improvements in our ability to evaluate prosodic deficits. Specifically, we highlight the need for a tool that: (1) has a representative normative comparison sample and strong psychometric properties; (2) is based on empirical information regarding the typical sequence of prosodic acquisition and is sensitive to developmental change; (3) meaningfully subcategorizes various aspects of prosody; (4) uses tasks that have ecological validity; and (5) has clinical utility.

It should be noted that the most recent prosody assessment tool, the Profiling Elements of Prosodic Systems-Children (PEPS-C; Peppé & McCann, 2003) has several strengths. First, it breaks prosody down into distinct, meaningful categories. This allows an examiner to determine whether individuals are having general difficulty with understanding and using prosody in communication (regardless of the type of message being communicated), or whether they are struggling with a broader faculty (i.e., affect) which is represented by atypical prosody in one specific area (i.e., expressing emotion in the voice) but not others. Research has shown that different types of prosody are processed differently in the brain (e.g., Friederici & Alter, 2004;Gandour et al., 2004), so the identification of discernible aspects of prosodic performance may be useful in discovering brain-behaviours connections. Second, the PEPS-C provides some degree of normative comparison against which the performance of children with communication disorders can be gauged. Third, it investigates both expression and reception, which is important because we know that language impairments do not necessarily affect both modalities equally. Fourth, it differentiates form from function, which is necessary because it differentiates perceptual and imitation difficulties from deficits related to understanding and producing meaning through the voice. Finally, it overcomes practical limitations of previous prosody assessments such as the time-consuming process of transcription. Still, there are several areas that need significant improvement in order for the PEPS-C (or any measure of prosody) to become a viable part of language assessment batteries.

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Standardization

First, there is a strong need for a measure of prosody that is standardized relative to a large, representative norming sample, and provides other measures of psychometric soundness, such as data on reliability, standard error of measurement, sensitivity, and so on. Currently, none of prosody assessments outlined by Peppé are standardized. The PEPS-C was normed on a sample of 80 children ages 5–14, and has been used on several experimental research samples of individuals including those with Autism Spectrum Disorders, Williams syndrome, and speech/language impairments (e.g., Peppé et al., 2007; Stojanovik, Setter, & Ewijk, 2007; Wells & Peppé, 2003). Crystal's PROP (Prosody Profile; Crystal, 1982) also provides some normative data, but is not formally standardized. The Prosody Voice Screening Profile (PVSP; Shriberg, Kwiatkowski, & Rasmussen, 1990) has over 200 samples of speech to which to compare vocalizations, but is not statistically referenced to a normative sample. Instead, the PVSP uses cut-off scores, and sets a cut-off of 90% of vocalizations rated as appropriate in order for prosody to be deemed typical.

By comparison, the CELF-IV was normed on a sample of 2650 children and young adults. The PPVT-IV was normed on a sample of 5500 children and 725 young adults, and stratified based on gender, race, and geographic location, among other factors (Dunn & Dunn, 2007; Strauss, Sherman, & Spreen, 2006). Clearly, there is a need for prosody assessments to emulate more closely other language measures in terms of standardization.

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Developmental changes

Second, there is a need for a measure that is developmentally sensitive, and can be flexibly used with different age groups. There are pronounced changes in how children comprehend and use prosody that have been documented over the developmental period (e.g., Cutler, Dahan, & van Donselaar, 1997; Snedeker & Yuan, 2008). Importantly, none of the current prosodic assessment measures discussed by Peppé has different forms or different items for different ages. In the PEPS-C, for example, children who are 5-years-old are presented with the same items as adolescents. This results in ceiling and floor effects on different subtests at the same age ranges. Therefore, the different subtests are not equally difficult, and are not comparable if a clinician aims to profile relative strengths and weaknesses across items for the purpose of remedial planning. Similarly, the PVSP does not delineate what percentage of correct prosody use would be appropriate at various ages. By contrast, common language tests such as the CELF-IV and PPVT-IV offer different stimuli, norms, and in some cases different forms based on a child's age. The CELF-IV, for example, covers ages 5–21, but is stratified into 12 age categories and has two different forms. The PPVT-IV covers ages 2.5–90 and is grouped into 25 age categories. Both of these tests are designed to account for non-linear changes in the abilities they test (Strauss et al., 2006).

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Task requirements

Third, there is a need for a measure that does not model or draw attention to the correct answers for the participants in order to ensure that performance is representative of actual prosodic abilities and not learning factors. In the productive prosody section of the PEPS-C, for example, the examiner teaches the child how to do the task, and this involves the use of the correct prosodic patterns for the practice examples. For example, in the first two practice items for Turn-End Type Output, the examiner provides examples of expected responses to pictures using the appropriate intonation pattern (i.e., “Carrots?” and “Tea.”). Then, children hear two items to which they respond, and the examiner provides feedback if they respond incorrectly. In the receptive prosody portion, the examiner demonstrates for the child the correct answer on the first two practice items. Then, as in the expressive tasks, the examiner gives feedback on the next two items if children give the appropriate response, and corrective feedback if they give the wrong answer. Moreover, receptive tasks are administered before the expressive tasks (although this is not an explicit requirement of the test), providing further examples of the correct prosodic productions for the children. Although the training items do not tell the child to pay attention to prosody, the examples and feedback draw considerable attention to prosody as a meaningful variable in the task.

While these instructions are intended to teach the child the task, the issues we have raised are important for several reasons. First, in everyday communication, prosody is not highlighted for the listener. It is likely that there are groups of children whose prosody processing deficits may include not knowing when to pay attention to the vocal characteristics in speech. Comparing performance on items with lexical content filtered (the PEPS-C uses a laryngograph) to unfiltered items does not fully obviate this potential problem because in both instances the instructions and task design draw considerable attention to prosody as the variable of interest. Also, with this design, it is difficult to determine if a child who responds correctly has learned the demands of this specific task or has actually mastered the prosody. This is especially important because many of the tasks on the PEPS-C are two-alternative forced choice (2AFC), a characteristic that raises the likelihood of a learning effect.

Much of the experimental research on prosody processing in typical and atypical development makes an effort not to call participants’ attention to prosody, in order to increase the ecological validity of the findings (Diehl et al., 2008; Kraljic & Brennan, 2005; Snedeker & Yuan, 2008;Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). For example, Snedeker and

Yuan (2008) asked children to perform actions on objects (e.g., Feel the frog with the feather) and set up the context such that two possibilities available (i.e., a frog could be felt by using a feather, and a frog holding a feather could be felt by the child's own hand). By simply changing the placement of the intonational phrase break, the same sentence could indicate either movement. Importantly, participants were given no practice examples with critical trials, and were told only to follow the instructions they were given. This type of design, which does not draw attention (even unintentionally in the practice items) to the prosodic aspect of the message, should be considered in developing clinical assessment tools.

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Length, labour-intensity and clinical utility

In order to be used for clinical assessment of prosody, measures need to be feasible for real-world settings. Measures like the PVSP (Crystal, 1982; Shriberg & Kwiatkowski, 1982) or PROP (Crystal, 1982) have high ecological validity due to their use of spontaneous speech samples, but are extremely labour-intensive because of the need for transcription of both lexical and prosodic elements. Emerging speech technologies such as those described by Hosum (2009, in press) and van Santen et al. (2009, in submission) may eventually result in the development of automated analyses that can classify natural prosodic productions as within or outside parameters defined by large normative samples. For now, however, measures that require transcription are difficult to implement in clinical settings.

The PEPS-C, while an improvement in terms of labour-intensity, is still very long for a clinical measure, especially when used in the context of a full-blown language assessment that requires the evaluation of other aspects of communication, as well. Further research on this measure, to identify the most sensitive and specific scales for a range of developmental levels, in conjunction with more standardization and psychometric development, could result in a measure that might be incorporated within existing batteries as an optional subtest for children for whom is appears relevant.

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Intervention

As Peppé noted, there is remarkably little published literature on methods of improving deficits in prosodic function in children. Yet, prosodic deficits are widespread in high-functioning children with ASD, and are common in children with other developmental language disorders and with hearing impairment, as well. As Hargrove et al. (1989) report, these disorders can seriously impair intelligibility. Moreover, several studies (Mesibov, 1992; Paul, Shriberg, et al., 2005;Shriberg & Widder, 1990) have shown that prosodic deficits negatively affect others' social perceptions about the speaker and negatively impact opportunities for mainstream integration. Thus, the need not only for convenient, reliable, and valid assessment procedures, but for more comprehensive, evidence-based intervention practices in this area is compelling.

The development of intervention programs in prosody faces many of the same challenges seen in the area of assessment instruments. Without knowledge of the sequence of typical prosodic acquisition, it is difficult to develop a comprehensive intervention curriculum. Without well-developed and established measurement tools, clinicians cannot readily accomplish on-going assessment in order to determine when goals have been achieved and new ones should be targeted. These difficulties are in addition to the basic lack of empirical data on what methods and techniques are effective for changing prosodic behaviour.

Despite these problems, there has been renewed interest in prosodic intervention for children, particularly as the prosodic deficits of speakers with ASD have reached a higher level of public awareness. As Peppé points out, some methods derived from programs for adults with acquired neurological disorders are being tried with children. Again, technology has made additional contributions. Software designed to provide visual models to be matched in production activities, as well as visual feedback for correct performance, incorporating devices such as the IBM SpeechViewer, has been used (e.g., Thomas-Stonell, McClean, & Dolman, 1991). In addition, the use of robotic toys for providing feedback is also being examined (e.g., Kim et al., 2008). Applications of music therapy are another avenue that has been explored for addressing prosodic deficits in children (Lim, 2008; Staum, 1987).

Despite some promising beginnings, though, the provision of effective intervention for prosodic deficits in children remains hampered by a dearth of empirical information on development, assessment methods and intervention procedures. It is to be hoped that additional focus on the issues of prosodic assessment and intervention for children, in venues like the present one, may be helpful in focusing additional interest and attention on this vital aspect of communicative competence.

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Neurological models of prosody

With the advent of neuroimaging techniques, there has been tremendous progress in our understanding of how language, and by extension prosody, is processed in the brain. Peppé (2009) mentions that early theories of prosody processing suggested that emotional versus linguistic prosody were lateralized. More recently, theories of prosody processing have been influenced by the acquisition of data from functional neuroimaging. For example, many studies have shown that prosody processing involves dynamic and bilateral networks and pathways for which cortical communication is essential (for extensive reviews, see Berckmoes & Vingerhoets, 2004; Friederici & Alter, 2004; Gandour et al., 2004). Berckmoes and Vingerhoets (2004), as one example, suggest a bilateral temporo-frontal network for emotional prosody processing.Gandour et al. (2004) described how prosody processing involves “neither a single region nor a specific hemisphere, but engages multiple areas comprising a large-scale spatially distributed network (pg. 344)”. Friederici and Alter (2004) emphasized the dynamic nature of prosody processing and the crucial nature of hemispheric communication (via the corpus callosum) for prosody processing.

In addition, in studies that have found hemispheric specialization, it is unclear whether lateralization actually functions at a conceptual level, such as affect or grammar, or is a reflection of lower-level processing of the acoustic signal (Gandour et al., 2004). For example, it has been suggested that the processing of spectral aspects of prosody are processed in the right hemisphere, while temporal aspects are processed on the left (Van Lancker & Sidtis, 1992;Zartorre & Belin, 2001). Therefore, it must be considered that neural models of prosody processing may not conform to traditional theories of the simple lateralization of prosody.

Speech acts, such as illocutionary force (operationalized as the “Turn-End Type” items in the PEPS-C), are a good example of this problem. In some studies, this type of item has been classified grammatical prosody (e.g., Paul, Augustyn, Klin, & Volkmar, 2005), whereas others have termed the same structures to represent pragmatic prosody (e.g., Wells & Peppé, 2003). In fact, this item can reasonably be seen to fit into both categories (and perhaps others, as well). It signals sentence type, it structures discourse, but it also communicates a type of mental state or intent in discourse (i.e., “I want you to know that I’m done speaking,” or “I want you to respond”). Perhaps unsurprisingly, then, neuroimaging results that have examined these speech act examples suggest interesting patterns of processing involving both hemispheres (Doherty, West, Dilley, Shattuck-Hufnagel, & Caplan, 2004).

In sum, there is still considerable work that needs to be done in order to understand fully how prosody is processed in the brain. Current theoretical models suggest the involvement of multiple brain areas, with cortical communication being a crucial component. Moreover, it is likely that neural models of prosody might not conform to our traditional means of conceptualizing prosodic categories. One crucial obstacle to studying prosody processing in the brain is that techniques used so far tend to have good temporal sensitivity (e.g., evoked response potentials) or good spatial sensitivity (e.g., functional imaging) but not both. Because prosody is reflected in changes in both tonal and timing patterns, we will not fully understand neural mechanisms until we have techniques that are both temporally and spatially sensitive.

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Summary and conclusions

As researchers and clinicians who have been interested for some time in the assessment and treatment of prosodic disorders in children, we are particularly pleased to have had the opportunity to participate in this forum, and we extend our thanks to Dr. Peppé for both her longterm commitment to prosodic research and her spearheading of this issue. It is our hope that increased discussion of the role of prosody in developmental disorders will stimulate research and clinical efforts to address this important area of communicative competence. In our remarks, we have attempted to outline the ways in which future research and clinical endeavour can lead to improvements in the currently sparse state of empirical data, diagnostic instruments, and treatment information regarding developmental prosodic disorders. We are encouraged by the evidence emerging from neuroimaging studies of prosody. Although currently, this information leads away from simplistic models of hemispheric lateralization of prosodic processing and may seem more complex than enlightening, in time these data will provide us with a more elaborated picture of what the brain does with prosodic information. As this information becomes integrated into clinical thinking about prosody, it will lead to more informed notions of the best way to characterize and train these abilities. We hope to be part of this important effort.

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