Continuing Peer Commentary

Response to "Infants' Perception of Musical Sequences: Implications for Language Acquisition" by Sandra E. Trehub

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I read with interest Dr. Trehub's article. This paper provides additional insight into the way infants perceive auditory sequences in the form of melodies. As an audiologist working with young hearing impaired children, I found the series of experiments described intriguing, however, I felt that caution must be exercised when generalizing the findings of these experiments to the development of speech processing in normal hearing infants and I was even more reluctant to consider the implications for the hearing impaired child. The work of Stoker (1979), which demonstrated a relationship between the perception of temporal patterning and performance on an auditory sentence identification task, and the work of Tait (1984), which found a parallel between the development of hearing impaired children's singing ability and the development of communication skills, suggests, however, that this research may have relevance for the hearing impaired child.

Visual Reinforcement Audiometry and Visually Reinforced Infant Speech Discrimination have proven to be valuable tools in the assessment of auditory development in children. These techniques have allowed both the clinician and the researcher the opportunity to examine the infants' ability to discriminate between auditory stimuli under carefully controlled conditions. Much of the research in this field has focused on the ability of the infant to discriminate between discrete units of auditory stimuli. This study moves beyond that and examines the infants' ability to recognize auditory sequences.

Trehub begins by examining the strategies used by the infant for melodic recognition. She concludes that melodic recognition for the infant is dependent upon the infants' ability to deal with the sequence in terms of the relative directional movement of the notes in the melody. It is this contour of the melody rather than the absolute pitch of the individual notes which make up the melody that seems to be the salient feature used by the infant in melody recognition. She suggests that it is quite possible that infants use similar strategies when processing speech and that mothers modify their speech to capitalize on this. She speculates that, "it is quite possible, then, that for infant-directed speech, the pitch contour *is* the utterance, with lexical or segmental content being optional." If this is in fact the case, there are some important implications for early habilitation of the hearing impaired child.

The hearing impaired child will have the opportunity to experience this infant-directed speech at a developmentally appropriate time in his or her life if the hearing loss can be identified in the first six months of life and the child is appropriately aided. Trehub points out that parents make these adjustments in their speech naturally without being conscious of exactly what they are doing. They seem to tune their speech to the perceptual abilities and attentional disposition of the infant. She suggests that, "parents are not consciously providing instruction but rather they are predisposed to share their knowledge, on one hand, and their infants are receptive to such exposure, on the other hand." The nurturing of this attitude in parents is the key to successful habilitation of the hearing impaired child. When the hearing loss is diagnosed after the first year of life, the child has begun to move out into the world as he or she becomes more mobile, and the communicative demands on both the parent and the child increase. It is more difficult to keep this attitude of sharing knowledge in sight.

We find the use of video taping interactions between parents and child very valuable. Diagnosis of the hearing loss can cause parents to question all of the things they have been doing naturally when communicating with their child. Video taping parents and child provides an opportunity for parents to focus on what is present in the interaction rather than what they assume is missing. Initially, video taping can be threatening for parents. We are very careful to deal only with what we see as positive aspects of the interaction. Parents often find that when they sit back and view the tapes they are able to see responses from the infant which they were unaware of during the interaction. This seems to help them recognize when they have their child's attention, how they got the child's attention, acknowledge the response on the part of the child, and then proceed with the interaction. The viewing the video tapes seems to help parents re-establish the confidence they need to

continue to engage their children in successful dialogues. With appropriate amplification, this may mean that the hearing impaired child too may be able to perceive the contour of the auditory stimuli and recognize the pattern and ultimately act on it.

At one time, parent-infant interactional studies were at one end of the communication research spectrum and auditory perceptual studies were at the other. The implications of studies such as this one by Trehub will help to unify these areas. This will ultimately provide us with a much better understanding of the communicative process.

References

Stoker, R.G. (1979). Temporal patterning in the perception of spectrally ambiguous speech by deaf and normal listeners. In J.J. Worf & D.H. Klatt (Eds.), *Speech Communication Papers*, 587-590. New York, NY: Acoustical Society of America.

Tait, D.M. (1984). *The Role of Singing in the Social and Linguistic Development of Nursery-Aged Deaf Children*, Ph.D. Thesis, University of Nottingham.

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Dr. Trehub summarizes a very interesting and well designed program of research on infants perception of music. While this topic is of interest in its own right, she also highlights potential parallels between the processing of music and the processing of infant-directed language. Basic to drawing these parallels is the notion that, at an acoustic level, both musical and non-musical stimuli can be viewed as auditory sequences and, thus, may be processed similarly. The basic claim is that attention to the musical (melodic and temporal) properties of infant-directed speech may aid in processing suprasegmental aspects of the input language and subsequently guide infants to further processing in terms of potential phrases or words.

It seems that nonlanguage stimuli have been used much more extensively in research on perception of speech input (e.g., see Aslin, Pisoni, & Jusczyk, 1983) than in research examining the role of language input in acquiring the semantic and syntactic aspects of language. Consequently, I would like to expand somewhat on the relevance of developmental research on music perception to fundamental problems in language acquisition that, while including questions about signal level processing, also involve questions about other levels of processing and other knowledge domains.

A fundamental problem in child language acquisition is specifying the nature of the interactive influences and relationships among social, cognitive, and linguistic (semantic and syntactic) domains of knowledge that together reflect communicative competence. Insights into this problem require the joint exploration of several questions: How do children analyze the input signal itself in terms of patterns or regularities? How do children identify regularities in their physical environment to form categories, and is this identification influenced by the input or accomplished independent of it? How do children relate the regularities in the input signal to their categorizations of the physical environment (often termed the *mapping* problem), and are there properties associated with the input that facilitate making these connections? (Bowerman, 1981). In addressing these problems a central question is whether the extraction of these patterns or regularities and their relationships reflect universal strategies or strategies specific to the particular input.

The role of music input in addressing these questions is important in a way directly analogous to that of cross linguistic research. Some early accounts of language learning (e.g., pivot grammar) formulated in the context of a specific language were subsequently not supported when examined cross-linguistically. They were not universal as originally thought. In like manner, work on the role of a variety of language input characteristics has been examined primarily in the context of natural speech input per se (and primarily in English, although see recent studies by Fernald, Taeschner, Dunn, Papousek, Boysson-Bardies, & Fukui (1989) and Grieser & Kuhl (1988)). However, given the acoustic similarities between music and infant-directed language, the developmental study of music perception provides a very valuable test context for evaluating questions of language specific versus more general information processing strategies. While the role of specific prosodic cues in extracting regularities in language input is beginning to be investigated (e.g., Kemler Nelson, Hirsh-Pasek, Jusczyk, & Wright Cassidy, 1989), there is much research to be done before the generality or specificity of infants' processing strategies begins to emerge. However, the move to utilize evidence from music perception research, or other auditory sequences for that matter, should converge with similar studies of language input to provide general insights into the fundamental processing strategies used by infants.

Following the logic above, I think the use of music input also may enhance our understanding of fundamental issues beyond those of signal level processing. In particular, this approach could provide important insights into the interactive influences between language input and specific cognitive abilities, a classic problem in the study of language. Essentially, the effect on a third variable (e.g., categorization, as an aspect of cognition important to the mapping problem) could be measured in the context of providing contrasting inputs, one linguistic and another nonlinguistic. The construction or choice of the nonlinguistic input to embody specific similarities or differences from language would provide a context for testing specific hypotheses about the basis for linguistic influ-

ences on cognition. Because of important similarities to language (specific acoustic characteristics) as well as differences (lack of words or semantic information), music appears to be a useful nonlinguistic input.

We recently reported two experiments using this approach (Roberts & Jacob, 1989). In experiment 1, infant-directed linguistic input appeared to stimulate successful categorization (animal) in 15-month-olds, when in the absence of that input categorization was unsuccessful (Roberts & Cuff, 1989). A second experiment, in which instrumental music was substituted for linguistic input, replicated the successful categorization found in experiment 1. Linguistic input and music appeared to have the same facilitative effect on categorization. Explanations of why language influences cognition have almost exclusively emphasized uniquely linguistic factors such as attention to linguistic segments (e.g., words; Markman & Hutchinson, 1984). However, the results of our second experiment suggest such uniquely linguistic factors are not necessary to explain the outcome of experiment 1. An alternative explanation (among several) lies in the prosodic characteristics common to both infant-directed language and music. We are currently examining the effect on categorization of a variety of acoustic factors in an attempt to detail the basis for linguistic influences on categorization and to clarify the interactive influences that lead to solving the mapping problem. Important for the present commentary is that the findings from music perception as well as language input studies provide important clues regarding prosodic factors which might prove influential.

Another issue which I found especially interesting was that of enhanced perception in the context of lawful melodies, as opposed to unlawful melodies. Trehub discusses several possible explanations for this effect but leaves the issue open. I was struck by the potential similarity of Trehub's effects to the prototype effects widely documented in the very influential studies of categorization conducted by Rosch and her colleagues (Rosch, 1978). A significant finding of this work was that some category exemplars are more prototypical (representative) than others. Categories (e.g., bird) are internally structured by "family resemblances," forming an exemplar gradient from most representative (e.g., robin or sparrow) to least representative (e.g., penguin or ostrich). The degrees of lawfulness implied by the lawful-unlawful contrast do not seem far different from degrees of representativeness. Prototype effects have been found to be very general, involving a wide variety of categories (Lakoff, 1987), including speech sounds (Grieser & Kuhl, 1989). Not unlike the differential performance in Trehub's studies, Rosch's work (and others) indicated that differential performance in a variety of processing/decision tasks correlated with representativeness. That is, enhanced performance (e.g., shorter response time, increased generalization) was found in the context of more representative exemplars. It may be that when viewed from the perspective of a general model of categorization, important insights may be gained into the performance differences reported for lawful versus unlawful melodies.

References

Aslin, R., Pisoni, D., & Jusczyk, P. (1983). Auditory development and speech perception in infancy. In M. Haith & J. Campos (Eds.), *Handbook of child psychology. Vol. 2. Infancy and developmental psychobiology.* New York: Wiley.

Bowerman, M. (1981). Cross-cultural perspectives on language development. In H. Triandis (Ed.), *Handbook of cross-cultural psychology. Vol. 4.* Boston: Allyn and Bacon.

Fernald, A., Taeschner, T., Dunn, J., Papousek, M., De Boysson-Bardies, B., & Fukui, I. (1989). A cross-language study of prosodic modifications in mothers' and fathers' speech to preverbal infants. *Journal of Child Language, 16,* 477-502.

Grieser, D., & Kuhl, P. (1988). Maternal speech to infants in a tonal language: Support for universal prosodic features in motherese. *Developmental Psychology, 24,* 14-20.

Grieser, D., & Kuhl, P. (1989). Categorization of speech by infants: Support for speech-sound prototypes. *Developmental Psychology, 25,* 577-588.

Kelmer Nelson, D., Hirsh-Pasek, K., Jusczyk, P., & Wright Cassidy, K. (1989). How prosodic cues in motherese might assist language learning. *Journal of Child Language, 16,* 55-68.

Lakeoff, G. (1987). *Women, fire, and dangerous things: What categories reveal about the mind.* Chicago: University of Chicago Press.

Markman, E., & Hutchinson, J. (1984). Children's sensitivity to constraints on word meaning: Taxonomic vs. thematic relations. *Cognitive Psychology, 16,* 1-27.

Roberts, K., & Cuff, M. (1989). Categorization studies of 9- to 15-month-old infants: Evidence for superordinate categorization? *Infant Behavior and Development, 12,* 265-288.

Roberts, K., & Jacob, M. (1989, April). *Facilitating nonlinguistic categorization in 15-month-olds: Linguistic vs. attentional factors.* Paper presented at the biennial meeting of the Society for Research in Child Development, Kansas City, MO.

Rosch, E. Principles of categorization. In E. Rosch & B. Lloyd (Eds.), *Cognition and categorization,* Hillsdale, Laurence and Erlbaum.

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