Duke University

# Solving the mystery of musical harmony

## Insights from a study of speech

DURHAM, N.C. -- For over two thousand years, musicians and scientists have puzzled over why some combinations of musical tones played together sound more harmonious than others. Now, Duke University perception scientists David Schwartz, Catherine Howe and Dale Purves have presented evidence that variation in the relative harmoniousness, or "consonance," of different tone combinations arises from people's exposure to the acoustical characteristics of speech sounds. Schwartz and Howe are postdoctoral fellows, and Purves is Director of the Center for Cognitive Neuroscience and the George B. Geller Professor of Neurobiology. The researchers said that their findings, reported in the Aug. 6, 2003, issue of the Journal of Neuroscience, constitute an important advance in understanding the biological basis of music perception. The work also extends to hearing the theoretical framework about brain organization that Purves and his colleagues developed in earlier work on visual perception. Those studies of vision led to the idea that evolution -- as well as individual experience during development -- created a visual system in which perceptions are determined by what a given visual stimulus has typically signified in the past, rather than simply representing to an observer what is presently 'out there.' That work is summarized in a new book entitled Why We See What We Do (Sinauer Associates, 2003). In their Journal of Neuroscience paper, the neurobiologists present a statistical analysis of the patterns of frequency and amplitude in human speech sounds, based on a collection of recorded utterances spoken by more than 500 people. They found that the points at which sound energy is concentrated in the speech spectrum predict the chromatic scale -- the scale represented by the keys on a piano keyboard. Moreover, the difference in the amount of sound energy concentrated at these points predicts the relative consonance of different chromatic scale tone combinations. These results suggest that certain pairs of tones sound more harmonious than others because they are physically similar to the patterns of sound energy most familiar to human listeners from their exposure to speech, said the researchers. In deciding to analyze speech as a natural basis for tone perception, the researchers were faced with a very different challenge from that of exploring visual perception. In the work on vision, Purves and his colleagues concentrated on analyzing the perception of visual illusions. "After studying the research literature on psychoacoustics, we discovered several phenomena in tone perception that, despite having been investigated for decades, remained unexplained," said Schwartz. "Our general framework is that the way to understand why somebody perceives anything the way they do -- whether the stimulus is light or sound-- is to consider the possible real world events that could have given rise to that particular stimulus."This work on music perception represents a natural extension of the work on visual perception," said Howe. "Hearing presents many of the same challenges as vision, in that the physical world cannot be known directly; we only know about objects in the environment because of the energy associated with them, such as light waves or sound waves. "Determining the actual state of the environment on the basis of this indirect information available to our senses is a real challenge. The solution we have evolved is evidently to respond to ambiguous optical and acoustical stimuli by taking account of the statistical relationship between stimuli and their sources. That seems to be the reason we hear music the way we do."