Available online at www.sciencedirect.com
ScienceDirect
Cognition 102 (2007) 434–454
COGNITION
www.elsevier.com/locate/COGNIT

Hearing a melody in different ways: Multistability of metrical interpretation, reflected in rate limits of sensorimotor synchronization ☆

Bruno H. Repp *

Haskins Laboratories, New Haven, CT, USA

Received 28 April 2005; revised 2 February 2006; accepted 7 February 2006

Abstract

Music commonly induces the feeling of a regular beat (i.e., a metrical structure) in listeners. However, musicians can also intentionally impose a beat (i.e., a metrical interpretation) on a metrically ambiguous passage. The present study aimed to provide objective evidence for this little-studied mental ability. Participants were prompted with musical notation to adopt different metrical interpretations of a cyclically repeated isochronous 12-note melody while tapping in synchrony with specified target tones in the melody. The target tones either coincided with the imposed beat (on-beat tapping) or did not (off-beat tapping). An adaptive staircase method was employed to determine the fastest tempo at which each synchronization task could be performed. For each metrical interpretation, a significant advantage for on-beat over off-beat tapping was obtained – except in a condition in which participants, instead of synchronizing, were in control of the target tones. By showing that a self-imposed beat can affect sensorimotor synchronization, the present results provide objective evidence for endogenous perceptual organization of metrical sequences. It is hypothesized that metrical interpretation rests upon covert rhythmic action.

☆ This manuscript was accepted under the editorship of Jacques Mehler.

* Tel.: +1 203 865 6163x236; fax: +1 203 865 8963.
E-mail address: repp@haskins.yale.edu

0010-0277/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.cognition.2006.02.003

Keywords: Rhythm; Meter; Music perception; Metrical interpretation; Beat induction; Synchronization

1. Introduction

1.1. Multistability in perception

Ambiguous stimuli have long occupied an important place in the study of perception and cognition. It is only when the information impinging upon the sense organs is insufficient fully to determine the percept or motor response that the perceiver's contribution can be assessed. That contribution may derive from autonomous brain processes that give rise to biases over which the perceiver has no control, or it may result from a conscious decision or intention to impose a perceptual interpretation on the stimulus.

The textbook examples of ambiguous stimuli are reversible visual figures, such as Necker's cube or Rubin's vase-face stimulus, that lend themselves to two mutually exclusive interpretations, each of which is quite unambiguous. Such stimuli are said to be perceptually *multistable* (Attneave, 1971; Kelso, 1995). When such a figure is viewed for an extended time, the two percepts alternate spontaneously, changing as often as every few seconds. This alternation has been attributed to neural adaptation or satiation (Hebb, 1949; Köhler & Wallach, 1944). However, there is also evidence that the perceiver's knowledge and intentions play a role. When participants do not know the two alternatives in advance, they often see only one of them (Girgus, Rock, & Egatz, 1977; Rock, Hall, & Davis, 1994). When they are instructed to either accelerate or retard perceptual reversals, or to see one of the alternatives longer than the other, they can do so to some extent (Hochberg & Peterson, 1987; Liebert & Burk, 1985; Pelton & Solley, 1968; Toppino, 2003). When their attention is diverted, they tend to reverse their percepts less frequently (Reisberg & O'Shaughnessy, 1984; Rock et al., 1994). As long as the alternatives are known, however, reversal can generally not be prevented.

Most of these studies have relied exclusively on participants' subjective reports. However, it is important to prove that the reports really represent different percepts and not merely cognitive judgments of an ambiguous but constant percept. Hochberg and Peterson (1987) describe how the perceived orientation of a Necker cube can be revealed by judgments about the perceived direction of rotation of the cube. Other avenues have been opened up by the methods of neuroscience. Thus, Andrews, Schluppeck, Homfray, Matthews, and Blakemore (2002) found in an fMRI study that activation of the fusiform gyrus, a cortical area specifically involved in the perception of faces, was significantly increased whenever participants viewing Rubin's vase-face figure reported seeing the faces. Using a method of discontinuous stimulus presentation, Kornmeier and Bach (2004) found that event-related potentials (ERPs) following exogenous (i.e., physically unambiguous) and endogenous orientation reversals of the Necker cube were highly similar. Endogenous reversals affected ERPs as soon as 160 ms after stimulus onset, which suggested involvement of early visual processes.