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# A Symposium on the Role of Rhythm in Cognition

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Rhythm permeates human experience, such as in listening, performing or dancing to music, in speech communication, or in many other common activities such as walking, running, playing a game of tennis, etc. Although it is easy to agree that many human activities elicit a sense of rhythm, both in the perceiver and the performer, the functional role of rhythm in cognition is less clear. This symposium provides an open forum for psychologists, computer scientists, linguists, philosophers, and neuroscientists to present and discuss research that specifically targets the role of rhythm in cognition. A central question concerns to what extent it is necessary to include rhythm as part of a theory of cognition.

Typically, cognitive scientists have placed a much greater emphasis on how cognitive processing consumes time (e.g., processing load) than on how it is shaped by time. In this symposium, presentations by established cognitive scientists focus on how cognitive processing is shaped by time. Talks by Professor Mari Jones, Dr. Bill Baird, Professor Robert Port, and Professor Elliot Saltzman address the role of rhythm in cognition, targeting the overlapping areas of attention, music perception and performance, speech perception and production, sensorimotor control, and neural dynamics.

Mari Jones has proposed a central role for rhythm in cognitive processing, suggesting that the temporal organization of perception, attention, and memory is inherently rhythmic (Jones, 1976). As part of this theory, it is assumed that the rhythms of music and speech entrain (synchronize) periodic attentional "pulses", forming an attentional rhythm. According to this view, entrainment enhances perception, memory storage and retrieval, and sensorimotor control. This contrasts with theories of cognition that leave out rhythm entirely (Newell, 1990).

Bill Baird reports physiological evidence for attentional entrainment, supporting Jones' theory of a central role for rhythm in cognitive processing. He proposes a neural network model of rhythmic expectancy based on an earlier model of adaptive synchronization of 5-15 Hz and 30-80 Hz oscillations between cortical areas (Baird, Troyer, and Eeckman, 1994). He argues that this model can account for psychological data demonstrating that auditory scene analysis is sensitive to rhythm.

Robert Port targets the role of rhythm in auditory cognition, discussing rhythmic constraints on the types of sound patterns that humans learn. He argues that

entrainment is a fundamental tool in our basic toolkit for auditory pattern learning, including language. He reports research from his lab investigating the rhythmic constraints exhibited by subjects repeating a phrase in synchrony with a metronome (Port et al., 1996; Cummins and Port, 1996b). In spite of the substantial timing variability of speech, the results from these studies suggest that speech is easily entrained by an external stimulus and that entrainment is a fundamental tool in speech processing.

Elliot Saltzman reports the results from a series of studies investigating rhythmic pattern generation in speech production. In these studies, speakers repeatedly produce a rhythmic utterance, while systematic mechanical perturbations are delivered to the speakers' articulatory gestures. Perturbations delivered during a critical phase window are found to induce systematic steady-state shifts in the timing of coordinated gestures, suggesting that there is a central "clock" that drives the articulatory periphery and that this clock can be phase-reset by event-specific feedback. Saltzman argues that the phase-resetting results imply that the timing of articulatory gestures are governed by sets of oscillatory units and that during speech production these oscillators behave as non-linear, coupled, limit-cycle oscillators (Saltzman and Munhall, 1989).

In addition to the four presentations at the symposium, several other papers published in the proceedings address the role of rhythm in cognition, providing additional reading and references (see Cummins and Port (1996a), Large (1996), and McAuley (1996)).

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