Rhythm & Metre

How do Drummers Process Rhythm and Metre? a DC-EEG Study

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To tackle the question of how temporal information is processed in the brain, we examined the abilities of professional drummers to process rhythm and metre. Rhythm is defined by the temporal relationship of adjacent acoustic events, whereas metre is the perceived (or even existing) underlying pulse of a sequence of such events.

In a simple same-different paradigm musicians judged two subsequent temporally structured acoustic sequences, presented by computer soundcard and a stereo system. The second sequence was either unaltered, or in half the trials, changes were introduced in either rhythm or metre. Slow cortical potentials were recorded by means of a 62-channel EEG system.

In contradiction to recent findings in lesion studies performed on musically untrained stroke patients (Schuppert et al., 2000), no evidence for an involvement of left hemispheric cortical networks could be established for processing of rhythm. Instead, both temporal parameters, i.e. rhythm and metre, yielded a right frontotemporal increase in neuronal activity. This points to the significance of these areas in processing temporal structures in music, at least in professional musicians.

Swing and Groove: Contextual Rhythmic Nuance in Live Performance

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The existence of jazz "swing" rhythm, "groove" feel and the rhythmic tensions created by playing slightly ahead of or behind the beat has been recognised by musicians, teachers and music writers for some time. But the mechanisms of "swing" and "groove" have never been fully explained. Composers, arrangers, performers, record producers, musicologists and teachers all have a vested interest in understanding the subtleties and nuances of these elusive musical phenomena. There is a lot at stake. The appeal of much popular music is often linked to an intangible, undefined emotional response to a particular rhythm of one kind or another. This rhythm may possess a certain visceral attraction which defies conventional analysis in its simplicity, and yet loses its essential character if attempts are made to capture it in score.

This paper reports on an investigation of rhythmic nuance and accuracy in selected recorded performances of well-respected artists Dave Brubeck, James Brown's drummer Clyde Stubblefield, and Gene Krupa and Buddy Rich. Percussive note attack timings, marked on a graphic waveform display of sound, were used to evaluate relative note position within successive bars of the selected recorded performances. The analyses revealed small, yet consistent, timing discrepancies or rhythmic nuances in every recording, indicating that these nuances may play an important part in the individuality and musical appeal of these performances.

Non-Isochronous Accent Structures and Meter Perception

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Many pieces of music - in a wide variety of musical cultures and styles - exhibit structurally significant, yet non-isochronous, patterns of accentuation. Balkan folk music routinely exhibits non-isochronous accent structures, and such structures can be found in other musical forms as well, for example the 2+2+2+3 rhythmic structure of Dave Brubeck's 1959 recording *Blue Rondo al a Turk*. Typically, a rapid series of isochronous pulses underlies the non-isochronous level of rhythmic organization, and the non-isochronous level is made explicit through dynamic accentuation as well as melodic and harmonic patterning. Are such accent structures to be understood as patterns of phenomenal accentuation overlying a simpler, isochronous meter, or as non-isochronous levels of metrical structure? We took a theoretical approach to this question. Models of entrained oscillation have been successful at capturing the perception of isochronous metrical structures, but the basic assumption of oscillation itself would appear to preclude non-isochronous levels of structure. We asked: Is it possible for an oscillation-based model to capture the perception of a non-isochronous meter? We began with a recently proposed model of meter perception, adding a simple yet flexible model of internal coupling among oscillators. The coupling allowed multi-frequency entrainment in both integer and polyrhythmic ratios. Non-isochronous patterns of accentuation could be represented in the network, and under certain conditions, could be sustained after the stimulus ceased. The natural frequency ratio of oscillators recruited for non-isochronous structures matched those of related polyrhythmic ratios. This points to a relationship between polyrhythmic and non-isochronous meters. Our results have implications in distinguishing those musical surfaces that give rise to non-isochronous metrical perception from those that are heard as syncopations against an isochronous meter. They also demonstrate how our ability to construe complex rhythmic surfaces under more than one metric framework may relate to dynamic models of entrainment and attending.

Neurophysiological Correlates of Meter Perception: Evoked and Induced Gamma-Band (20-60 Hz) Activity

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Meter plays an important role in coordinating action and perception among musical participants by generating precise temporal expectancies for sound events. We used electro-encephalography to understand the manifestations of auditory rhythmic anticipation in brain activity on a millisecond time-scale. Subjects listened to simple monotonic patterns based on a western duple meter, defined by alternating intensity accents, with occasional missing tones at the strong and weak beats within the metrical cycle. In addition subjects listened to a metronome pattern and a duple alternating accent pattern with no missing tones. Gamma-band oscillations (20-60 Hz) began prior to both missing and presented tones. Induced (non-phase-locked) activity was constantly present and increased prior to the onset of expected tones. Presentation of a tone resulted in the immediate activation of evoked (phase-locked) activity, suggesting phase resetting of gamma-band oscillations by tone onsets. The amplitude of gamma-band activity was larger for intensity-accented tones. We propose these phenomena as correlates of metrical processing, possibly revealing a direct representation of temporal expectancy in cortical activity. This approach to meter perception may prove particularly useful for studying populations without explicit musical knowledge or without sufficient motor capabilities to perform behavioral experiments.