# Decrypt the groove: Audio features of groove and their importance for auditory-motor interactions

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When we listen to music we often experience a state that can be described as 'in the groove'. This state is characterized by the wish or even the urge to move our body to the musical pulse (Janata et al., 2012; Madison, 2006). A previous study showed that high-groove music modulates the excitability of the motor system, whereas no effect of low-groove music was found (Stupacher et al., 2013). But which musical qualities contribute to the feeling of groove? To answer this question, we extracted audio features of 80 song clips with similar instrumentation and correlated them with subjective groove ratings. Song clips and groove ratings of 19 participants were taken from Janata et al. (2012). The following features were extracted with Matlab's MIR toolbox (Lartillot & Toiviainen, 2007): RMS energy, spectral flux, sub-band flux, pulse clarity (*'MaxAutocor'* and *'Attack'*), and event density. Additionally we used the Genesis Loudness toolbox to compute measures of loudness using the loudness model of Glasberg and Moore (2002).

Results showed that groove ratings correlated positively (all *p*s < .01) with following audio features: RMS energy ($r$ = .37), RMS variability ($r$ = .57), pulse clarity 'attack' ($r$ = .38), spectral flux ($r$ = .34), sub-band flux of band 1 (0-50 Hz, $r$ = .29), and band 2 (50-100 Hz, $r$ = .29). Additionally, groove ratings correlated positively (all *p*s < .05) with band 3 (100-200 Hz, $r$ = .23), band 5 (400-800 Hz, $r$ = .23), and band 6 (800-1600 Hz, $r$ = .24). The mean loudness of song clips did not affect groove ratings.

Since energy in low frequency bands (Burger et al., 2012; Van Dyck et al., 2013), percussiveness (similar to pulse clarity 'attack'), and spectral flux (Burger et al., 2012) have previously been shown to affect motor movements, our results indicate that the experience of groove is a phenomenon predominantly based on auditory-motor interactions (cf. Janata et al., 2012; Stupacher et al., 2013).

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