Proceedings of the 12th International Conference on Music Perception and Cognition and the 8th Triennial Conference of the European Society for the Cognitive Sciences of Music, July 23-28, 2012, Thessaloniki, Greece
Cambouropoulos E., Tsougras C., Mavromatis P., Pastiadis K. (Editors)

From 'Wanting' to 'Liking': Listeners' Emotional Responses to Musical Cadences as Revealed by Skin Conductance Responses

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ABSTRACT

Background

Research on the emotional responses and brain activations evoked by music has been a topic of great academic and public interest. A recent brain-imaging study by Salimpoor et al. (2011) suggests the involvement of mechanisms for 'wanting' and 'liking' when subjects listened to intensely pleasurable music. Their paper elaborates the roles of the reward system in music listening, and its correlates to musical emotions.

It is widely reported that music influences listeners' emotional state. An emotional response can be related to an isolated musical event and/or the temporal structure of a music piece. In the past decades, physiological measures have been used to investigate the relationship between musical structures and listeners' emotional reactions. Skin conductance is one of the most commonly used response systems. There is a high correlation between bursts of sympathetic nerve activity and skin conductance responses (SCRs). An SCR is characterized by an abrupt increase of skin conductance and should be interpreted as arousal elevation. Music-induced chills are often accompanied by SCRs (Grewe *et al.*, 2007; Guhn *et al.*, 2007; Salimpoor *et al.*, 2009). An alternative method of quantifying SCRs focuses on their instantaneous slope (Blain *et al.*, 2008). Since a positive SCR slope reflects activity of sweat glands, the SCR slope may serve as an indicator of arousal.

Aims

The present study aims to explore the listening behavior of authentic cadences through combining music analysis and listeners' physiological measures. A cadence is "a melodic or harmonic configuration that creates a sense of repose or resolution" (Randel, 1999: 105). In Western classical music, important musical events were often marked by an authentic cadence, which is a progression from the dominant chord to the tonic chord. We hypothesize that cognition of the dominant chord and the following tonic chord may engage mechanisms for 'wanting' and 'liking', respectively. The associated experiences of peak emotion may be detected by measuring skin conductance.

Method

Participants' skin conductance was measured during music listening. In Experiment 1, we used 48 short music stimuli (<30 sec). In Experiment 2, we used long music stimuli, including complete popular songs (3-5 min) and excerpts of German art songs (Kunstlied) (50-100 sec). A moving window of 2 seconds was used to detect increases of skin conductance within this window. The SCR amplitude at the central point of this time window was the maximum increase within this window, and the instantaneous SCR slope was the first difference of the 10 Hz-sampling-rate SCR signal at this central point. Following Dawson et al. (2007), only supra-threshold SCRs were considered. We chose the thres-

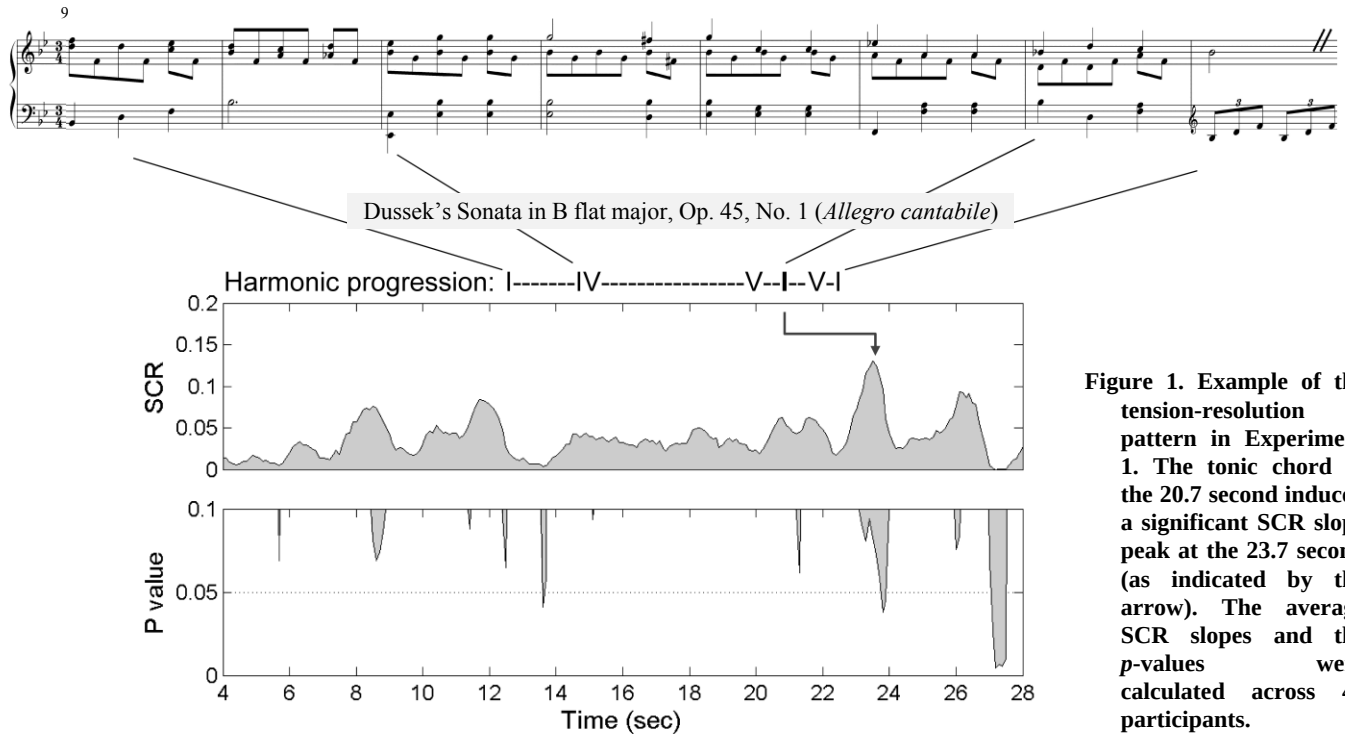

Figure 1. Example of the tension-resolution pattern in Experiment 1. The tonic chord at the 20.7 second induced a significant SCR slope peak at the 23.7 second (as indicated by the arrow). The average SCR slopes and the *p*-values were calculated across 41 participants.

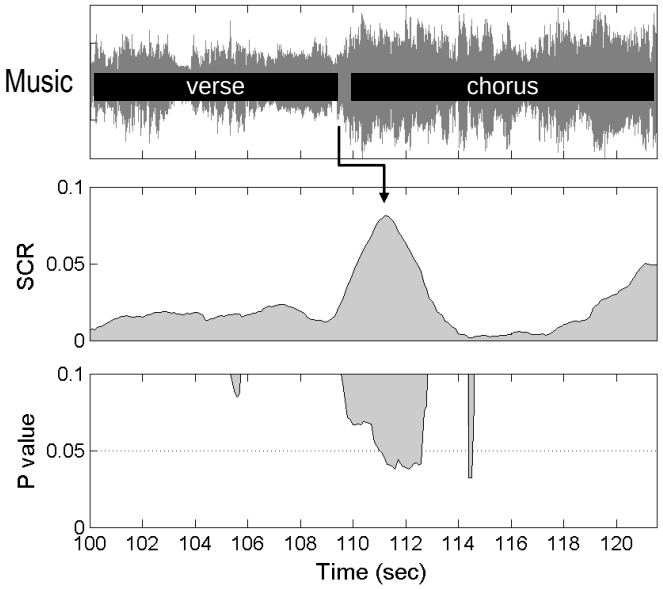

Figure 2. Example of the tension-resolution pattern in Experiment 2. The first verse-chorus progression in a popular song is associated with an authentic cadence. The dominant at the 109th second induced a significant SCR amplitude peak at the 111th second (as indicated by the arrow). A significant decrease of the SCR amplitude at the 114th second may be associated with the harmonic/thematic resolution. The average SCR amplitude and the *p*-values were calculated across 30 participants.

hold of SCR amplitude to be 0.01 microsiemens, and the threshold of SCR slope to be 0.01 microsiemens per second. Sub-threshold values were set to zero.

Because of the skewness of the SCR amplitude distribution, logarithmic transformation or square root transformation are commonly used for normalizing SCR data (Dawson et al. 2007). At each point of time, we transformed the SCR data of amplitude and slope into log(1+SCR) and averaged them across all participants, obtaining the time courses of average SCR amplitude and average SCR slope. We performed a paired *t*-test for each point of time of the SCR curve with the SCR of the baseline, to examine whether the SCRs were significantly different from the baseline. In Experiment 1, the baseline was chosen as at 1 second before the warning tone of the eighth (last) trial, because the SCR signals were relatively stable at this moment. In Experiment 2, the baseline was chosen as the 2-seconds interval around the lowest average SCR amplitude within the second chorus.

Results

We observed that some authentic cadences induced listeners' SCRs that were significantly different from the baseline ($p<0.05$). Figure 1 shows the music score, the average SCR slope, and the *p*-value curve of a tension-resolution pattern. The dominant-tonic cadence is preceded by a subdominant chord lasting for three bars (the 11-13 bars) and a high-pitched melody. These three bars may evoke a strong feeling of 'wanting' in listeners, thereby strengthening the 'liking' feeling when the tonic chord arrived. The SCR at approximately 3 seconds after the tonic chord might be related to the conjecture in Huron (2006), that a harmonic/melodic tension evoked a prediction of cadence, and the subsequent success of this prediction evoked a physiological reaction of SCR. The tension-resolution pattern in a popular song manifests in the verse-chorus progression (Figure 2). It is interesting to note that both examples showed a significant decrease in SCR after the authentic cadence.

Conclusions

If an authentic cadence is emphasized by an accumulated tension or the recurrence of a theme, listeners are likely to experience intense emotion of 'wanting' and 'liking'. Our results of average SCRs are consistent with the tension-resolution patterns in Western classical music (Meyer, 1956). Both the dominant chord and the tonic chord can evoke significant SCRs, with the latency being approximate 1.9 seconds. After the harmonic/thematic resolution, a significant decrease in skin conductance can be observed (4-6 seconds after the tonic chord).

To take into account ecological validity, we selected musical stimuli from commercial CDs. Because there were considerable technical difficulties with manipulating musical features in these stimuli, we did not alter these stimuli except for cutting and volume-normalization. This lack of systematic manipulation limited our interpretation of SCR-inducing musical events and the underlying cognitive/emotional processes. Future experiments should involve a systematic manipulation of musical parameters so as to be able to assess their contribution to the chill-response or SCR.

Keywords

Cadence, Reward system, Tension-Resolution Pattern, Skin Conductance

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