

# How Does Music Arouse “Chills”?

## Investigating Strong Emotions, Combining Psychological, Physiological, and Psychoacoustical Methods

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**ABSTRACT:** Music can arouse ecstatic “chill” experiences defined as “goose pimples” and as “shivers down the spine.” We recorded chills both via subjects’ self-reports and physiological reactions, finding that they do not occur in a reflex-like manner, but as a result of attentive, experienced, and conscious musical enjoyment.

**KEYWORDS:** emotion; chill; music

Music can arouse extraordinarily strong emotional responses, even up to ecstatic “chill” experiences. 1–3 Such strong psychological reactions are often accompanied by measurable bodily reactions, such as goose pimples or shivers. Because emotional states can change over the course of a piece of music, it is necessary to measure psychological and bodily reactions continuously. To investigate distinct musical events related to chill reactions, we combined psychological, psychoacoustical, and physiological methods.

### METHODS

We asked 38 subjects to press a mouse button whenever they experienced a chill while listening to music. A selection of seven pieces from different musical styles was used for all subjects. Additionally, subjects were asked to bring 5 to 10 “personal” pieces of music that regularly induced strong emotions. All kinds of musical styles were accepted. The subjects’ mean age was 38 (SD, 16), with a range of 11 to 72 years. Subjects had different musical experiences and education.

Pressing of the mouse button was recorded simultaneously to the music. The mere pressing of the mouse button did not influence skin conductance response.

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Within the whole piece, musical events that triggered chills could thereby be identified with an accuracy range of ~5 seconds. After each piece of music, subjects completed a questionnaire regarding their knowledge of the piece and perceived bodily reactions.

Chills had to fulfill three criteria: (1) pressing of the mouse button; (2) a measurable skin conductance response; and (3) report of goose pimples or shivers down the spine indicated on the questionnaire.

After the experimental session, subjects answered further questions concerning their musical taste and experience, and completed three standardized personality inventories. 4–6 Psychoacoustical parameters of the stimuli were analyzed using dBsonic software.

To check for the reproducibility of our results, we repeated the same experiment with one female musician (a 24-year-old soprano) on seven subsequent days. Conditions were kept as stable as possible.

### RESULTS

Chills are rare events. A maximum of 8 out of 37 subjects had chills within the same piece of music. Chills do not occur interindividually as a deterministic response to a single musical event. Chills occurred mainly during defined semantic musical structures. Subjects with an extremely high number of chills exhibited differences in character and musical experience as compared with subjects with no chill reactions. Changes in loudness seem to have an influence on chill events.

Here, we present an example from the retest experiment. Figure 1 shows all chill reactions to the fourth movement (“Urblicht”) of Gustav Mahler’s Symphony No. 2.

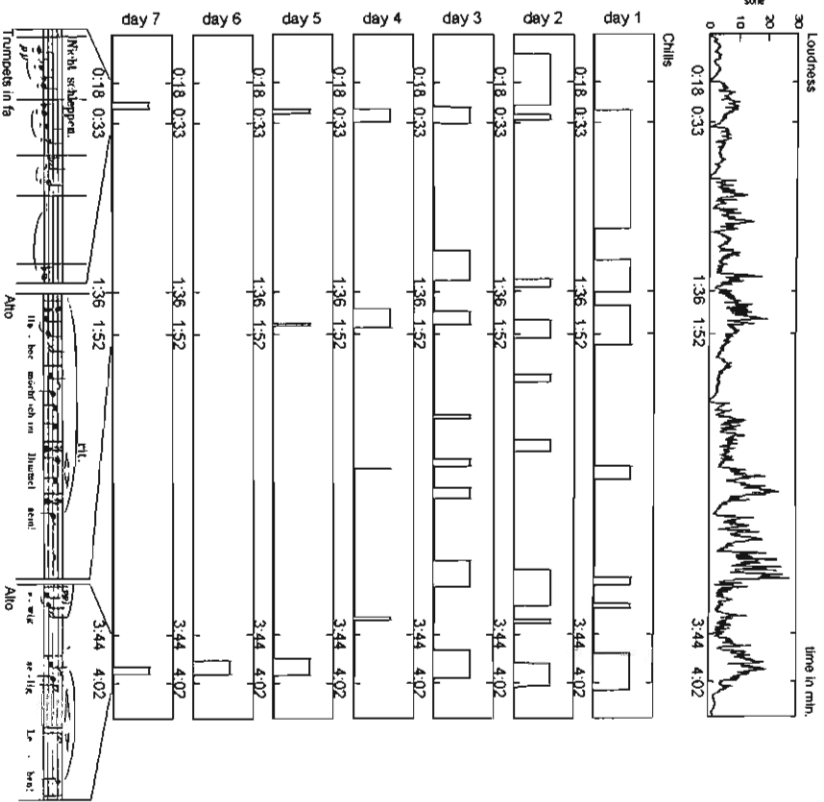
Three musical excerpts are presented for the three parts of the piece where chills occurred repeatedly on 5 to 6 days. Each shows a highly similar musical motive repeated throughout the movement in different voices of the orchestral score (trumpets, alto [human voice]). This motive does not occur at other times during the movement. Mahler indicated “espressivo” in the score when the motive is performed in the alto voice. Additionally, he specified a small crescendo, that is, an increase in loudness, in two of the three excerpts. The change in loudness can also be seen in the psychoacoustical loudness analysis.

The three excerpts are very similar because of their musical structure. They are three harmonic variances of the same motive, all being a V-I or V-I sequence. The first two excerpts finish in G-flat major, the dominant; the last example is the final resolution [closing] on the tonic, D-flat major.

The psychoacoustical time series analysis reveals strong changes in loudness for all three excerpts, but also at points in time that stimulate less stable or no chills. In the questionnaires, the subject mentioned that excerpts 1 and 3 were extraordinarily pleasant.

### DISCUSSION

The preliminary results presented here reveal evidence that strong emotions in response to music are related to structural musical elements. These can partially



**FIGURE 1.** Chills are related to structural musical elements and changes in loudness. Example: Mahler, Symphony No. 2, "Urlicht." The experiment was repeated for 7 days with one subject. Chills are presented for each day as time series for the duration of the piece. Chills are presented as bars, and the length reveals how long the mouse button was pressed. The loudness time series analysis is shown in the *upper panel*. All data are synchronized. The musical parts related to chills occurring on 5 or more days are presented as excerpts of single voices from the score. The excerpts last from 0:18 to 0:33, 1:36 to 1:52, and 3:44 to 4:02, respectively. The whole piece lasts 4:17 minutes.

be described psychoacoustically; a distinct chill-triggering acoustical pattern could not be found, though. Important musical factors seem to be harmonic sequences,<sup>3</sup> the entrance of a voice, and the beginning of a new part, that is, a violation of expectations.<sup>8,9</sup> Even if chills do not interindividually occur as a deterministic response to a single acoustical trigger, in single individuals, chills can be stable responses to distinct musical structures. Subjects often report the musical structures related to chills as being extraordinarily pleasant. On the basis of these results, we hypothesize that strong emotions in response to music do not occur in a reflex-like manner, but as a result of attentive, experienced, and conscious musical enjoyment.

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