

Chills As an Indicator of Individual Emotional Peaks

Oliver Grewe,^a Reinhard Kopiez,^b and Eckart Altenmüller^a

^a*Institute of Music Physiology and Musicians' Medicine, and* ^b*Institute for Research in Music Education, Hanover University of Music and Drama, Hannover, Germany*

Chills (goose bumps) have been repeatedly associated with positive emotional peaks. Chills seem to be related to distinct musical structures and the reward system in the brain. A new approach that uses chills as indicators of individual emotional peaks is discussed. Chill reactions of 95 participants in response to seven music pieces were recorded. Subjective intensity as well as physiological arousal (skin conductance response, heart rate) revealed peaks during chill episodes. This review suggests that chills are a reliable indicator of individual emotional peaks, combining reports of subjective feelings with physiological arousal.

Key words: emotion; chill; music; physiology

All in all, the creative act is not performed by the artist alone; the spectator brings the work in contact with the external world by deciphering and interpreting its inner qualification and thus adds his contribution to the creative act.

—Marcel Duchamp,
Session on the Creative Act,
Convention of the American Federation of Arts,
Houston, Texas, April 1957

The last years have seen an increasing number of studies examining the so-called chill phenomenon. After Goldstein, in the beginning of the 1980s, introduced chills or thrills as indicators of strong and positive emotions, Sloboda and Panksepp presented some pioneering work during the 1990s about chills in response to music.¹⁻⁴ In the last years more and more researchers started to use chills as a parameter in studies concerned with emotional reactions to music.⁵⁻⁹ What is it that makes this phenomenon interesting for an increasing number of scientists?

Chills are a pleasant experience of an emotional peak and are regularly perceived in re-

sponse to music.^{1,2} Whereas it is not clear whether subjectively reported feelings and objectively measured physiological reactions do synchronize during emotional episodes,¹⁰⁻¹² chills, in contrast, seem to consist in a strong feeling response combined with a measurable bodily reaction: goose bumps elicited by the peripheral nervous system. Chills can be reported via a simple button press and are, in contrast to emotion terminology, easily defined. The results presented by Rickard suggested that the skin conductance response (SCR) and chills are the best indicators of strong emotional responses, compared to skin temperature, heart rate (HR), level of cortisol, and other standard measurements.⁹

In this short review, we would like to show that chills might have an even higher potential: Chills might be used as an indicator of individual emotional peaks.

Can Emotions Be Triggered?

One major difficulty of research is that positive emotions are difficult to trigger. There are various stimuli that make people happy, but for a systematic analysis of the phenomenon

Address for correspondence: Oliver Grewe, Institute of Music Physiology and Musicians' Medicine, Hanover University of Music and Drama, Hohenzollernstrasse 47, 30161 Hannover, Germany. Voice: 0049-511-3100-552; fax: 0049-511-3100-557. Oliver_Grewe@gmx.de

“happiness,” it would be helpful to trigger “happiness” in response to the same stimulus in many people. Music was used in some studies as such a trigger.¹³ However, some voices have doubted that distinct emotions can be elicited by music at the same time in different listeners.¹² If we distinguish between utilitarian and aesthetic emotions, it seems obvious that strong positive aesthetic emotions are usually perceived in response to highly individually selected stimuli.¹⁰ One solution for a systematic analysis might be to focus on individually occurring emotional peaks. This strategy needs, of course, a good argument that emotional peaks perceived in response to individual stimuli are nevertheless the same or at least highly similar compared to emotional peaks perceived by other participants. Thus, reliable indicators of the individual occurrence of comparable positive emotional peaks are needed for the analysis of the underlying physiological and neurologic correlates of these events. We hypothesize that chills can be used as such an indicator.

Individual Reactions to Music—The Chill

Previous studies demonstrated that chills can be repeated in response to the same musical event over several days in one individual.^{12,14} However, they cannot be triggered reliably in different individuals in response to the same musical stimulus.¹⁵ In a recent experiment a new approach was tested.¹⁶ Chill samples of 95 listeners in response to seven musical pieces of Mozart, Bach, and Puccini were collected. Instead of using the music as the independent variable, the individual chill responses were selected and merged. Subjective as well as physiological emotion components occurring during the chill episodes were analyzed. Ratings of the intensity of subjective feelings were recorded and synchronized to measurements of SCR and HR in the range of milliseconds. Samples of the responses in intensity of feeling, SCR, and HR corresponding to the chills were cut out of the

data from 10 s before to 10 s after the chill. A random permutation test allowed comparing the chill samples to random nonchill samples second-per-second.¹⁷ Chill samples were related to significantly higher responses in subjective feeling component (intensity of feeling ratings) as well as the physiological arousal component (SCR, HR) of emotion compared to control nonchill samples (Fig. 1). Furthermore, chills were reported by participants of both genders, of all ages, and with virtually all levels of musical education. The influence of familiarity with the stimulus was tested in detail, confirming that familiarity with a certain piece has a strong impact on the frequency, and that, at the same time, a more intimate knowledge of the piece does not increase the number of chills significantly.

Summary

Conventional, directly stimulus-related evaluation of self-report and physiological measurements led to incongruent results. No synchronization or clear relation between psychological and physiological reactions could be found.^{11,12,18,19}

However, when individual chill experiences are evaluated, a strong and synchronized relationship between the intensity of subjective feelings, SCR, and HR could be stated. These individual events have no longer a direct relation to a defined stimulus pattern identical for all participants. Thus, the question arises whether the comparability of the collected reactions can be assumed.

Chills are defined as goose bumps and shivers, a definition that can hardly be misunderstood. Participants might disagree on the intensity of a perceived shiver that causes them to press the button, but hardly on the reaction itself. It can be assumed that a reaction as simple as goose bumps is comparable between individuals. Moreover, Blood and Zatorre could demonstrate that neuronal circuits corresponding to networks activated during

Chill Samples vs. Random Nonchill Samples

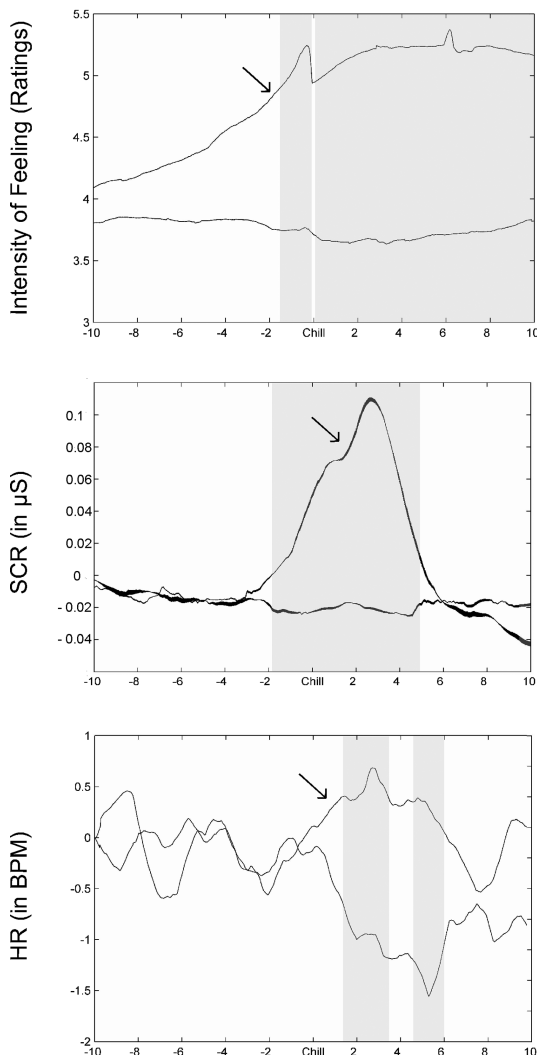


Figure 1. Comparison of 622 chill samples (upper line marked with arrow) with 622 random nonchill samples (lower line). Gray shaded areas indicate significant differences (Random Permutation Test). (From Grewe *et al.*¹⁶ Reproduced by permission.)

sex, food intake, and drug abuse are activated during chill episodes.⁵ This means, on the one hand, that it is probable that chills are correlates of a common neuronal activation pattern which is comparable between different individuals. On the other hand, it further demonstrates the strong relation between chills and positive

emotional peaks. This last relationship is also supported by the early results of Goldstein,³ who showed that chills could be suppressed by the specific endorphin antagonist naloxone.

Conclusion

Chills are without question not the only tool to deal with some of the many difficulties in music and emotion research. A lot of challenges will have to be overcome before chills becomes a useful paradigm. However, chills demonstrate that it is possible to cope with individual responses in a controlled and objective way. Chills are one example of objective indicators that help to study responses that cannot simply be triggered in a reliable stimulus-response way and consequently offer a new perspective in emotion research.

Acknowledgments

This work was supported by the DFG (Al 269-6) and the Centre for Systemic Neurosciences, Hannover. Some of the results shown here are presented in more detail in a manuscript submitted elsewhere.¹⁶ We would also like to acknowledge the work of our trainees Benedikt Zöfel, Kristina Schmidt, and Björn H. Katzur. Finally, we applied the FLAE approach for the sequence of authors.

Conflicts of Interest

The authors declare no conflicts of interest.

References

1. Panksepp, J. 1995. The emotional sources of “chills” induced by music. *Music Percept.* **13**: 171–207.
2. Sloboda, J.A. 1991. Music structure and emotional response: some empirical findings. *Psychol. Music* **19**: 110–120.
3. Goldstein, A. 1980. Thrills in response to music and other stimuli. *Physiol. Psychol.* **8**: 126–129.
4. Panksepp, J. & G. Bernatzky. 2002. Emotional sounds and the brain: the neuro-affective foundations

- of musical appreciation. *Behav. Process.* **60**: 133–155.
5. Blood, A.J. & R.J. Zatorre. 2001. Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion. *Proc. Natl. Acad. Sci. USA* **98**: 11818–11823.
 6. Craig, D.G. 2005. An exploratory study of physiological changes during “chills” induced by music. *Musicae Scientiae* **9**: 273–287.
 7. Konecni, V.J. 2005. The aesthetic trinity: awe, being moved, thrills. *Bull. Psychol. Arts* **5**: 27–44.
 8. McCrae, R.R. 2007. Aesthetic chills as a universal marker of openness to experience. *Motiv. Emot.* **31**: 5–11.
 9. Rickard, N.S. 2004. Intense emotional responses to music: a test of the physiological arousal hypothesis. *Psychol. Music* **32**: 371–388.
 10. Scherer, K.R. 2004. Which emotions can be induced by music? What are the underlying mechanisms? And how can we measure them? *J. New Music Res.* **33**: 239–251.
 11. Cacioppo, J.T., D.J. Klein, G.G. Berntson & E. Hatfield. 1993. *The Psychophysiology of Emotion*. Guilford. New York.
 12. Grewe, O., F. Nagel, R. Kopiez & E. Altenmuller. 2007. Emotions over time: synchronicity and development of subjective, physiological and mimic affective reactions to music. *Emotion* **7**: 774–788.
 13. Juslin, P.N. & J.A. Sloboda. 2001. *Music and Emotion*. Oxford University Press. New York.
 14. Grewe, O., F. Nagel, R. Kopiez & E. Altenmuller. 2005. How does music arouse “chills”? Investigating strong emotions, combining psychological, physiological, and psychoacoustical methods. *Ann. N. Y. Acad. Sci.* **1060**: 446–449.
 15. Grewe, O., F. Nagel, R. Kopiez & E. Altenmuller. 2007. Listening to music as a re-creative process: physiological, psychological and psychoacoustical correlates of chills and strong emotions. *Music Percept.* **24**: 297–314.
 16. Grewe, O., F. Nagel, R. Kopiez & E. Altenmuller. 2009. The chill parameter: goose bumps and shivers as promising measures in emotion research. *Music Percept.* In press.
 17. Good, P. 1994. *Permutation Tests: A Practical Guide to Resampling Methods for Testing Hypothesis*. Springer. New York.
 18. Etzel, J.A., E.L. Johnsen, J. Dickerson, D. Tranel & R. Adolphs. 2006. Cardiovascular and respiratory responses during musical mood induction. *Int. J. Psychophysiol.* **61**: 57–69.
 19. Gomez, P. & B. Danuser. 2007. Relationships between musical structure and psychophysiological measures of emotion. *Emotion* **7**: 377–387.