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When and Where are Chills Induced in Musicians?

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ABSTRACT

The aim of this study was to explore how chills are induced in musicians, modelled on the recent study conducted by Bannister (2018). Current relationships under investigation include the link of chills with musical features such as crescendos, social communion and personality traits. This study used an online survey to collect qualitative and quantitative data from musician and non-musician participants (n = 29), using two-minute musical excerpts to assess chills responses. The findings from this study suggest that musicians had a greater number of chills and a higher intensity of self-reported chills versus non-musicians. Further research is needed to understand the reasons and causes behind this difference in response between the musician and non-musician groups.

1. INTRODUCTION

The phenomenon of 'musical chills' has been widely discussed and examined within the field of music psychology, particularly within the last two decades. The experience of chills and the intersection between chills responses, aesthetic experiences (Konečni et al., 2007), personality traits (Colver and El-Alayli, 2016; McCrae 2007), social environment (Seibt, 2017) and listening contexts has been variously explored in the contemporary empirical literature.

One such study is that conducted by Bannister and Eerola (2018), wherein the authors claim that the evidence regarding chills thus far in the literature is correlational, and therefore further experimental investigation is needed. The study identified predefined 'chills sections' within three existing pieces (Glósóli by Sigur Rós, Jupiter by Gustav Holst, and Ancestral by Steven Wilson), removed these chills sections and spliced the remaining sections together using cross-fading techniques, and played these to listeners using a repeated-measures, pseudo-randomised design. The authors' main hypothesis proposed that the pre-identified chills sections in the three musical stimuli would result in more chills experiences and stronger emotional responses compared to other notable moments in the piece; in other words, by removing the chills section, the frequency of chills experienced across listeners would be reduced.

Limitations of Previous Studies. Although the study by Bannister and Eerola (2018) is beneficial due to its experimental nature (in contrast to the correlational nature of most literature surrounding the chills phenomenon), there are certain ways in which the study could be improved upon. With regards to the sample, the recruitment method, educational background and information on ethnicity are omitted, which may make applying the results of this study to a more diverse population difficult. Further studies may wish to employ a statistically diverse sample for greater generalisation. One question which is important to consider is whether the manipulation of the stimuli, even with careful cross-fading techniques and a pilot test, can accurately represent the ways in which listeners might experience music in their daily lives, which may have an implication for the applicability of the study to wider listening contexts; a field-based experiment may prove a useful alternative for further study. The authors' use of skin conductance measures is only a general indicator of emotional arousal and in future studies more accurate measures such as functional magnetic resonance imaging (fMRI) may be used. The central limitations which the authors highlight include the verification problem; as skin conductance was the only objective measurement, the chills response was not fully confirmed, alongside possible confounding effects of fatigue using long (5-8 minute) extracts and the broad nature of the authors' musical manipulations. Possible avenues for exploration and consolidation of these findings could include investigating the ways in which chills might be verified in laboratory settings (e.g. using fMRI, nerve conduction tests and brain scans) and targeting more specific musical or psychoacoustic features (Bannister and Eerola, 2018).

Music and Chills Research. In a similar study, Grewe et al. (2005) examined the ways in which music arouses chills in listeners. Using 38 participants and 7 pieces from different musical styles (as well as 5-10 "personal" pieces which the participants were asked to bring to the experiment), the authors aimed to examine what characteristics of music specifically induced 'chills'. The authors found that only a maximum of eight out of 37 participants experienced chills to the same piece, changes in loudness were linked to chills, and subjects with a higher number of chills exhibited differences in character and experience, compared with subjects who experienced no chills (as reinforced by the personality and chills studies of Colver and El-Alayli, 2016, and McCrae, 2007).

As with the study by Bannister and Eerola (2018), there are aspects of this study by Grewe et al. (2005) which may be further explored and improved in future research. With regards to the pariticpant sample, the author states that the participants had different musical and educational experiences, but does not expand on this point further; this is unfortunate as the sample characteristics and recruitment process remain vague, creating difficulties with assessing the diversity and wider applicability of the sample. Future studies may wish to select larger populations to examine the chills phenomenon across a more diverse and representative demographic data set. Moreover, chills in participants were required to fulfil three criteria: 1) pressing of a mouse button to signal a perceived chill; 2)

measurable skin conductance response; and 3) self-report of 'goosebumps' or 'shivers' down the spine (Grewe et al., 2005). Given the wide variability of skin conductance responses (Bannister and Eerola, 2018) and the subjective experience of the chills response in many cases (Colver and El-Alayli, 2016; Konečni et al., 2007; Seibt, 2017), this narrow criterion may unnecessarily omit relevant chills experiences from the analysis. Future studies, therefore, may wish to take a broader approach towards chills and examine these experiences as a socio-cultural and often personal experience beyond narrow experimental criteria.

2. REPLICATION STUDY

With this context in mind, the present study aims to explore how chills are induced and experienced in musicians versus non-musicians using a survey approach. This research is based on the study "*A Survey into the Experience of Musically-Induced Chills: Emotions, Situations and Music*" by Bannister (2018). In the original study, Bannister used a survey collecting qualitative responses regarding specific experiences of musical chills from 375 participants, as well as quantitative ratings of music qualities and mechanisms. Bannister's study concluded that chills are often experienced in mixed and moving emotive states and that certain musical features were linked to chills, namely crescendos, the human voice, lyrics and concepts of unity and communion. Bannister's findings therefore reinforce the findings of existing literature regarding the importance of crescendos (Grewe et al., 2005) and social communion (Seibt, 2017).

Whilst this research project replicates Bannister's study, it is distinct due to its focus. This study will explore whether being a musician or not affects susceptibility to the chills phenomenon, and if familiarity affects the induction of chills. This focus on the response of musicians will be enabled by using a non-musician control group. This study therefore will explore the chills response of both musicians and non-musicians when exposed to musical stimuli and will aim to interpret the situations in which these chills occur, and to assess the implications of this study for our future understanding of the chills phenomenon in the context of contemporary music psychology literature. For this study, it is hypothesised that musicians will have a greater number of chills and higher chills intensity versus non-musicians.

3. METHODS

Study Design. As with Bannister's 2018 study, this study employed an online survey to collect data regarding chills in both musicians and non-musicians. The survey platform used was Online Surveys and the survey was circulated informally to friends and classmates via the social media website Facebook.

Participants. The survey received a total number of 29 responses. The age range of the population was 18-30 (M = 24), reflecting the overall age of the Durham University student population. The gender distribution was 18 males, 10 females and 1 non-binary. With regards to musicianship status, 75.9% of respondents self-identified as musicians whilst 24.1% did not. Of the sample, 17.2% studied music as a degree. The most common frequency of musical practice was 'every few days' (37.9%), followed by not applicable/not a musician (17.2%).

Stimuli. Four pieces were chosen from four distinct genres and eras: The Baroque period, the Classical period, the Romantic period, and the Popular music genre. This was to capture a wider spread of musical experience and tastes, as well as to control for familiarity, given that an individual would be less likely to have the same extent of familiarity across varied genres than within a single genre. Moreover, the selected pieces were chosen to range in popularity from very familiar (Coldplay's Fix You) to largely unfamiliar (Rachmaninoff's Symphony No. 2, Mvt. III), further controlling for familiarity.

The specific pieces were chosen via informal self-reported experiences of chills from members of the Durham University music department in response to these chosen pieces. The pieces consisted of:

Bach's *Double Concerto For 2 Violins, Strings, And Continuo in D Minor, BWV 1043 - 2. Largo ma non tanto*

Mozart's *Sonata No. 17 in B-Flat Major, K570: I. Allegro*

Rachmaninoff's *Symphony No. 2 in E Minor, Op. 27: III. Adagio*

Coldplay's *Fix You*

Each researcher for this project listened to the four extracts and selected the time frames ('timestamps') which elicited the greatest emotional response. These were then chosen as the start and end points of the two-minute musical extracts used as stimuli.

Task. To control for musical preferences, the STOMP scale (Short Test of Musical Preferences) was used (Rentfrow and Gosling, 2003). Before each excerpt, a (1-5 unipolar) familiarity scale was employed. Participants were asked to describe if they had chills (yes or no), note any moments where chills occurred, describe the emotional experience qualitatively, mark the chills intensity on a unipolar (1-7) scale, and note if they experienced any physical sensations from the possible options: Coldness, warmth, frowning, smiling, goosebumps, tears, lump in throat, and tingling. The musical extracts were all two minutes in length and were embedded as short YouTube clips with predetermined start and end points.

At the end of the survey, participants were asked whether they had experienced chills with any other pieces, and to list them if so. By means of conclusion, participants were also asked whether they had anything else to add. The survey was completed with a debriefing section and statement of the study's aims and hypothesis.

4. RESULTS

Overall, the study's findings supported the hypothesis that musicians would have a greater chills response versus non-musicians. With regards to familiarity, the Romantic extract was the most unfamiliar, with 55.2% of participants reporting that they were completely unfamiliar with the piece by marking this as 'never heard it before' on a unipolar familiarity rating scale after listening to the extract. This was followed by the Classical excerpt at 51.7%, the Baroque extract at 37.9% and the Popular extract which was by far the most familiar with only 3.4% of participants being very unfamiliar with the piece (see Figure 1).

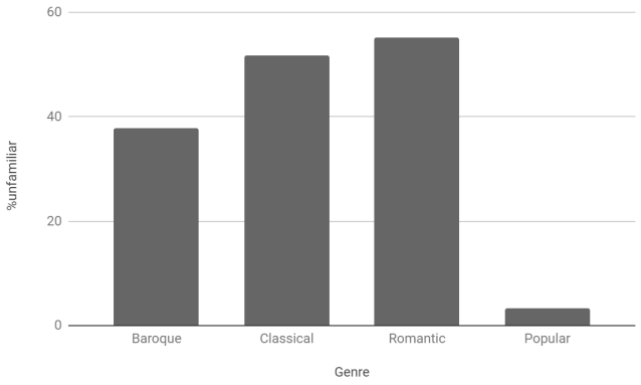

Figure 1. Percentage of participants who reported themselves as unfamiliar with the extract by genre ('never heard it before')

The percentage of participants who reported experiencing chills also varied by genre. The extract with the highest percentage of reported chills was the Romantic extract (69%) followed closely by the Popular extract (65.5%). The figures were comparatively less for the Baroque and Classical extracts, with 34.5% and 27.6% respectively (see Figure 2).

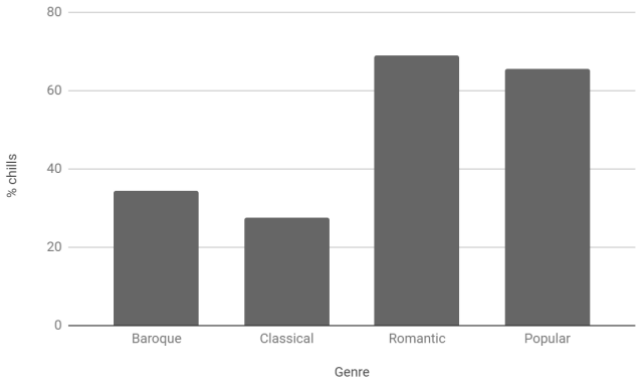

Figure 2. Percentage of participants who reported experiencing chills in response to the extract by genre

Data Analysis of Chills. As predicted, the total number of reported chills was greater in musicians than in non-musicians. From the total of 22 musicians (including 2 participants who reported no chills), the self-reported chills intensity ratings for each participant was added (with no chills = 0). The mean number and intensity rating of the self-reported chills was greater in the musician (8.227) versus the non-musician group (4.572). This data therefore supports the hypothesis that musicians have a greater average frequency of reported chills in comparison to non-musicians (see Figure 3).

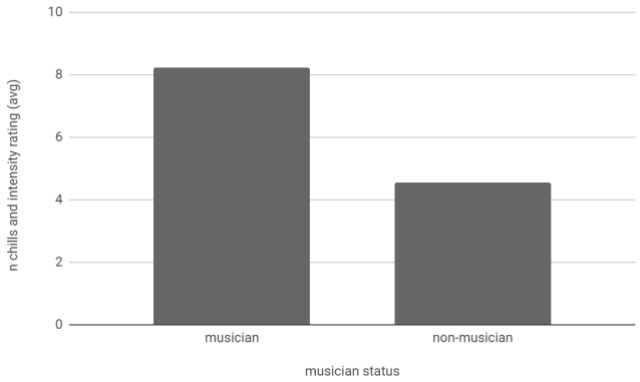

Figure 3. Average number of chills across musician status

Further statistical analysis revealed interesting information regarding the self-reported physiological and qualitative responses reported by participants. For the Baroque extract, the most common physiological responses were warmth (41.4%) followed by smiling (31%) and coldness (27.6%). For the Classical extract, the most common physiological responses were smiling (45%), followed by warmth (35%) and coldness (20%). In the case of the Romantic extract, feelings of warmth predominated (43.8%), followed by goosebumps (31.3%) and coldness (25%) (see Table 1).

Table 1. Most Commonly Reported Physiological Responses by Genre

Genre	**Most common physiological responses**
Baroque	Warmth (60%), Smiling (45%), Coldness (40%)
Classical	Smiling (60%), Warmth (46.7%), Coldness (26.7%)
Romantic	Warmth (56%), Goosebumps (40%), Tingling (32%)
Popular	Warmth (56%), Smiling (48%), Tingling (36%)

Qualitative Data Analysis. Qualitative data provided by participants also gave an insight into the overall mood produced by the four extracts, as well as moments in the pieces where chills were most commonly identified. For the Baroque extract, the most commonly identified moment for eliciting chills was the beginning (22.2% of responses). In the Classical extract, this was the loudest point of the piece where forte chords are used prominently (57.14%), whilst in the Romantic and

Popular extracts this is at the beginning of the extract where crescendos are used (72.2%) and at the climax of the song where the instrumental interlude appears (62.5%) respectively (see Table 2).

Table 2. Most Commonly Identified 'Chills-Inducing' Moments by Genre and Corresponding Percentage of Participant Responses Highlighting these Moments

	Baroque	**Classical**	**Romantic**	**Popular**
Most commonly identified 'chills-inducing' moment	Beginning of extract	Loudest point where forte chords appear	Beginning of extract where crescendos are used	Climax of the song; interlude
Percentage of participant responses	22.2% (2/9 responses)	57.14% (4/7)	72.2% (13/18)	62.5% (10/16)

The overall mood of the extracts could also be identified by examining the content of participants' self-reported emotional responses. In the case of the Baroque and Classical genres, the overall feeling provoked by the extract as reported by participants was a feeling of calm, relaxation and pleasantness (52.38% of responses to the Baroque extract; 50% Classical). For the Classical extract, participants noted that this elicited a pleasant experience, but did not evoke any strong emotions. By contrast, the Romantic and Popular genres produced more strongly evocative feelings, with the Romantic extract producing dramatic and uplifting feelings (72.2%), and the Popular genre eliciting feelings of nostalgia and reflection (50%) (see Table 3).

Table 3. Overall Feeling Provoked by the Extract as Reported by Participants and the Percentage of Participant Responses who Referred to these Feelings

	Baroque	**Classical**	**Romantic**	**Popular**
Overall reported feeling provoked by extract	Calm and relaxing	Pleasant	Dramatic, uplifting	Nostalgic, reflective
Percentage of participant responses	53.38% (11/21 responses)	50% (8/16)	72.2% (13/18)	50% (11/22)

5. DISCUSSION

In summary, the data provided by a statistical analysis of the survey from this study supports the original hypothesis that musicians would have a greater and more intense chills response than non-musicians. In general, the results of this study supported Bannister's observations that chills are emotive responses linked to specific musical features (2018). Within the context of broader research in music psychology, this study is novel because of its focus on musicians by contrasting with a non-musician control group.

There are many possible reasons for this heightened chills phenomenon in musicians. It is possible, on the one hand, that musicians were simply more able to articulate their responses to music and identify their responses correctly as chills versus non-musicians. This may be reinforced by the presence of musically-coded language in some responses, such as the response 'anger at uncorrected intonation issues' directed towards the Baroque extract, where a non-musician is unlikely to have an awareness of intonation issues within an extract. In other words, musicians may simply be better at identifying and expressing their chills response in concrete terms. As Colver and El-Alayli (2016) hypothesise, individuals who score highly on the Openness to Experience personality trait are more cognitively aware of new experiences and are emotionally primed, and thus experience stronger emotions; it is therefore possible that musicians are similarly primed through experience and possess a heightened cognitive awareness to expect emotionally-moving stimuli. There may also be an inherent tendency in musicians to be more sensitive towards chills due to differences in neurobiology, such as differences in corpus callosum brain structure (Schlaug et al., 1995) that cannot be explained merely by increased experience or training relative to non-musicians.

It is important to note, however, that there are current limitations to the findings of the study. The sample size of 29 participants, whilst consistent with the literature in general (Bannister and Eerola, 2018) could be larger and more diverse. The study only considered Durham University students and as a result had a limited age range across participants (18-30), as well as having implications with regards to the "Educated" and "Industrial" components of WEIRD (white, educated, industrialized, rich and democratic) sampling. The data therefore may not be sufficiently diverse to generalise empirical results to wider populations. Future studies could collect larger samples of data using survey methods to capture a broader cross-section of society and render the results more generalisable.

Implications for Further Research. The current study only assessed four chosen extracts from Western music and future research could explore non-Western genres as well as more obscure genres for broader results. As this study is correlational and survey-based rather than experimental, it is not possible to definitively describe the causes of greater 'chills' in musicians as explored in this study. Future studies, therefore, could design experimental methods of assessing the reasons behind why, according to this data, musicians may appear to have a higher number and self-reported intensity of chills responses, and what implications this may have for future research.

REFERENCES

Bannister, S. 2018. 'A Survey into the Experience of Musically-Induced Chills' *Psychology of Music*: 1-18. Doi: 10.1177/0305735618798024.

Bannister, S., and Eerola, T. 2018. 'Suppressing the Chills: Effects of Musical Manipulation on the Chills Response' *Frontiers in Psychology*, 9: 2046. Doi: 10.3389/fpsyg.2018.02046.

Colver, M., and El-Alayli, A. 2016. 'Getting Aesthetic Chills from Music: The Connection between Openness to Experience and Frisson'. *Psychology of Music*, 44/3: 413-427. Doi:10.1177/0305735615572358.

Grewe, O., Nagel, F., Kopiez, R., and Altenmüller, E. 2005. 'How does music arouse "chills"? Investigating strong emotions, combining psychological, physiological, and psychoacoustical methods'. *Annals of the New York Academy of Sciences*, 1060: 446–49. Doi:10.1196/annals.1360.041.

Konečni, V., Wanic, R., and Brown, A. 2007. 'Emotional and Aesthetic Antecedents and Consequences of Music-Induced Thrills'. *The American Journal of Psychology*, 120/4: 619–43. doi:10.2307/20445428.

McCrae, R. 'Aesthetic Chills as a Universal Marker of Openness to Experience'. *Motivation and Emotion*, 2007. 31/1: 5-11. Doi:10.1007/s11031-007-9053-1

Rentfrow, P. and Gosling, S. 2003. 'The do re mi's of everyday life: The structure and personality correlates of music preferences'. *Journal of Personality and Social Psychology*, 84: 1236-1256. Doi: 10.1037/0022-3514.84.6.1236.

Schlaug, G., Jäncke, L., Huang, Y., Staiger, J., Steinmetz, H. 1995. 'Increased corpus callosum size in musicians'. *Psychologia*, 33/8: 1047-1055.

Seibt, B., Schubert, T., Zickfeld, J., Zhu, L., Arriaga P., Simão, C., Nussinson, R., and Fiske, A. 2017. 'Kama Muta: Similar Emotional Responses to Touching Videos Across the United States, Norway, China, Israel, and Portugal'. *Journal of Cross-Cultural Psychology*, 49/3: 418-435. Doi:10.1177/0022022117746240.