Music-Induced Chills

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INTRODUCTION

Chills are rapidly spreading, tingling feelings that consist of goosebumps and shivers (Harrison & Loui, 2014; Mori & Iwanaga, 2014). These "aesthetic chills" are distinct from chills/goosebumps induced by cold temperatures (Craig, 2005). There are two broad categories of chills: "goosetingles" which are associated with positive feelings and approach-related constructs, and "coldshivers" which correspond to negative emotions and avoidance-related constructs (Maruskin et al., 2012). Music has been shown to be a stable and powerful inducer of chills (Goldstein, 1980) associated with the former type: goosetingles.

There is agreement in the literature that general reward sensitivity predicts chills (Harrison & Loui, 2014). This link is promising because there is already a plethora of knowledge on reward pathways. Several mysteries in music research could potentially be elucidated if viewed in the context of reward sensitivity, such as how sad music makes people feel pleasure (Sachs et al., 2015).

Not everyone experiences music-induced chills equally. Some researchers found that females experience more chills and hypothesized that this is because females use music to influence mood more than males do (Panksepp & Bernatzky, 2002). However, it is difficult to test whether females and males truly use music for different purposes. Contrary to Panksepp & Bernatzky (2002), Grewe et al. (2007) argue that personality factors rather than demographic factors (age, gender, music education) characterize chill responders and non-responders (Grewe et al., 2009). Indeed, more of the recent literature seems to agree with this perspective.

This review aims to clarify which individual-based personality and neurological traits predispose one to experiencing more chills in response to music. We will focus on general reward sensitivity, openness to experience, and high resting physiological arousal.

Chills in the context of social behavior

In their review paper, Panksepp & Bernatzky (2002) posit, "Chills are related to socio-emotional systems that generate separation-distress.". The researchers primarily base this idea off of a PET imaging study that showed arousal of the ventral striatum and midbrain regions that include the periaqueductal gray areas that are thought to play a role in separation distress. According to their review paper, "…the perception of separation could provide motivational urgency for social-reunion responses." Some time after this review paper was published, Grewe et al. (2007) found that among several different musical sections, the entry of a voice consistently elicited the most chills. Similarly, in their review paper, Harrison & Loui (2014) note that melodies occupying the human vocal register were major chill-inducers.

These observations about the human vocal register in music work together with the separation distress idea. The "voices" in the music could be reminiscent of a child calling out to his or her parent. Ultimately, this idea is difficult to properly verify and the cited PET study does not provide specific enough evidence to strongly back this claim. The stated brain regions have many functions and cannot be tied solely to separation distress. However, with more experiments and evidence to bolster it, this idea could provide an interesting framework for viewing the relationship between a social, communicative feature of music and chills.

Chills are linked to reward pathways

In one study, as the intensity of chills increased, there were increases in cerebral blood flow and decreases in the ventral striatum, midbrain, amygdala, orbitofrontal cortex, and ventral medial prefrontal cortex - brain regions thought to be involved in reward/motivation, emotion, and arousal (Blood & Zatorre, 2001). This finding would explain why people enjoy listening to chill-inducing music, even if the subject matter or mood of the piece is melancholic.

In addition, Salimpoor et al. (2013) noted that people find music more rewarding

when they have increased functional connectivity of the auditory cortices, amygdala, and ventromedial prefrontal regions with the nucleus accumbens. The wide brain connectivity with the nucleus accumbens implicates reward pathways with music listening and corollary experiences like chills.

Chills and their corresponding anticipation are highly pleasurable

One study observed that endogenous dopamine was released in the striatum at peak emotional arousal during music listening (Salimpoor et al., 2011). While this study did not use the term "chills", "peak emotional arousal" seems to be an analogous phrase, as Harrison & Loui (2014) simply categorize these chills as "strong experiences with music." Salimpoor et al.'s study also found that the anticipation of chills generated neurological activity linked to reward. Specifically, the caudate was more involved during the anticipation phase, while the nucleus accumbens was more involved during the peak emotional response (Salimpoor et al., 2011).

Furthermore, in their review, Panksepp & Bernatzky (2002) discuss a relationship between endogenous opioids and chills. Researchers established that naloxone, an opiate antagonist, can reduce the incidence of chills (Naloxone Injection: MedlinePlus Drug Information, 2016). This fact suggests that the chill response is caused by an abrupt increase in endogenous opioid activity or an endorphin rush. These results collectively suggest that both anticipating and experiencing music-induced chills is a highly pleasurable experience.

Higher openness and BAS scores correspond with more chills

Openness to experience, one of the "big five" personality traits (McCrae and Costa 1997) and high Behavioral Activation System (BAS) scores are also thought to be highly related to likelihood of experiencing chills from music (Silvia & Nusbaum, 2011; Mori & Iwanaga, 2015). The BAS is a neurobehavioral system thought to regulate positive affect and approach behavior in response to rewards (Livingstone, 2008). These two traits are often found hand-in-hand, such as in the context of determining career adaptability (Li et al., 2015). Given its association with approach behavior, it is likely that high BAS scores are associated with high levels of openness. Openness corresponds with an increased curiosity and extraversion, which could make these people more actively engage with external stimuli (Cherry, 2016; McCrae and Costa, 1997).

Nusbaum & Silvia (2011) found that degree of music engagement, rather than genre preference, directly related to amounts of chills. This finding makes sense when viewed in conjunction with Mori & Iwanaga's (2015) observation that people experience more chills when the music is self-selected as opposed to experimenter-selected. Further support for the link between music engagement and chill experiences comes from the finding that skin conductance response (SCR) during chills was higher when people listened in solitude versus in the company of others (Egermann et al., 2011). This higher SCR suggests that music is more arousing when listened to alone, and the authors of the study suggest that this effect could be due to increased engagement and concentration on the music during solitude. These findings point to a link between the degree of engagement with music listening and the experience of chills.

Physical Arousal

Chills are associated with high emotional arousal. Salimpoor et al. (2009) observed a "…strong positive correlation between ratings of pleasure and emotional arousal.". Researchers found that individuals who did not experience pleasure also showed no significant increases in emotional arousal. Not only are chills associated with high emotional arousal, but they are also associated with physical changes as well. One study found that people with high resting psychophysiological arousal experience chills more frequently than those with lower resting psychophysiological arousal (Mori & Iwanaga, 2015). Indeed there is a close relationship between chills and SCR/piloerection, two indicators of sympathetic nervous system arousal (Craig, 2005). In addition to galvanic skin response (GSR) and piloerection measurements, cardiac signatures of emotionality (EK) values, as well as heart rate, increased significantly during moments of peak positive emotion accompanied by piloerection (Sumpf et al., 2015).

CONCLUSION

Several studies have established that certain subsections of the population experience music-induced chills more than others: people with more general reward sensitivity, higher levels of openness, and higher degrees of resting physiological arousal. Knowledge about the type

of people that experience music-induced chills can reveal mechanisms behind not only the pleasurable emotions conjured by music, but also physical responses caused by music.

There has been much research about the types of acoustic qualities in music that induce chills. Grewe et al. (2007) observed that shivers were most reliably evoked by passages containing new or unexpected harmonies or sudden dynamic or textural changes. This finding is confirmed in a study that found peaks in loudness, moments of modulation, and melodies in the human vocal register to be common chill-inducers (Harrison & Loui, 2014). Future research could further explore the acoustic qualities that influence music-induced chills and also expand the scope to non-musical sounds that elicit chills. For instance, many people report a tingling effect similar to chills as part of a phenomenon called autonomous sensory meridian response (ASMR) which involves non-musical sounds (Barratt & Davis, 2015). Understanding the neurological and physical effects of musical and nonmusical sounds can eventually contribute to a better understanding of the power of music in our lives.

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