their headphones (in phases 2–4 of the pilot) or seek another activity.

This "attentional curve" may in part be explained by the first component of J&V's model: brain stem reflex. The initial spike in interest may be less a function of emotional response to the music itself than attenuation to a novel auditory stimulus – a response to "music as sound" (sect. 3.1.1, para. 1). As this novelty wears off, the child's attention falls to a baseline level. Subsequent and fleeting spikes (Fig. 1d) accompany the beginning of new excerpts, and may again be a function of novelty.

This pattern of attention also lends further support to Berlyne's theory that listener preferences are related to arousal by the Wundt curve (an inverse parabolic relationship; see Berlyne 1971). Berlyne posited that if the arousal potential of a piece of music is misaligned (either too high or too low) relative to the listener's preferences, it will be rejected. The children in this study – well rested following naptime and well fed following a snack – were likely to have a preference for music with a high arousal potential. When the musical excerpts failed to deliver, the children rejected them, less through a demonstration of displeasure than of disinterest or apathy. This rejection may also be a function of genre: Classical music cannot match commercial music for gross aspects of arousal potential such as frenetic energy or volume.

A "genre effect" also lends tentative support to two other mechanisms underlying emotional response. In conversations with children's teachers and parents it was revealed that the primary (and in many cases only) time children listened to classical music was when it was time to go to sleep. The repeated pairing of classical music (conditioned stimulus [CS]) with sleep (unconditioned stimulus [UCS]) would explain a relaxation response through evaluative conditioning. Another aspect of the model, musical expectancy, may also help explain this result. As J&V note, both the pleasure of fulfilled expectation and the displeasure of frustrated expectation are predicated on the listener possessing sufficient knowledge to form an expectation – knowledge that is gained through learning. With limited exposure to classical music, children would not possess the knowledge requisite to forming an expectation. Gaining such knowledge in a relatively rapid fashion might be possible with other genres, but classical music, which does employ self-referential techniques to create coherent structural wholes, makes little use of literal repetition – the sort that would allow expectations to be quickly formed.

In part, young children were chosen for this study to control for the role of emotional contagion and episodic memory, judged (perhaps incorrectly) to be secondary or tangential aspects of emotional response. It was reasoned that young children would be less likely to perceive the emotional character in a piece music and mimic that emotion (Stein & Levine 1999); their emotional responses would be genuinely their own. They also have had relatively little time to form episodic memories, musically linked or otherwise. The subdued emotional response displayed by children in this study could be taken as preliminary support for either assertion. However, it is interesting to note that when children listened to music in the company of their classmates – as in pilot phases 1 and 4 – they were far more emotionally responsive than when they listened alone. Some degree of emotional contagion may be less one's mimicry of the music than of those nearby.

Considering these preliminary results in the context of J&V's theoretical framework suggests a path for future research. Understanding – even in a hypothetical sense – the mechanisms underlying emotional response to music suggests that studies should be designed to isolate and explore the proportionate role of individual mechanisms in total response. For example, using musically trained and untrained individuals, and varying the level of structural complexity of musical excerpts, could enable a more direct assessment of the role of musical expectancy. In this way, it may eventually be possible to estimate the relative strength of each mechanism in producing emotional response, both in terms of direct and of interaction effects. With a testable model guiding these efforts, it should be possible to produce more consistent and interpretable results.

A skeptical position on "musical emotions" and an alternative proposal

doi:10.1017/S0140525X08005372

Vladimir J. Konečni

Department of Psychology, University of California–San Diego, La Jolla, CA 92093-0109.

vkonecni@ucsd.edu

http://psy.ucsd.edu/pages/people/faculty/vkonecni.html

Abstract: Key premises of the target article by Juslin & Västfjäll (J&V) are challenged. It is also shown that most of the six "psychological mechanisms" proposed by the authors as underlying the induction of emotion by music involve *nonmusical* proximal causes. As a replacement for "musical emotions," the state of *being-moved* – from the recently developed Aesthetic Trinity Theory – is proposed.

Introductory sections of the target article by Juslin & Västfjäll (J&V) contain important information but are based on three erroneous premises. In the first premise, stated in the opening sentence of the Abstract ("Research indicates that people value music primarily because of the emotions it evokes") and in the lead paragraph, "people" refers exclusively to youths listening to pop music (Behne 1997; Sloboda & O'Neill 2001; Zillmann & Gan 1997).[1] Such evidence from adolescent self-reports – generally permeated by lay music-emotion (M-E) theories – is treated as relevant to the genuinely important theoretical question: Can instrumental (especially non-referential, "absolute") music directly induce emotion? Meanwhile, the methodologically sound empirical evidence about this relationship is miniscule, weak, and limited to classical music (Konečni 2008; Konečni et al. 2008).

The second erroneous premise is that there is inexplicable disagreement among M-E researchers although the explanation is straightforward: The neuroscientists cited (Kölsch, Peretz, and Panksepp & Bernatzky) generally define emotion exclusively as brain events (in a reductionist manner) – with no or little reference to subjective experience and verbal report, whereas others (Gabrielsson, Kivy, Konečni, Scherer) consider subjective experience indispensable – usually without ignoring the physiological response. An additional aspect of the rather misleading way of setting the stage is the neglect of the terms "directly" and "mediation" in the rendering of some researchers' views (for a review, see Konečni 2003) – which is that music does not *directly* induce emotions and that the M → E effect is typically *mediated* by memories, associations, and various social emotion-inducing behaviors, such as dance (Fig. 1).

The authors suspect, disapprovingly, that the skeptical position on M → E stems from its over-reliance on cognitive appraisal; this is odd because major, perhaps dominant, emotion theories emphasize appraisal and it is unclear why they should accommodate "musical emotions" – a term Zangwill (2004, p. 35) calls "obscurantist." Furthermore, J&V themselves assign a key role to cognitive mediators (see examples in the central ellipse in Fig. 1) in at least four of the six "psychological mechanisms" that they believe underlie M → E.

Figure 1 diagrams the third of the article's inaccurate premises. J&V state that providing evidence that music affects all of the components in their Table 2 would "demonstrate that music can evoke 'real' emotions" (sect. 2, para. 4). But most of

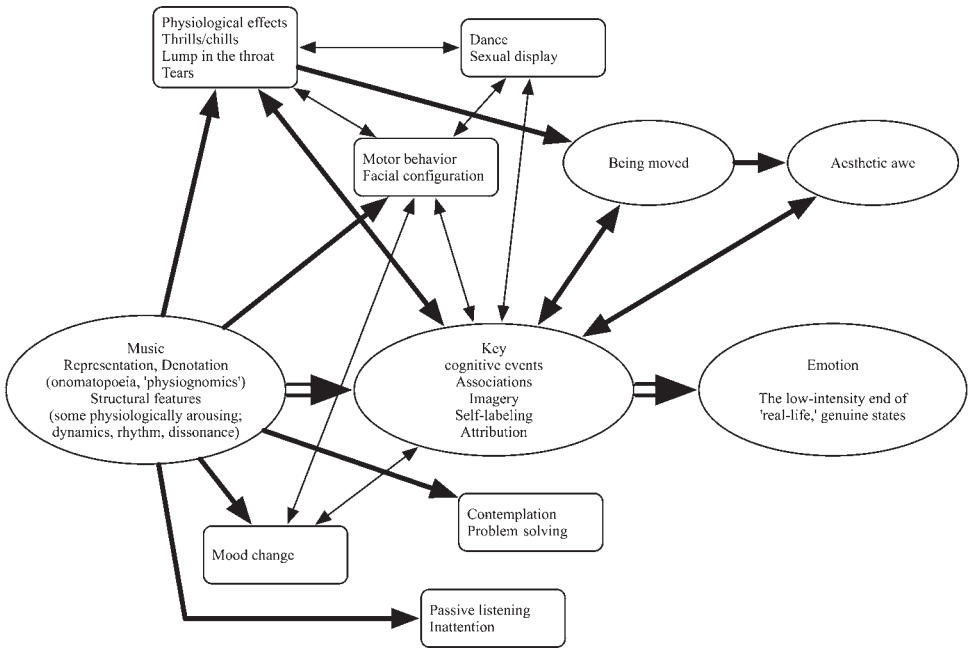

Figure 1 (Konečni). Relationships relevant to the induction of emotion by music. The *thickest arrows* show the central route. From Konečni et al. (2008). (©2008 Sage, with permission.)

the studies in Table 2 are limited to a single component, and my Figure 1 shows how certain measures taken singly (e.g., psychophysiological thrills/chills) may be dead ends that do not escalate to emotion *unless mediated* (Konečni et al. 2007).

Turning to the article's core, *nonmusical mediation* of the possible M → E effect is involved in the following proposed psychological mechanisms: *visual imagery* (the visual image, not the music that gives rise to it, is the proximal cause in the induction of emotion); *episodic memory* (memories of real-world emotional situations, not music, are the proximal causal factor); *emotional contagion* – whereby emotion might be induced by the music's expressiveness being mimicked internally – "admittedly … remains speculative" (sect. 3.1.3, para. 6) and seems unlikely to be effective without some episodic-memory involvement; *evaluative conditioning* (a nonmusical emotional event with which music has been temporally paired is the true cause of emotion); finally, there are no rational grounds to hypothesize dissonant chords (re: *brain stem reflex*; see the left ellipse in Fig. 1) and violations of *musical expectancy* to induce emotions without nonmusical enhancement.

In summary, in causal-modeling terms, if these nonmusical mediators (images, memories, associations) were to be kept constant, there would be no effect of music on emotion. This being so, and given that all of the proposed concepts are well known in psychology and aesthetics, one must conclude that the target article's proposals are neither innovative nor conducive to a deeper understanding of the direct M → E effect.

However, having acknowledged the key role of nonmusical mediators, and rejected the term "musical emotions"[2] (Konečni, 2008), what about the subjectively real and sometimes profound quasi-emotional state that (even) absolute music can produce, one that is different from "real-life" emotions (right-hand ellipse, Fig. 1)? It might be advantageous to use the term *being-moved* or *being-touched*. This concept (quasi-emotional state) is one of the three hierarchically arranged, dynamically related, components (along with thrills/chills and aesthetic awe) of the recently developed *aesthetic trinity theory* (ATT; Konečni 2005; 2008) shown in Figures 1 and 2.

Being-moved (authentic substantives exist in many languages) is proposed as a distinct and reportable (measurable) state inducible by non-aesthetic (e.g., witnessing selfless sacrifice; Konečni et al. 2007) and aesthetic events; among the latter, music is perhaps foremost – because of its temporal nature and rich network of mediators outlined in the target article (cf. Konečni 2005; 2008). The nuances in being-moved may be due to two sources: (a) contemplation simultaneous with listening (e.g., on infinity or on exquisite musical skill) and (b) subtle expressive attributes of music, such as nobility, grace, or serenity. Colorations of being-moved may thus effectively capture the meanings desired by terms like "less terrible," "less coarse," and "refined" emotions (Darwin 1871/1902, p. 735; James 1884; Frijda & Sundararajan 2007), whereas the overlap, in Figure 2, of being-moved and the fundamental emotions suggests that the cognitive mediators listed in the central ellipse of Figure 1 may convert the state of being-moved into (low-intensity) sadness or joy.

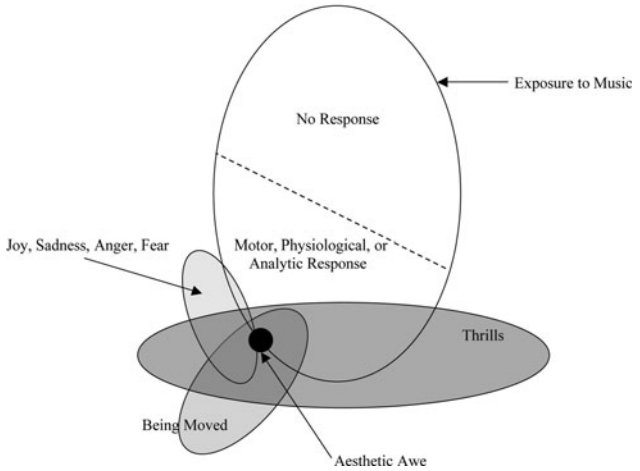

Figure 2 (Konečni). Quasi-emotional, emotional, and nonemotional responses to music and a hypothetical comparative estimate of their prevalence. From Konečni (2008). (©2008 American Psychological Association, with permission.)

NOTES

1. *Mood* (defined in Table 1 of the target article) might be a more appropriate term for much of what J&V discuss, but they are evidently not content with it. Apart from perhaps yielding to "convention . . . [and] force of habit" (Stravinsky 1936/1998, p. 54), there is the irresistible siren call of the evolutionary basis of the (fundamental) emotions.

2. J&V (in their Note 1) define "musical emotions" as "emotions that are induced by music," which unjustifiably commandeers the effects of *non*musical mediators. There are other imprecise and misleading uses of the term in the literature.

Musical expectancy: The influence of musical structure on emotional response

doi:10.1017/S0140525X08005384

Carol L. Krumhansl and Kat R. Agres

Department of Psychology, Cornell University, Ithaca, NY 14853.

clk4@cornell.edu katagres@gmail.com

http://www.psych.cornell.edu/people/Faculty/clk4.html

Abstract: When examining how emotions are evoked through music, the role of musical expectancy is often surprisingly under-credited. This mechanism, however, is most strongly tied to the actual structure of the music, and thus is important when considering how music elicits emotions. We briefly summarize Leonard Meyer's theoretical framework on musical expectancy and emotion and cite relevant research in the area.

Our starting point is the very last entry in the target article's Table 4, which indicates that musical expectancy is the only mechanism that depends strongly on musical structure. Fortunately, the field of music theory provides conceptual tools for analyzing music, and this raises the question of what musical structures give rise to expectations and what are the emotional consequences. Our approach is to begin on the musical side and consider how understanding musical processes leads to a somewhat different perspective on musical emotions than that associated with Juslin & Västfjäll's (J&V's) other five mechanisms.

We identify Leonard Meyer's (1956) monograph, *Emotion and Meaning in Music*, as the most influential theoretical framework for studying musical emotions. Its success stems from his shift from the question "Why does music produce emotions?" to the more tractable question, "How does music produce emotions?" This focuses attention on the music itself and how it is constructed. Another important aspect of Meyer's theory is that it deemphasizes the general mood (such as happy, sad, or peaceful) engendered by passages, movements, or entire musical pieces, and emphasizes instead the moment-to-moment response to the ongoing flow of music.

The theory's essential claim is that music produces emotions because listeners actively generate expectations (mostly unconsciously) for what is to follow. Depending on the relationship between these expectations and what actually happens, listeners experience varying degrees of tension or relaxation. In Meyer's words, "Thus in a very general way expectation is always ahead of the music, creating a background of diffuse tension against which particular delays articulate the affective curve and create meaning" (Meyer 1956, p. 59). The feeling of tension is not necessarily negative, nor is the feeling of resolution necessarily positive. Rather, the response depends on the particular way expectations are fulfilled, perhaps in a particularly artful way or at an unexpected delay.

Meyer emphasizes three different sources of expectation. The first, *extra-opus knowledge* or style knowledge, refers to quite general patterns in a musical style. These are codified in music theory, and empirical research extensively documents that listeners' knowledge about melody, harmony, and rhythm influences what they expect in a given musical context (e.g., Bharucha & Stoeckig 1986; Boltz 1993; Jones 1990; Jones et al. 2006; Krumhansl 1990; Schmuckler 1989). This knowledge does not depend strongly on explicit musical training; non-musicians internalize it through passive exposure.

A second source of expectations, called *intra-opus knowledge*, refers to the listener's experience of a particular piece of music and the expectations that are based on its characteristics. For example, if a piece of music begins with a particular theme, then the listener will expect that the theme is likely to recur later in the piece or reappear in variations.

Meyer also emphasizes the influence of Gestalt principles of perceptual organization on music perception. In this tradition, Narmour (1990; 1992) proposed what is called the *implication-realization model*. Its five principles for melodic expectations have been tested using a fairly wide variety of musical styles and listeners in different cultures (e.g., Krumhansl 1995; Krumhansl et al. 1999; 2000; Thompson & Stainton 1998). The results find support for principles such as: Generally expect small changes in pitch, but if there is a large jump expect a tone that fills the gap.

To study the rise and fall of tension, real-time measures have been developed in which listeners move a device to indicate the amount of tension they experience throughout the course of a piece or a segment of music (e.g., Fredrickson 1995; Krumhansl 1996; Nielsen 1983). Theoretical models, especially Lerdahl's (2001) tonal pitch-space model, have been developed to provide a precise account of the degree to which musical structures produce tension (see Lerdahl & Krumhansl 2007).

But how does this relate to the more usual sense of emotion? Several studies suggest music results in changes in emotion physiology associated with real-life emotions. For example, respondents in Sloboda's (1991) questionnaire study were able to pinpoint the particular moment in pieces where they experienced, on repeated occasions, a strong emotion, and these coincided with points in the music where an expectation of some kind was violated. Different physiological reactions (such as tears or shivers down the spine) were produced by different kinds of violations.

Real-time judgments of tension in the study by Krumhansl (1997) correlated most strongly with real-time judgments of fear, but judgments of happy and sad also made a contribution. Changes in emotion physiology showed a similar pattern. This suggests that tension is a multivalent attribute influenced by different emotions. Supporting this, Krumhansl and Schenck (1997) found that judgments of tension were almost identical with judgments of the overall amount of emotion for both music and dance.

Early event-related brain potential (ERP) studies (Besson & Faita 1995; Janata 1995) found correlates of the degree to which expectations are violated, a result replicated in other studies (e.g., Koelsch et al. 2000). A recent study (Steinbeis et al. 2006) bridged the gap between musical expectancy and emotion by measuring listeners' physiological responses to music. Tension, subjective emotionality of the music, an early negativity ERP response, and electrodermal activity (EDA) increased with harmonic unexpectedness.

Blood and Zatorre's (2001) positron emission tomographic (PET) study showed brain responses at specific listener-identified time points with strong emotions, as well as other physiological changes. In an functional magnetic resonance imaging (fMRI) study, areas of secondary auditory cortex were active when listeners heard violations of expectations for pitch and rhythm (Krumhansl 2005). Lastly, a study using irregular, unexpected chords (Koelsch et al. 2005) found that unexpected chords elicited orbital frontolateral cortex activation, an area shown to support emotional processing.

In summary, empirical evidence, using a variety of behavioral and neuro-cognitive measures, strongly supports the idea that listeners develop constantly changing expectations while listening to music, and these give rise to waves of tension and relaxation.