# Violations of Musical Expectations and Emotion: A Qualitative Study and Interpretation

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Abstract

This study investigates the possibility of a relationship between types of violations of musical expectations and perceived emotions. A natural consequence of listening to music is the development of musical expectations, or rhythmic, harmonic, and structural anticipations of what the listener expects to hear. Existing research in psychology and neuroscience demonstrates that violation of these musical expectations has significant physiological and emotional effects on the listener. Through a survey format, participants were asked to evaluate their experience listening to twelve excerpts by providing written responses and completing two rating scales. This allowed for a qualitative and quantitative evaluation of emotion in contrast to physiological measures used in other studies. Nonparametric tests showed statistically significant differences between ranked mean ratings according to type of violation. Thus, this study provides evidence supporting the existence of a relationship between types of violations of musical expectation and perceived emotions in listeners. Further research is suggested for clarification of this relationship and its possible applications in musical compositions.

*Keywords:* Emotion, Musical Expectation

## Introduction

In a Bayesian model of analysis, musical expectations develop over time through cultural, social, and musical background (Chander & Aslin, 2023). This background also interfaces with immediate external input (Chander & Aslin, 2023). In other words, one's previous exposure to music interacts with the current listening experience to anticipate what will occur next in a piece. This interaction is processed quickly, often in the first few seconds of listening to a piece (Gebauer et al., 2012). This is true across different groups of listeners. Regardless of the level of musical training or level of exposure to different musical cultures, people are remarkably adept at identifying musical patterns and departures from them (Bigand et al., 1996; Mizener & Dowling, 2022; Stevens et al., 2013). Much of the existing research on music explores musical expectations by examining the relationship between the development and violation of expectation and how they impact emotion.

Studies demonstrate how the violation of musical expectations can lead to similar dopaminergic responses as other "reward" stimuli such as food and pleasurable experiences (Salimpoor et al., 2011). Further evidence shows that violations of musical expectations are related to increases in attention and predispose a listener to different emotional states (Maher et al., 2013, Nagy et al., 2022). Maher et al. outlines how music that violates expectations leads to compensatory behaviors in which the listener is more inclined to favor ingroups, or expected relations (2023). Nagy et al. used two rating scales to measure if a listener's violation of expectation was related to a perception of humorousness in the melody (2022). However, the relationship between the type of violation of musical expectation and perceived emotion as reported by a listener has not been explicitly investigated. This paper examines this relationship and proposes possible applications of the researcher's findings.

## Current Literature

Existing research on musical expectations has largely focused on quantitative measures (Correa, 2023). Physiological measures such as electrodermal activity, heart rate, and electroencephalography have been used to approximate emotional responses to musical stimuli, with studies finding that increased harmonic expectancy—the anticipation of individual chord qualities, such as major or minor, or chord progressions—is related to greater neurological activity and feelings of pleasure (Steinbeis et al., 2006; Juslin et al., 2013). The release of dopamine in the brain has also been used as a mechanism to relate violation of musical expectations and increased emotional states (Salimpoor et al., 2011; Blood & Zatorre, 2001). fMRI studies indicate that musical expectations lead to activation of the striatal dopaminergic system in anticipation of an abstract musical reward (Salimpoor et al., 2013). These are sometimes supplemented with participant reports of "chills" in response to music but do not include descriptions of the emotions felt (Salimpoor et al., 2011; Correa, 2023).

However, most of these studies focus specifically on harmonic violations of expectation and restrict excerpts to a single genre of music. Few studies venture out of the Western body of music, though some have used southeast Asian music such as Gamelan to judge a Western listener's ability to detect departures from an unfamiliar form (Stevens et al., 2013). On the whole, classical music has been used to study musical expectations because of its identifiable structures and departures from standard Western music theory (Besson & Faïta, 1995; Chander

& Aslin, 2023; Mizener & Dowling, 2022; Steinbeis et al., 2006). The method of introducing violations of musical expectations varies between new compositions of melodies based on Western music theory or violation of an established cadence pattern in a realized piece (Chander & Aslin, 2023). Pieces by composers such as J. S. Bach and Joseph Haydn are commonly used to create harmonic expectations and subsequently violate them through the introduction of less commonly used cadences (Chander & Aslin, 2023; Steinbeis et al., 2006). The composition of "emotionally neutral" melodies is another common method to create harmonic expectations before introducing a variation on the composed melody (Timmers & Crook, 2012).

Popular music has also been used to test the effects of listener familiarity with a melody on emotional response. The method of choosing songs differs between studies, but excerpts are generally chosen through published bodies of data such as the McGill Billboard Project or pre-screenings that participants are required to complete (Miles et al., 2017; van den Bosch et al., 2013). This allows researchers to manipulate participant familiarity with excerpts based on general popularity or previous listening exposure. These studies demonstrate how emotional priming—the emotional context in which a listener is exposed to music—and familiarity with a melody generally increase the valence of an emotional reaction (van den Bosch et al., 2013).

Additional studies have defined types of violations beyond harmony. In each type of violation, participants developed musical expectations based on extra-opus knowledge, or knowledge of conventions within a musical style; intra-opus knowledge, or inferences made based on the individual piece of music; and general inferences based on all previous experience with music (Krumhansl & Agres, 2008). These types of knowledge inform different types of violation—rhythmic, instrumental, dynamic—that can be subverted by metric modulation, or changes in rhythm based on tempo or pulse; unexpected instrumentation for a particular song or musical style; or sudden changes in dynamics.

Using the types outlined above, this study aims to examine the relationship between violation of different types of musical expectation and emotion using self-reported ratings and written responses. It addresses previously discussed limitations of musical genre and familiarity by using excerpts from a range of time periods and genres. The lack of detailed emotional responses from participants in previous studies is addressed by gathering subjective descriptions of emotions felt by the participant directly after listening. Furthermore, participant's descriptions

were used to categorize violations of musical expectations into four types: rhythmic, harmonic, instrumental, and dynamic. These types of violation of expectation have been identified in other studies but have not yet been investigated in relation to elicited emotion (Boltz, 1993; Krumhansl & Agres, 2008).

## Methods and Materials

### Instrument

The survey in this study 1) identifies types of violations of musical expectation as perceived by the listener and 2) determines if there is a relationship between types of violation and elicited emotion. By identifying types of violation and emotion through a written response, this study enriches the current body of research that focuses on physiological and neurological measures of emotion through subjective descriptions. However, a written response is restricted to the participant's discretion and may exclude explanatory elements that are necessary for analysis. Therefore, emotional rating scales and visual representations of data are provided to compare relationships between types of violation and emotion. To remove subject bias in the form of emotional priming and time pressure from a researcher-supervised setting, the study was conducted in an online, untimed survey format. Subjective rating scales were used to assign emotional valence scores to excerpts for later comparison with written responses.

The survey included 60 items that were divided into three sections. The first four items comprised the "opening" section, which included IRB exempt information, instructions, definitions of terms used in the study, and an attention check. Participants were directed to complete the online survey on a mobile device or personal computer in a quiet location with headphones. "Excerpts and questions," the next 49 items, asked the same four questions for each excerpt, totaling 48 items with an additional attention check. The four questions would ask the participant to: 1) listen to the excerpt and answer whether it followed or violated their expectation, 2) explain their previous response with example prompts following the types of violations defined in the literature review, such as "Were there instruments you didn't expect?", 3) self-report their feelings according to a pleasant (-2) to unpleasant (2) scale, 4) self-report their feelings according to a relaxed (-2) to unpleasant (2) scale. An excerpt and its corresponding four questions were presented on one page without a time limit. Participants would advance to the next excerpt and set of questions at their own pace but were not allowed to return to previous

excerpts after completing its questions. One attention check was included in this section. The numerical ratings were coded according to Thayer's emotional valence scales, with a graphic made by the author for clarity (Faith & Thayer, 2001). The numerical scale included -1 and 1 to represent weaker emotional responses and 0 to represent a neutral emotional response. The last section, "closing", asked for demographic information such as enrollment at the University of Florida, age, contact email, recruitment origin, asked for general feedback on the survey, and debriefed the participant on the purpose of the study along with the researcher's contact information.

**Figure 1.** Researcher-created graphic provided to participants
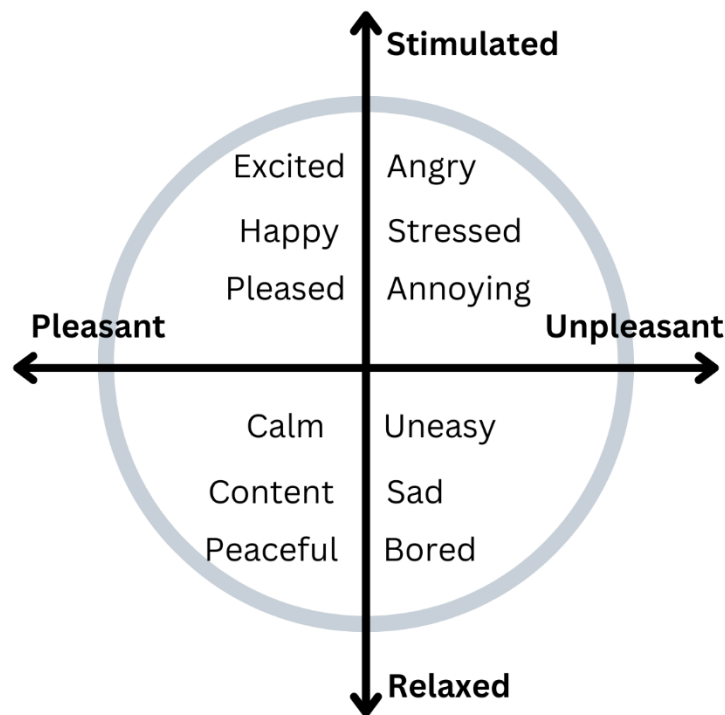


## Recruitment

This study met the IRB criteria for exempt research. Participants were briefed on IRB exemption at the beginning of the survey and had access to a document explaining IRB exempt principles. Participants were recruited via email listserv and QR code flyers at the University of Florida. Flyers were posted in four locations with high student activity on campus: The Department of Psychology, Marston Science library, Keene-Flint Hall, and the Reitz Union. To include a range of ages and backgrounds, the survey was made available to undergraduate and

graduate students in nine colleges of the university. This decision was made to reduce the effects of social background on the development and violation of musical expectations (Egermann et al., 2013). The responses were filtered for integrity based on completion of the survey along with correct answers to three attention check questions. As an incentive for completion, every 50th participant was given a $50 Visa gift card. Out of 336 responses, 135 met the criteria for inclusion.

**Stimuli**

The twelve songs in the survey represent a range of genres and possible types of violations of expectation. Excerpts were chosen from ten songs based on their inclusion of a clear establishment and departure from a musical pattern, with two additional songs acting as control stimuli with no departures. The type of violation in an example was designated by the researcher prior to survey distribution and confirmed using participant responses. Four categories became apparent: harmonic, instrumental, dynamic, and rhythmic. Each excerpt began at a defined section (i.e. chorus, melodic phrase, verse) and had a duration of 30 seconds to ensure time for the development of musical expectations in the listener (Krumhansl & Agres, 2008). The excerpts ended with a 2.5 second fade to silence to control for variations in volume. Table 1 includes the full list of excerpts.

**Table 1.** List of Excerpts with Type of Violation and Time Stamp

| Excerpt | Type | Time |
|---|---|---|
| A Dream is a Wish Your Heart Makes (Cover) - Juliana Chahayed | Instrumental | 0:00-0:30 |
| Also Sprach Zarathustra - Richard Strauss | Instrumental | 0:00-0:30 |
| Omnes Percussion Trioe - Andrea Venet | Rhythmic | 0:00-0:30 |
| On a Frosted Hill - Anthony Green | Dynamic | 0:30-1:00 |
| Symphony No. 94 Mvmt 2 - Joseph Haydn | Dynamic | 0:00-0:30 |
| Gimme Gimme - ABBA | Control | 1:08-1:38 |
| Here Comes the Sun (Cover) - The Beatles | Harmonic | 0:00-0:30 |
| Smash the Mirror - The Who | Instrumental | 1:00-1:30 |
| I Will Survive (Cover) - CAKE | Instrumental | 0:00-0:30 |
| Verklarte Nacht - Arnold Schoenberg | Harmonic | 4:45-5:15 |
| Toreador March - Georges Bizet | Control | 0:00-0:30 |
| Everybody Wants to Rule the World (Metric Modulation) - Eric Downs | Rhythmic | 0:00-0:30 |

# Results

## Violation of Expectation

After each excerpt, participants chose whether the excerpt followed or violated their musical expectations. These responses were assigned values (follow = 1, violate = 2) for numerical analysis and graphical representation. The proportion of responses for each excerpt was calculated and represented in a stacked bar chart (See Figure 1).

**Figure 2.** Bar chart of proportion of participant responses by excerpt
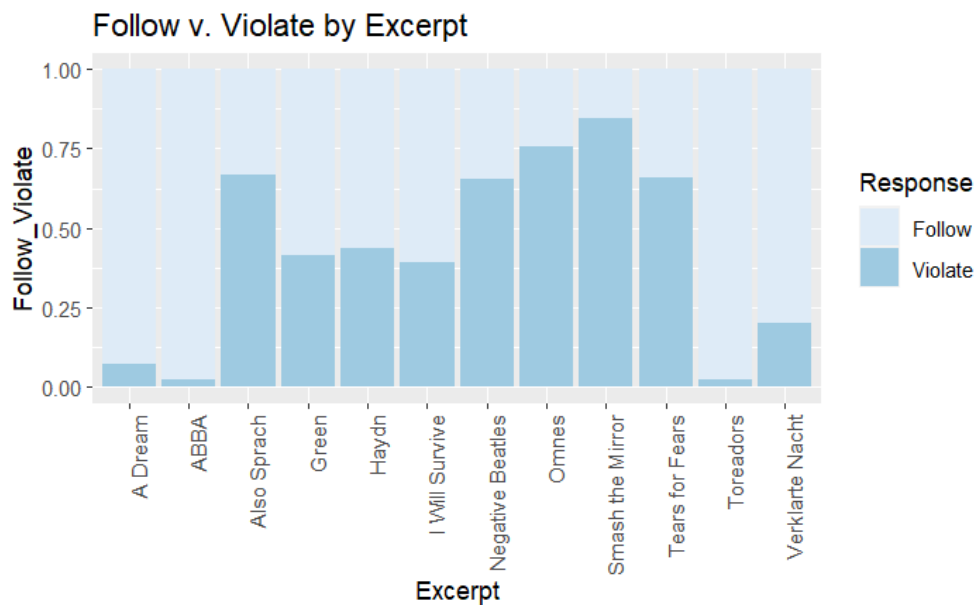


Two control excerpts, ABBA and Toreadors, were chosen because of their repetitive and recognizable structures with no violations of musical expectations. These had the lowest proportion of "violate" responses. No clear relationship was found between the type of violation and the proportion of responses.

Interestingly, two of the remaining excerpts, "A Dream" and *Verklarte Nacht*, had low proportions of "violate" responses compared to the other eight excerpts. These can be explained by a Zygonic theory of cognitive processing of musical structure (Ockelford, 2006). This theory frames music as a series of auditory variables, such as harmony, instrumentation, rhythm, and dynamic (Ockelford, 2006). In a listening experience, these variables are processed according to previous experiences with musical patterns. Musical expectations are created accordingly, with

variables being perceived as "ordered" if they follow patterns established within the current experience or in the cumulation of previous experiences (Ockelford, 2006). Thus, a variable is not "ordered," or it violates musical expectations, if it does not exist in imitation of a previously experienced variable (Ockelford, 2006). This aligns with Zygonic theory's perception of "order" as a result of repetition. The excerpt "A Dream" changed the instrumentation of the classic associated with Disney's *Cinderella,* but the harmonic structure and dynamic largely remained the same. This, combined with its high recognizability, likely contributed to the excerpt still being perceived as "ordered." The low "violate" response for *Verklarte Nacht* can be understood in two parts from Zygonic theory: 1) the harmonic violation of the excerpt may not have been strong enough to be "unordered" to most listeners, and 2) the harmonic progression may have been perceived as "ordered" in the context of the excerpt itself.

Participants were also asked to write a short explanation of their response for each excerpt. These responses were used to assign types of violation musical expectation to each excerpt by identifying the most common descriptors and phrases used in written explanations. Examples of descriptors used to assign types of violation are listed in Table 2.

**Table 2.** Descriptors for Type of Violation

| Violation | Descriptors |
|---|---|
| Harmonic | Unexpected release, unexpected melody |
| Instrumental | New, unexpected, or jarring instruments |
| Dynamic | Unexpected dynamic change (e.g. harsh, startling, very loud) |
| Rhythmic | Steady beat but not right, "off |

## Rating vs. Violation

The two control excerpts associated with small proportions of "violate" ratings were centered on a rating of -2 (pleasant). Eight of the remaining excerpts were rated by participants as pleasant to neutral (-2 to 0). Two excerpts—"Smash the Mirror" and "Everybody Wants to Rule the World"—were rated by participants as mildly unpleasant (1). For the second data set, excerpts were also rated on a scale from -2 (relaxed) to 2 (stimulated), with 0 representing a neutral stimulation response. "A Dream" had a median rating of -2. The remaining excerpts had

median ratings that ranged from 0 to 2. In other words, the majority of excerpts had a neutral or positively stimulating effect. These data sets are represented in aligned box plots to compare the general distribution of responses across excerpts (See Figure 3).

**Figure 3.** Boxplots representing participant ratings by excerpt and type of scale
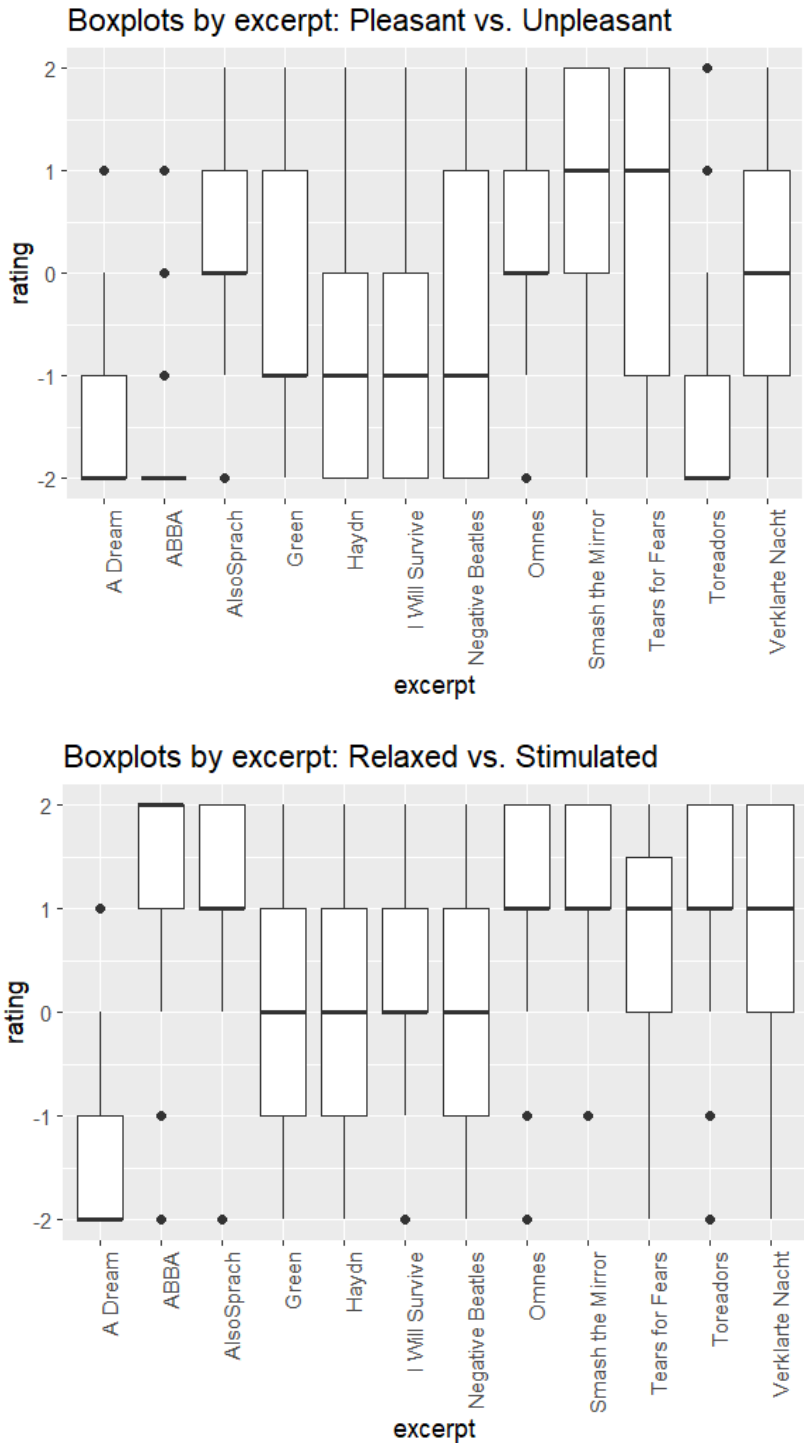
In light of Figure 1, the distribution of ratings presented in Figure 3 suggest that the perception of a violation of musical expectation does not have a strong influence on rating of emotional valence or arousal. There is not a clear relationship between the proportion of "violate" responses shown in Figure 1 and the ratings shown in Figure 3. Rather, the perception of a violation of musical expectation could interact with other factors such as familiarity with the work and emotional context to affect rating. This can be seen regarding the effect of type of violation of expectation in the following analysis.

For statistical analysis, the type of violation was coded to a numerical value. Each type of violation of musical expectations was assigned a numerical value—instrumental = 1, rhythmic = 2, dynamic = 3, harmonic = 4, control = 5. See Table 1 for the violation assigned to each excerpt.

The statistical testing program "R" was used to check three assumptions necessary for the validity of ANOVA tests: normality of data, equal variances, and independence of error. Bartlett's test and a time series plot of residuals vs. order were created for the pleasant and relaxed data sets. The results of these tests showed that the assumptions of equal variances and independence of error were met for both data sets. However, a normality QQ plot showed that the assumption of normality of data was not met for either data set. Thus, Kruskal-Wallis tests with a p-value $p < 0.05$ were used as a nonparametric method of preliminary testing for a relationship between rating in pleasant and relaxed vs. type of violation of musical expectation. The Kruskal-Wallis test yielded a chi-squared value of 267.67 and 150.72, a low p-value ($p < 2.2e\text{-}16$) for both data sets, demonstrating that the data provides strong evidence that there is a relationship between type of violation and rating.

Dunn tests with a p-value $p < 0.05$ were conducted as a post-hoc test to Kruskal-Wallis to determine which types of violations of expectation had significant differences between participant ratings. These tests demonstrated that the ratings associated with each type of violation of musical expectation were all statistically significant from each other. Each type of violation of musical expectation was different in terms of rating on scales of pleasant vs. unpleasant and relaxed vs. stimulated. The most significant differences in rating occurred between no violation (control) vs. violation (harmonic, rhythmic, dynamic, instrumental) and rhythmic vs. dynamic. In other words, there is a strong indication that the type of violation of musical expectation is related to rating on scales of perceived emotion.

## Discussion

This study was conducted to 1) identify types of violations of musical expectation and 2) examine a possible relationship between types of violations and emotion as described by a listener in terms of valence (pleasant vs. unpleasant) and arousal (relaxed vs. stimulated). The results from the present data sets provide evidence for a relationship between the type of violation of musical expectation—harmonic, rhythmic, dynamic, or instrumental—and the emotion perceived by a listener. In contrast to previous studies in which violations were related to physiological measures of stimulation, this research relied on self-reported descriptions and ratings of emotion to identify types of violation and emotional state according to the participant's experience. A graphic of emotions represented by possible ratings (Figure 1) was given to participants to mediate variability in interpretation of the emotional rating scales.

The existence of a relationship was supported by nonparametric measures of difference between independent groups and a chi-squared test of association. A Kruskal-Wallis analysis and Dunn post hoc test done on both pleasant and relaxed datasets yielded strong evidence that mean ratings on emotional rating scales described by Faith and Thayer (2001) differed by type of violation of expectation. This demonstrates that each type of violation of musical expectation, as defined by participants in this study, is distinct in its emotional effect. More specifically, rhythmic and dynamic violations were shown to have the most significant differences in mean rating. In other words, types of violations of expectation are not just distinct, but clearly influence ratings of emotional valence and arousal.

It is important to note that, though these distinctions may be statistically significant, they may not be significant in interpretation. The average rating of arousal for different types of violations of expectations are between 0 and 1, or neutral to mildly stimulating. Therefore, while each type of violation of expectation has a measurable effect on rating for emotional valence and arousal, the differences between each effect may not be large enough to warrant distinction between types of violation. Further study is needed to determine if this interpretation can be generalized to larger sets of excerpts and different populations than the ones used for this study.

## Further Study

Additional studies could be done in two ways, 1) refining definitions of types of violations of musical expectation and 2) using different scales for participants to indicate perception of emotion. The first study could be done through a structural analysis of a larger number of musical excerpts, organizing excerpts into groups based on unique characteristics. By presenting these groups to participants, researchers could control for factors such as tempo, genre, and tonality to determine what factors listeners rely on to define types of violation of musical expectation.

A second possible study represents a larger issue in measuring emotion in psychological research. Emotion is defined differently across methodologies, each with their own assumptions influencing the scope of generalization (Gendron, 2010). The lack of scientific consensus on criteria makes it difficult to discuss the implications of any study on emotion. In addition, subjective ratings of emotion are influenced by the scale provided. In other words, participants will answer questions on feeling according to the adjectives presented to them rather than their true feelings (Quigley et al., 2014). Subjective measures of emotion based on rating can also only be used to assess the contents of a feeling, not the process behind a feeling (Quigley et al., 2014). As this study was meant to study the relationship between violations of musical expectation and the listener's perceived feeling, subjective measures of rating sufficed. However, future study on this topic must define emotion carefully to prevent large discrepancies in application. Multiple scales of emotion could be used in different iterations of this study to confirm results through cross-validation.

## Acknowledgements

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