# Effects of Music-Induced Arousal on Responses to Unpleasant Pictures

Cassandra L. Baldwin

The University of Alabama in Huntsville

Abstract

Russell's (1980) circumplex model of affect, one model of emotion, has been widely used to examine the emotional and physiological effects of music arousal and pleasantness, most recently on responses to affective pictures. The present study examined the physiological and emotional effects of music on responses to unpleasant images garnered from a recently developed picture archive. The study contained a 2 x 2 (Audio: beep, music by Visual: fixation cross, unpleasant pictures) within subjects design with a 2 x 2 (MusicArousal: high, low by MusicValence: pleasant, unpleasant) nested within the Music factor. University undergraduates were presented with different types of audio and visual stimuli and instructed to complete the Semantic Differential Scales. Pulse wave amplitude was employed as a physiological measure. Main effects for MusicArousal with and without coinciding unpleasant pictures were found with subjective arousal. Some types of music may attenuate some types of subjective affective responses to unpleasant pictures.

*Keywords*: arousal, pleasantness, psychophysiology, music

# Effects of Music-Induced Arousal on Responses to Unpleasant Pictures

Research has established the notion that music is an emotional stimulus, and as a result research has used emotion models to explain its effects on individuals. One widely used model has been Russell's (1980) circumplex model of affect. This model proposed that emotions contain two dimensions characterized as pleasantness, also called valence, and arousal. These two dimensions, which could act independently, would intersect to form an emotion space that is made up of four quadrants. As such, these four quadrants would contain differing types of emotions based on the interaction of the arousal and pleasantness aspects of emotions.

The effects of music on physiology have been examined within the context of the circumplex model. For example, Gomez and Danuser (2007) explored the effects of structural elements of music on emotion based on subjective reports of arousal and valence and corresponded the elements with physiological effects. The authors reported that elements such as rhythm and tempo were positively related to measures of subjective and physiological arousal. They also found that mode, or the key of a music piece, influenced experienced valence. Many times the major mode would be associated with positive valence and the minor mode would be associated with a negative valence. Given that heart rate, respiration, and skin conductance were employed physiological measures, it could be possible that pulse pressure would be a viable method with which to measure the physiological effects of music.

Research into the combined emotional processing between hearing and vision has demonstrated that music can modulate humans' responses to pictures. When comparing the effects of music, pictures, and music and pictures on emotions in women, Baumgartner, Esslen, and Jäncke (2006) used pictures from the International Affective Picture System (IAPS) that induced the target emotions happiness, sadness, and fear and concurrently presented IAPS

pictures with music that induced these same emotions. Through the use of self report, the authors found that pictures were more effective at inducing a target negative emotion more effectively than music, despite music resulting in more reported emotional involvement. The authors also found that presenting the pictures and music simultaneously was more effective in inducing target emotions than presenting pictures or music alone. When physiological measures were used, the authors found that presenting music alone and with a picture resulted in more physiological arousal that presenting a picture alone. Although the research examined the effects of music on emotional responses to affective images, valence and arousal were not explicitly measured via self report. Arousal, however, was measured through physiological measures. The current study would extend this research through the examination of musical valence and arousal on the valence and arousal of men and women in response to affective pictures.

More recently, Marin, Gingras, and Bhattacharya (2012) showed IAPS pictures immediately after short Romantic piano music primes. All stimuli differed in valence and arousal, and the authors found that only arousal significantly transferred from music to pictures. Valence marginally influenced this transfer; volunteers felt more arousal from the IAPS pictures after hearing unpleasant music than after hearing pleasant music. No physiological data, however, were collected in this research. The present experiment would extend results by employing a physiological measure to track music-induced arousal from music to pictures.

The Geneva Affective PicturE Database (Dan-Glauser & Scherer, 2011), hereafter referred to as the GAPED, could provide a picture archive useful to learning more about crossmodal transfer. It was developed as an alternative to the widely used IAPS and as a way to facilitate the study issues of interest to clinical researchers. As such, the majority of the pictures collected by the authors have been negative in valence, although images that are positive and

neutral in valence are included as well. These images have been validated as having differing levels of arousal and valence. Negative pictures included various types of injury to animals and humans, snakes, and spiders. Positive pictures included young animals and babies, as well as landscapes, and neutral images include objects. The present study would extend music research through the use of this database.

The literature has suggested that converging operations by testing crossmodal transfer of arousal and valence from music to images could be demonstrated with emotional and physiological data. Music has been found to influence the emotions that an affective picture can impart onto an individual (Baumgartner et al., 2006). Further, music-induced subjective arousal has been found to influence the subjective ratings of picture-induced valence and arousal (Marin et al., 2012). Through combining methods and materials from Baumgartner et al.'s (2006) and Marin et al's (2012) studies, several hypotheses were created. First, it was hypothesized that participants would report more subjective arousal after being presented with pictures and after being presented with concurrent pictures and music than after being presented with music. This hypothesis stemmed from Baumgartner et al.'s (2006) finding that presentation of pictures alone and together with music induced fear and sadness more effectively than presentation of music alone. A hypothesis is that presentation of music with and without concurrent presentation of pictures would induce more physiological arousal than presentation of pictures. This hypothesis stemmed from Baumgartner et al's (2006) finding that presentation of music with and without concurrent presentation of pictures induced more physiological arousal than presentation of pictures. One final hypothesis was that music-induced physiological arousal would accompany the transfer of music-induced subjective arousal to unpleasant affective pictures. Through the

addition of a physiological measure, this hypothesis served to extend the findings of Marin et al. (2012) in which the arousal dimension crossmodally transferred from music to pictures.

## Method

### Participants

Undergraduate students ($N$ = 18) completed the experiment. The data of 3 participants were excluded from final analyses, with the emotional data being incomplete from 2 participants and 1 participant being excluded for excessive movement, for a total of 15 participants. The average age of this sample was 21.2 years. There were 4 freshmen, 4 sophomores, 4 juniors, and 3 seniors. There were 5 liberal arts majors, 1 who was a music major, 2 nursing majors, 2 science majors, and 2 engineering majors; the rest were unknown. The sample included 4 African Americans and 11 Caucasians. In assessing musicianship, 8 volunteers reported being musicians; the lowest reported experience was 2 years. All participants except one were nonsmokers, and all except one participant reported consuming no caffeine during the preceeding 1.5 hours. Students under age 19 were required to provide a consent form signed by a parent or guardian as dictated by law, and participants were treated per APA ethical guidelines.

### Design

The study was a 2 x 2 (Audio: beep, music by Visual: fixation cross, unpleasant pictures) within subjects design with a 2 x 2 (MusicArousal: high, low by MusicValence: pleasant, unpleasant) within subjects design nested within the Music factor. Dependent variables were pulse wave amplitude and emotion ratings of pleasantness and arousal based on subjective responses on Mehrabian and Russell's (1974) Semantic Differential Scales.

**Materials**

A BioNomadix PPG amplifier (BIOPAC Systems, Inc., Aero Camino Goleta, CA), consisting of a photoplethysmogram, was used to measure pulse wave amplitude. A photocell was attached to the left hand third finger to measure blood volume. *AcqKnowledge* 4.3 was used to collect and analyze the signals on an HP netbook. Music stimuli included 5 Romantic piano piece excerpts drawn from Marin et al. (2012) that were 30 s in length and rated as pleasant/unpleasant and high/low in arousal. Table 1 lists a description of the music excerpts. The Pleasant/High Arousal clip was Opus 37 of Peter Tchaikovsky's *The Seasons*. The Pleasant/Low Arousal clip was from Opus 38 of Edvard Grieg's *Berceuse*. The Unpleasant/High Arousal clip was from Opus 28 of Frédéric Chopin's *Préludes*. The Unpleasant/Low Arousal clip was from Opus 22 of Edvard Grieg's *Piano Sonata in G minor*. Opus 27 of Frédéric Chopin's *Nocturnes* was used as a recovery piece to bring participants back to baseline.

Unpleasant pictures were drawn from the GAPED; these pictures included scenes of injured and sick animals and humans as well as pictures of spiders. Pleasant pictures were drawn from the same database and the Pixabay website (Pixabay, n.d). These pictures included pictures of landscapes. Neutral stimuli included a series of beeps and a slide containing fixation cross. Microsoft PowerPoint, operated on a Dell laptop with attached headphones, presented the musical and visual stimuli. A slide with the neutral stimuli were presented for a total of 8 min, 6 unpleasant pictures were presented alone for 30 s, and the music clips were presented alone for a total of 2 min. Regarding pictures, 18 unpleasant pictures in addition to the above mentioned 6 were presented with the 4 music clips for a total of 2 min, and 18 pleasant pictures were presented for 3 min.

The arousal and pleasantness scales from Mehrabian and Russell's (1974) Semantic Differential Scales were used to rate participants' emotions. Each scale involves 6 pairs of words of opposite poles and is presented on a scale of *1-7* between the two words. The scales were scored on scales of -3 to +3, with 4 on our scale corresponding to 0 on the scored scale, 1 corresponding to -3, and 7 corresponding to +3 .

**Procedure**

Individuals were seated in front of a laptop that contains the stimulus files, headphones were comfortably placed over the ears, and the photocell was attached to the middle finger of the left hand. A 2 min baseline period containing the neutral stimuli was used to establish baseline recordings. After this period, each of the 4 experimental music clips was presented with a fixation cross, with 90 s intermusic intervals of the neutral stimuli between each clip. A second stimulus block containing 6 unpleasant pictures with the beep as the audio was presented after the last intermusic interval. A 2 min interblock interval was played, after which a final stimulus block in which pictures were presented simultaneously with music was presented. Each trial in this block contained 1 music clip and 6 pictures presented in 5 s intervals and followed by 90 s interstimulus intervals wherein the neutral stimuli are presented to return physiological measures to baseline.

After the final interval of the combined pictures and music block, participants viewed nature scenes and heard low-arousing, pleasant music for 3 min. During all intervals in the study and after the recovery period the participants were asked to complete the Semantic Differential Scales. After the recovery period students were asked to complete demographics and answer questions about the subjective importance of music and their music training. They were then

released. The photocell and headphones were cleaned with a kimwipe and a sanitary wipe to prepare for the next session. Participants completed the experiment within 45 min.

## Results

Data were analyzed via the Statistical Package for the Social Sciences (IBM, Armonk, NY). Figure 1 illustrates that a main effect for MusicArousal was found, $F(3, 42) = 13.317$, $p < .001$, $\eta_p^2 = .487$. Students reported lower arousal after hearing the Low Arousal pieces while viewing the fixation cross. A main effect for MusicPleasantness was not found, $F(3, 42) = 2.127$, $p = .111$, $\eta_p^2 = .132$. Furthermore, as seen in Figure 2, with the addition of pictures, a main effect for MusicArousal was found, $F(3, 42) = 3.726$, $p = .018$, $\eta_p^2 = .210$. Arousal ratings were lowest after hearing the Unpleasant/Low Arousal clip while viewing the unpleasant pictures and highest after hearing the Unpleasant/High Arousal clip while viewing the unpleasant pictures.

Regarding physiological data, no main effects for MusicArousal were found when music was presented with a fixation cross, $F(1, 14) = .066$, $p = .801$, $\eta_p^2 = .005$. Likewise, no main effects for MusicPleasantness were found, $F(1, 14) = .956$, $p = .345$, $\eta_p^2 = .064$. No interaction was found, $F(1, 14) = 1.645$, $p = .220$, $\eta_p^2 = .105$. With simultaneous presentation of pictures and music, a trend for a MusicArousal main effect was found, $F(1, 14) = 4.492$, $p = .052$, $\eta_p^2 = .243$. Pulse wave amplitude tended to be higher during presentation of Low Arousal excerpts than high-arousing clips and lowest during presentation of the Unpleasant/High Arousal excerpt. No main effect for MusicPleasantness was found, $F(1, 14) = 1.677$, $p = .216$, $\eta_p^2 = .107$, nor was an interaction found, $F(1, 14) = 1.039$, $p = .325$, $\eta_p^2 = .069$.

## Discussion

Several hypotheses were made for this study. First, it was hypothesized that the unpleasant pictures would be result in higher subjective arousal ratings than the musical stimuli.

Second, Romantic piano music was hypothesized to be found more physiologically arousing than unpleasant pictures. Third, it was hypothesized that physiological arousal responses would accompany any subjective arousal responses. Regarding emotional responses, only a main effect for MusicArousal when music was played with the neutral fixation cross was found, with ratings being lowest when Low Arousal music was played and highest when Pleasant High Arousal music was played. Further, reported arousal ratings for all pieces except the Pleasant High Arousal piece were lower than ratings reported for the set of pictures. This finding partially supports the hypothesis that pictures can be found more subjectively arousing than music, which can be corroborated with Baumgartner et al.'s (2006) results showing that pictures can more effectively induce a negative target emotion than music.

In addition to the aforementioned main effect, a main effect for MusicArousal occurred when Romantic piano music was presented concurrently with the unpleasant pictures. Ratings were lowest when the Unpleasant Low Arousal Music was played and highest when the Unpleasant High Arousal music was played. It appears that music that is not unpleasant and highly arousing can attenuate subjective arousal responses to unpleasant pictures, as ratings collected after presenting these types of music with the pictures were lower than arousal ratings collected after presenting a set of unpleasant pictures. This could result from Arousal and Pleasantness having differential effects, as no main effect for pleasantness occurred, a result that occurred in Marin et al.'s (2012) study. When physiological data were examined, a trend for a main effect for MusicArousal was found when unpleasant pictures were added to the Romantic piano music. The Low Arousal pieces presented with the unpleasant pictures tended to result in the highest amplitude, the Pleasant High Arousal piece tended to result in an intermediate amplitude relative to the Low Arousal pieces, and the Unpleasant High Arousal piece tended to

result in an amplitude that was lowest and well below that examined with a block of pictures occurring with the neutral beep. Here it is possible that arousal influences transfer based on pleasantness, as the Low Arousal pieces had similar amplitudes while the High Arousal pieces had very different amplitudes. Participants may have experienced an effect similar to the polarizing effects of arousal in which high arousal music can pull responses in the direction of the content of the viewed pictures, as seen in Gorn, Pham, and Sin (2001) who examined music arousal effects on affective evaluations of print advertisements. One other possible conclusion for the finding is that the Unpleasant High Arousal excerpt pulled participants' physiological responses in the direction of the unpleasant pictures. Although participants' level of pleasantness was measured instead of sadness, it may be possible the unpleasant pictures resulted in sadness among the participants. The Pleasant High Arousal excerpt, opposite in valence to the pictures may have competed in valence for participants' responses, which resulted in similar amplitudes between this piece and the picture block. This possible conclusion provides an avenue for future research in which this study could be replicated, participants could complete emotion scales that measure discrete emotions in addition to arousal and valence and the two scores could be compared.

Some limitations of the study exist. First of all, the music excerpt that was validated to be an unpleasant, highly-arousing piece by Marin et al. (2012) was rated to be relatively pleasant compared to the other three experimental pieces in the present sample. This could be a reason for the lack of any main effects for pleasantness or interactions. Although music pleasantness may not influence responses to static pictures on its own, it has been demonstrated to marginally influence the transfer of arousal (Marin et al., 2012). Another possible limitation involved the length of the study and asking participants to sit still. Although pilot sessions established an

optimal period allowing for physiological recovery between stimuli without somnolence, it is still possible that progression through the study may have had an influence on physiological responses to the stimuli, as amplitude appeared to be higher when music was presented with only the fixation cross than when presented with the pictures. One last limitation is the use of only unpleasant pictures; however, this limitation provides an avenue for future research by comparing the effects of musical arousal on pleasant pictures with that of unpleasant pictures. Previous research has demonstrated that musical arousal affects emotional responses to pleasant and unpleasant films differently (Ellis & Simons, 2005). Although music arousal may not affect physiological arousal with negative films, the examined trend found with the unpleasant pictures illustrates that this may not be the case with static pictures.

This study examined the effects of musical valence and arousal on emotional and physiological responses to unpleasant pictures. Emotional and physiological responses to the presentation of music, pictures, and a combination of both were evaluated in university undergraduates. The arousal dimension of music was found to affect arousal ratings in response to hearing music with and without concurrent presentation of unpleasant pictures. A trend was found for pulse pressure in response to simultaneous presentation of pictures and music, which may suggest the polarizing effects of arousal. Further research could elucidate the relationship between arousal and pleasantness and how they influence each other in the crossmodal transfer from music to pictures.

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Table 1

*Music Pieces Used*

| Code | Artist | Piece |
|---|---|---|
| PLA | Grieg | Berceuse Op. 38 No. 1 |
| UPLA | Chopin | Préludes, Op. 28, No. 6 |
| PHA | Tchaikovsky | The Seasons, Op. 37, February: Carnaval |
| UPHA | Schumann | Piano Sonata in G minor, Op. 22, No. 1, So rasch wie möglich |
| Recovery | Chopin | Nocturnes, Op. 27, No. 2 in D-flat Major: Lento Sostenuto |

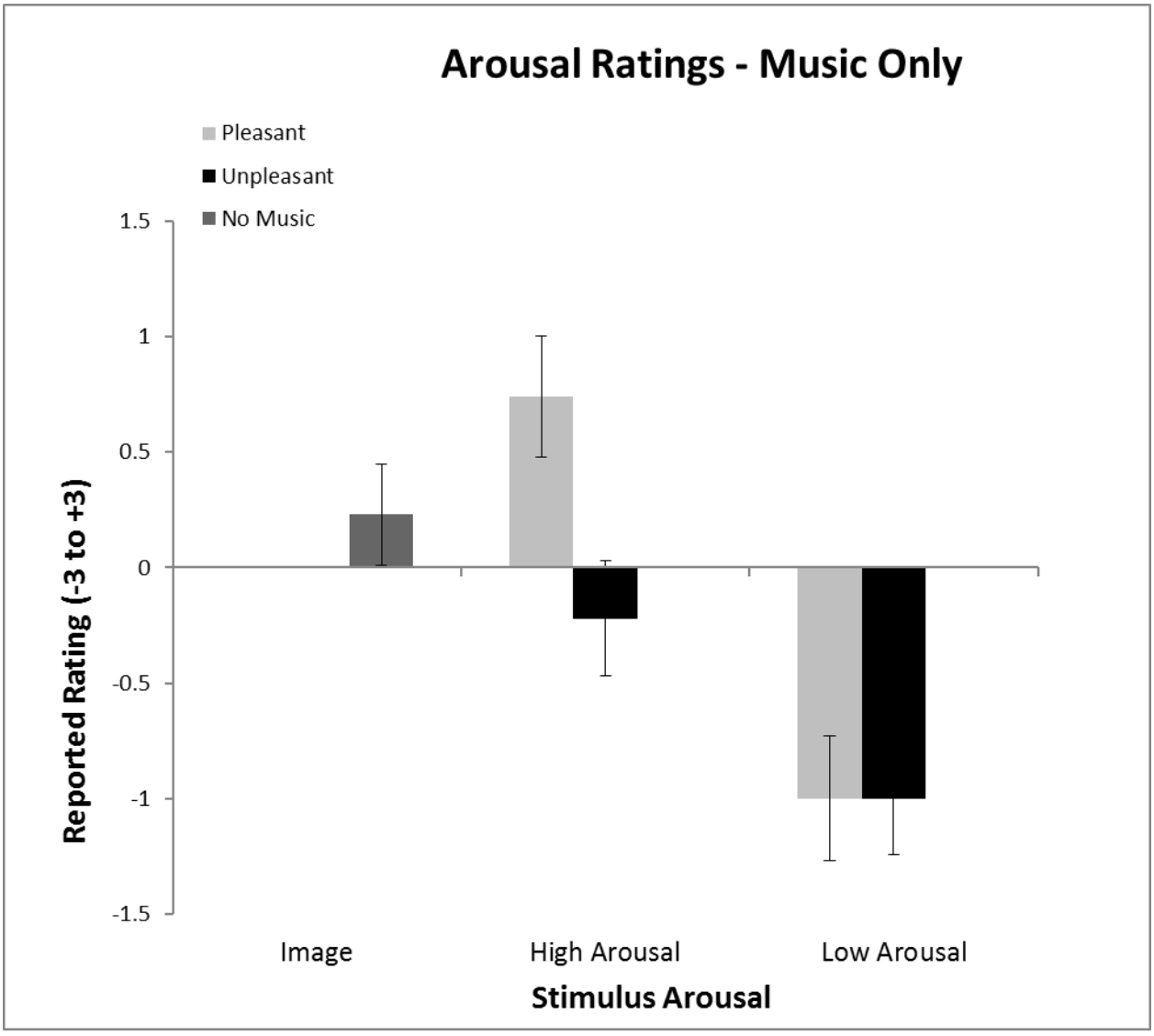


*Figure 1.* In most cases, the set of pictures presented with the neutral beep sound resulted in higher reported arousal ratings than music presented with the neutral fixation cross.

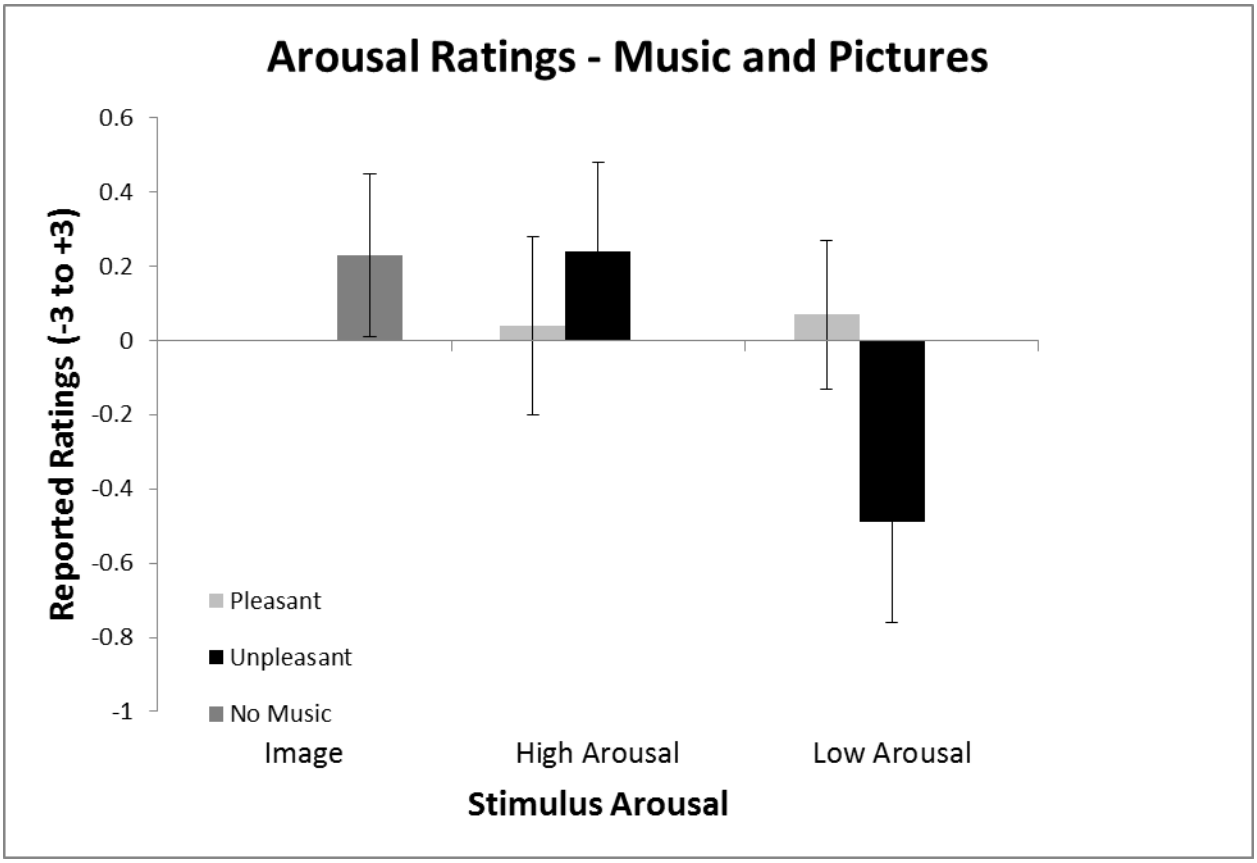


*Figure 2.* Arousal may have differential effects based on pleasantness.

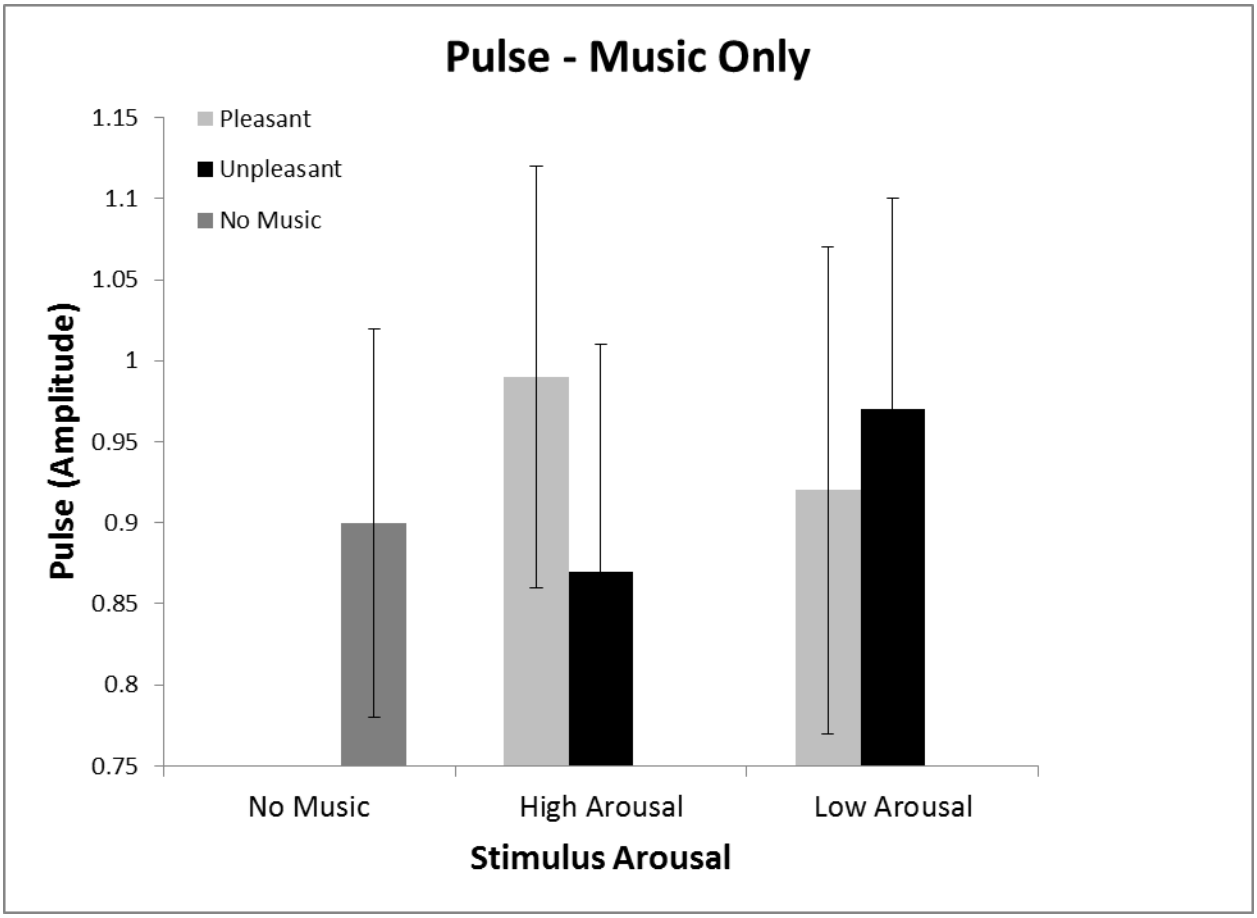


*Figure 3.* No main effects or interactions were found when music was presented with the fixation cross.

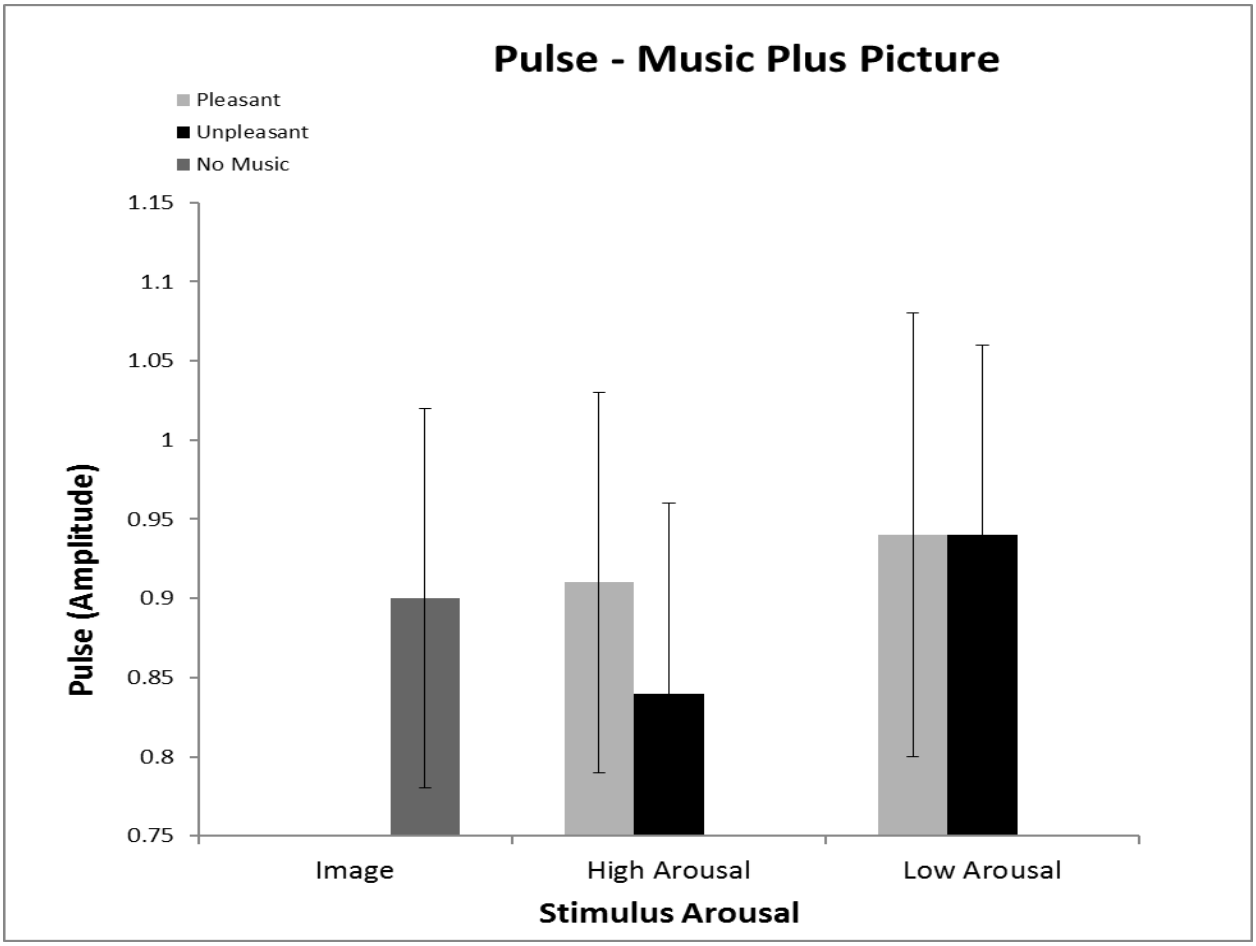


*Figure 4.* The possible trend for a main effect for MusicArousal with concurrent presentation of pictures and music illustrates the possibility for differential effects of arousal on responses to unpleasant pictures.