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The Effect of Brightness on Listeners' Perception of Physiological State and Mood of the Music During Listening

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Abstract

The purpose of this study was to examine the effect of light condition on physiological state and mood perception of music during listening. Seventy-six participants were assigned randomly to 2 experimental conditions: regular and dim light conditions. Visual analogue scales were used to indicate changes in physiological state and the perceived mood of the music. Participants assessed their physiological state between "relaxed" and "tensed" before and after the music listening. At posttest, they also indicated the perceived mood of the music on a second Visual Analog Scale. Analysis of covariance and analysis of variance were used to analyze the group differences in physiological change and perception of music, respectively. The results indicated that there was a statistical difference in physiological change between the 2 group conditions ($P = .005$), with greater changes present in the dimmer light condition than in the regular light condition. There was no significant difference in the music mood perception between the groups. These results indicate that brightness may be a significant paravariable in the listening experience.

Keywords

music listening, brightness, light, mood, tension

The influence of music on a listener's mood and physiological state is an ongoing research theme for musicologists, music educators, music theorists, music therapists, and so on. Among many musical experiences, listening has been extensively studied by music therapists, clinicians, and music educators in terms of its various effects on human responses. Listening to various forms, ranging from a simple sound to an entire musical piece, were used to examine the therapeutic effect on emotions and moods.[1-5]

The effects of music listening on human responses have been studied for many years, and studies have showed that there are multiple variables that affect a listener's response. The variables studied can be categorized as music-related, listener-related, and nonmusic or environment-related variables. In terms of music-related variables, studies have described that certain characteristics of musical elements can induce moods and various degree of physiological response. These variables included various rhythmic and tonal components including timbre, texture, and form. Korhan et al[6] found that music significantly helped in reducing the physiological signs of anxiety in patients, specifically the respiratory rates and systolic and diastolic blood pressure.

For music inducing mood changes, Husain, Thompson, and Shellenberg[2] showed that tempo and mode were related to arousal and mood. Thomas and colleagues[7] also examined music's effect on the physiological and psychological functioning as mediating role of emotion regulation and stress reactivity. Wong et al[8] found that the sedating effect of musical elements influenced a person's emotion feelings and physiological states. Davis-Rollans and Cunningham[9] examined the physiological responses to selected music for patients in coronary care. Lastly, music's dynamic and texture can also elicit strong emotional reactions, which are colloquially referred as chills.[10]

In terms of listener-related variables, studies have examined variables including the listener's precondition and personal relationships, preferences, needs, traits, and so on. Thaut[11] showed that a listener's own selection of music affected the level of anxiety and relaxation. Preference was found to be a significant variable that affects listeners' mood,[12] as were musical selection[13] and the listener's psychological needs.[14]

In terms of nonmusic variables, some studies have examined the listener's response to music with the presence of other sensory variables alongside listening and how these might alter a listener's perception of music. Stratton and Zalanowski[15] examined the influence of music cognitive appraisal on mood by visually presenting paintings of different moods during

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music listening. They found that these variables interacted with the listening experience and that the visual stimuli combined with music had a greater effect on mood than either stimulus did alone. Byrnes[16] studied the effect of visual and auditory stimuli on the experience of stress and mood and showed that there was a significant difference between beginning and ending stress responses. Boltz, Esendorr, and Field[17] examined whether visual information influences mood perception and memory, and results showed that both the affect and format of visual information differentially influenced the way a melody was perceived. Kim and colleagues[18] examined the level of stress when music was played with light, facilitating visual and auditory integration, from which they derived the implication that multisensory input can be essential part of milieu therapy.

According to Bruscia,[19] different types of stimuli exist in musical environments: premusical, musical, extramusical, and paramusical. Premusical stimuli are those that are not yet developed or considered intrinsically musical, such as as vibration, sound, vocalization, and so on. Musical stimuli are those that have sufficient meaning, composed of musical elements, form, and objects, such as instruments and voices. Extramusical stimuli are those that have referential aspect of music, such as lyrics, stories, dramas, artworks, and so on. Paramusical stimuli indicate those aspects of a music environment that impinge upon an individual while listening to or making music. These occur independently from the music, but coincide in a tangential way, serving as a foreground for the client's experience with music in the background. Representative examples of paramusical stimuli include lighting, props, paintings, furniture, window views, and so on. It is necessary to verify the potentially significant effects of such stimuli in the musical environment because they may elicit a response due to the background stimulating effects and levels of musical experience.

Among many visual variables in the listening environment, brightness is one of the paramusical stimuli which may directly or indirectly affect the listener. Studies that dealt with brightness examined the effect of light on the human physiological, mood, and biological functions.[20,21] In terms of mood, light has been used as a powerful treatment for alleviating depression[20] Work of this nature reflects not only clinical interest in affective disorders but increasing interest in the fundamental effects of variations in light parameters such as duration, timing, and intensity upon mood physiology and behavior.

Physiologically, light has been used as a therapeutic means of reducing physical symptoms such as fatigue and shift in circadian rhythms.[22-24] Biologically, researchers found that light may control nocturnal melatonin secretion and also has an immunological effect by enhancing T-cell counts.[25] Also light can indirectly control energy regulation as it affected oxygen consumption during the exercises.[21]

The preceding studies suggest that the brightness of the light in a listening environment may have some impact on the listener's physiological state and mood perception for the music. When it comes to the therapeutic environment, these peripheral variables function as important compounding variables. Especially in a music therapy setting, the listening experience can be a primary component of the client's passive participation; however, studies on light condition's effect on listening environment are few. The purposes of this current study were to investigate, first, how listeners perceive music under different light conditions and, second, how this difference in perception may bring changes to their physiological state.

Table 1. Information of Participants.

Factor	No.
Gender	
Female	51
Male	25
Major	
Voice	17
Composition	14
History	24
Performance	11
Musicology	10
Year	
Freshman	32
Sophomore	24
Junior	16
Senior	4
Total	76

Methods

Participants

A total of 76 university students, all of whom were music majors without any visual or auditory disabilities, participated, as shown in Table 1. The participants were divided randomly into 2 experimental groups. Participants listened to music only in one light condition to avoid preconditioning or preexposure effects. Group 1 ($n = 38$) listened to music under a regular light condition; group 2 ($n = 38$) listened to music in a dim light condition. The homogeneity of the groups was analyzed using the pretest scores for physiological state. The result indicated that there was no statistically different group difference ($P = .176$), which implies that participants' initial physiological state should not affect the result of the experiment at a significant level.

Procedure

The participants were randomly assigned to 2 different light conditions. They were scheduled to participate in the study individually. They entered the research room and sat on the listening chair placed in the middle of the room. Before the experiment, they were given 2 sheets comprising an informed consent form, one of which they were asked to submit after signing.

They were asked to take 1 minute to focus on their body and assess their tension level. Following this, they were asked to indicate it on the sheet placed in front of them, the first Visual

Analog Scale (VAS) scale. After their indicating, music was played for the listening. After the music, they were given 1 minute to refocus on their tension level and were asked to indicate their tension level one more time on the second VAS scale.

Following the posttest assessment, they were given 1 minute to evaluate how they perceived the mood of the music. After they evaluated the music's mood, they were asked to indicate it on the third VAS scale that has the adjective listings on each end.

Music Listening Condition

For the study, the music was selected based on 3 characteristics: first, low familiarity to minimize any association effect; second, sedating characteristics since the scope of this study was to examine the effect of brightness on physiological level. Lastly, music had to have a sufficient length so as to be processed by the listeners to achieve mood and physiological response. Based on these criteria, the music selected was "My Father's Favorite" composed by Patrick Doyle, taken from the soundtrack of the film *Sense and Sensibility* (1992), which was 3 minutes 50 seconds long.[26]

The study was conducted in 2 different light conditionings: one in dim light and another in bright light. The brightness of light was measured using a light meter made by Gossen, the model name of which was Panlux. The level of brightness in the dim light condition was measured 12-foot candles, whereas the level of brightness in the bright light condition was average room brightness for reading in day time. Except for the level of brightness, the physical environment and the listening conditions were controlled for both rooms.

Measurements

Participants were tested individually using VAS to assess their perception of the physiological state and mood of the music. The first VAS is a scale that is composed of 2 lines on which the participants self-indicate their perceived level of tension and mood. The length of each line was 170 mm long. For this tension scale, one end represents feeling "uplifted and relaxed" and the other end represents feeling "tensed and anxious." Before listening to the music, the participants measured their physiological state on the first VAS scale. After listening to the music, participants repeated the assessment, allowing detection of any perceived change in the physiological state on the second VAS scale.

Following the posttest of physiological level, participants were given third VAS to indicate the perceived mood of the music. For this mood scale, one end represented "dark, depressing, doleful, melancholy, pathetic, sad and tragic" and the other end represented "bright, cheerful, gay, happy, joyous, and merry." These adjectives were taken from the adjective checklist systematically developed and constructed by Hevner from the clusters 2 and 6, as this set provides adjectives that are appropriate for indicating contrasting and opposing qualities of mood.[27] They were asked to draw a vertical mark on the continuum line. To assess physiological changes, data were collected by measuring the difference between pretest and posttest.

Table 2. Observed and Adjusted Means for Variables at Posttest.

		Mean	
Variable	Group	Observed	Adjusted
Physiological variable	Regular	71.83	72.01
	Dim	92.55	92.37

Table 3. Analysis of Covariance in the Physiological State Between the 2 Groups.

Source	SS	*df*	MS	*F*	Sig
Brightness	7862.97	1	7862.979	8.447	.005[a]
Error	67 955.02	73	930.891		
Total	590 477.79	76			

[a]$P < .05$.

Data were analyzed using analysis of covariance (ANCOVA) and analysis of variance (ANOVA). Analysis of covariance was selected to examine the difference between groups, setting the pretest scores as a covariate on the grounds that participants were randomly divided into 2 groups.[28] Analysis of variance was used to examine the difference between the 2 groups in their perception of the mood of the music.

Results

Before the analyses, the study examined the homogeneity of the 2 groups using the pretest scores for physiological state. The result indicated that there was no statistically different group difference ($P = .176$), which implies that the participants' initial physiological state should not have affected the result of the experiment at a significant level. Given this finding, data were further processed.

The first analysis was administered to examine the statistical group difference in participants' change in physiological state after listening to the music in 2 different light conditions. In order to reduce some of the variance between the groups due to individual differences in pretest, ANCOVA was selected as the statistical test to examine the difference between the groups, using the pretest scores as a covariate. This method minimizes the effect of pretest scores on group difference, as the preexperiment condition of participants may work as a confounding variable.[28] The ANVOCA yields changes in the group mean as shown in Table 2.

The result of the ANCOVA indicated that there was a statistically significant difference at the level of .05 ($P = .005$) in physiological change after listening to the music in 2 different light conditions. This indicates that listeners perceived greater changes in their physiological state in the dim light condition as shown in Table 3.

Table 4. Descriptive Statistics on the Perception of Music's Mood.

Group	N	Min	Max	M	SD
Regular	38	55	170	99.19	26.79
Dim	38	28	150	86.17	32.26

Table 5. Analysis of Variance on the Perception of Music's Mood Between the 2 Groups.

Source	SS	*df*	MS	*F*	Sig
Light	3221.40	1	3221.408	3.663	.060
Error	65085.27	74	879.531		
Total	721100.12	76			

Second, the study examined whether there was a significant difference in music mood perception between the groups under 2 different light condition using ANOVA. The mean difference between the 2 light conditions showed that under dim light condition, the participants perceived music as being darker and more melancholy, whereas under the bright light condition, they perceived the music to be brighter and more gay (Table 4). However, ANOVA showed no significant group difference in how the mood of music was perceived between the 2 different light conditions ($P = .060$; Table 5).

Discussion

The study aimed to find out whether different brightness levels in the music listening environment had any effect on the listener's perception on the changes in their physiological state and mood of the music. The result showed that in the dimmer light condition, listeners reported greater change in their tension and anxiety levels, yielding a statistical difference between the 2 groups: dimmer light condition was conducive to more change during listening. Tension and relaxation are incompatible; therefore, a listener may experience reduced anxiety along with lesser tension. This may imply that there might be a potential effect of reduced light on auditory sensitivity. One can surmise that the absence of visual stimuli may have allowed the listener to become more engaged with listening to the music due to the elimination of potential visual distractions.

In terms of the perception of the music's mood, the results did not reveal any statistically significant difference in participants' musical perceptions between the 2 light conditions. Just as a reference, the participants appeared to perceive music as being more "bright, cheerful, gay, happy," and so on under the regular light condition and "dark, depressing, doleful, melancholy" under the dimmer light condition.

Existing research on the relationship between human mood states and light exposure is relevant to considerations of brightness and mood perception for music. One can say that this result is congruent with the clinical insight behind the light therapy[20]; that is, the brighter the condition, the more positive the perception of music. However, one needs to note that in this study the aim was to examine the facilitative effect of light on music listening instead of its direct effect on mood.

Lastly, for the dimmer light group, there may have been a placebo effect since the light was controlled after describing the study to the participants. This act of light adjustment may have prompted the listeners to perceive the mood of the music differently to the regular light group.

For the future research, it would be interesting to collect and analyze qualitative data on the listening experience of the 2 groups. For this study, after the experiment, some participants made introspective comments that in the dimmer condition, music sounded louder in their auditory sensation. Another participant verbalized that dimmer condition helped the participant to be more engaged with the music at a deeper level, without being distracted by exposed elements of the room. These comments indicate that fewer visual stimuli may have reinforced attentiveness to the music. Therefore, qualitative study on music listening in 2 different light conditions might derive substantial information.

Overall, the results indicated that different light conditions in a listening environment affect how the listeners perceive their physiological state and its changes. One shortcoming of the present study may be its relatively small sample size, and as such, replication using a larger sample would increase statistical power. It is necessary to find a redefined measurement tool or scale with strengthened reliability and validity which can measure the dimensions of changes, in terms of both the intensity and the quality of the perceived mood. Along with this, more sophisticated research design is needed to examine the facilitative and direct effects of light.

Declaration of Conflicting Interests

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