

Religious Ecstasies, “Deep Listeners,” and Musical Emotion

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ABSTRACT: The aim of this study is to begin to provide an explanation for the worldwide linkage of music and ecstatic religious ceremonies. The basic hypothesis is that the physiological ability to respond to musical stimuli with strong emotional responses is one of the pre-conditions for the propulsion into ecstasy. A second hypothesis is that a sub-set of the music-loving community, the “deep listeners” who are profoundly moved (chills, tears) by musical listening will have emotional reactions similar to those of religious ecstasies. 60 participants, divided into five groups, were tested using galvanic skin response and heart rate measurements. The results seem to support the hypotheses by demonstrating 1) a correlation between being a religious ecstatic and having a strong GSR while listening to favorite music, in comparison with control groups, and 2) a correlation between being a secular “deep listener” and having a similarly strong GSR listening to favorite music, in comparison with control groups.

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KEYWORDS: *trance, emotion, music, religion, galvanic skin response*

[Editor’s Note 1: Two versions of this manuscript were prepared by the author: a Science version and a Humanities version. Because these versions are similar, they have been combined into a single manuscript. Sections or Figures that appear only in one of the two versions are indicated by an Editor’s note. The endnotes referenced throughout this manuscript are from the Humanities version only]

INTRODUCTION

MUSIC is an essential part of trance/ecstatic rituals the world over (Bourguignon, 1966, p. 3; Rouget, 1985, p. xvii). (In this article, ecstasy and trance are used interchangeably.) Trance is an altered state of consciousness experienced by a select subset of the congregation in many religious rituals across the planet. Trance is a cognitive, emotional, and behavioral state characterized by the loss of sense of self, the cessation of inner languaging (everyone’s silent inner monologue) (Becker, 2004, p. 28-29), and an extraordinary ability to withstand fatigue or pain. Trance, or ecstasy, is often also accompanied by a particular kind of knowledge, a sense of unity with all humankind, a certainty of an encounter with the divine (James, 1982, pp. 380-381). Trancers are usually physically active and may display characteristics such as trembling or rigidity. The trance episode may conclude with a loss of consciousness and a collapse to the floor. Trancing is hard to fake.

Nonetheless, trancing is often dismissed. Musical experience and religious experience are admittedly highly subjective, and trance is often considered as either fraudulent or psychotic (Prince, M., 1930, p. 288; Decker, 1986, p. 48; Janet, 1920; Buranelli, 1975, p. 121). Besides the suspicion that trance is either fakery or a pathology such as hysteria, bipolar disorder or schizophrenia, there is widespread confusion between trance and meditation. Below is a chart (partially based on Rouget, 1985) of the distinction between meditation (an altered state of consciousness widely accepted by Western educated society) and trance (an altered state of consciousness not widely accepted by Western educated society).

<u>Meditation</u>	<u>Trance</u>
sensual deprivation	sensual overload
silence/chanting	music/drumming
stillness	movement/dance
private/solitude	public/communal
short or long duration	short duration
no amnesia	often no memory of event

Meditation has been well received by the western academy, scientists and other scholars alike (e.g. Wallace and Benson, 1972; Herzog et al, 1990-91; Saver and Rabin, 1997; Newberg et al, 1997; Austin, 1998; Travis, 2001; Peng et al, 2004). Scientific empirical studies of trance are very rare, due in part to the fact that trancers are constantly in motion and the technology to handle this field situation is only now developing (e.g. Simons, Ervin, and Prince, 1988; Ervin et al, 1988; Oohasi et al, 2002). In addition to innumerable anthropologists who have spent years among ecstasies (e.g. Belo, 1960; Bourguignon, 1968; Berliner, 1978; Stoller, 1989; Kapferer, 1991; Csordas, 1994; Friedson, 1996; Guenther, 1999; Mueggler 2001), a few Western scholars have attempted to present a more balanced view of ecstasy. William James (1842-1910) championed the view that ecstatic states are not pathological (James, 1950, Vol. 1, p. 393; James, 1950, Vol. 2, p. 593; James, 1982). Other scientific scholars who are sympathetic to this particular altered state include Fischer (1971), Mandell (1978), Inglis (1989), and Newberg, d'Aquili, and Rause (2001).

In a recent article, John Sloboda has written "Both the psychology of music and the psychology of religion are very much 'fringe' topics in contemporary psychology. The number of psychologists interested in both must be tiny" (Sloboda, 2005, p.345). If music and religion are "fringe" topics, then music, religion, and trancing must be beyond fringe.

One of the objectives of this article is to try to bridge the gap between humanistic approaches and scientific approaches to the study of music, emotion, and altered states of consciousness. The study of humankind demands both, they are not inimical to each other, and communication across disciplines is salutary for all parties (Becker, 2001, p. 152; Becker, 2004, p. 108; Sloboda and Juslin, 2001, p.98). One recent study of music and spirituality among Pentecostals has explicitly called for such cooperation (Miller and Strongman, 2002, p. 24). However, for some scientists, the confluence within this study of musical experience, religion and altered states of consciousness makes any empirical study highly problematic.

In attempting to bring the humanistic particularity of ethnomusicology and the scientific universalism of psychology into meaningful dialogue, some honored tenets of each will be violated. Humanists are interested in the particular, in the unique, in the special. The psychologist looks, rather, for universals, or at least aspects of human behavior that can be widely applied across cultures and across time. Humanists tend to draw large conclusions from particular instances of human musical behavior. The psychologist will draw only limited or constrained conclusions from a study with masses of data. In this study, broad conclusions are drawn from limited data, violating psychological best practices.

A basic tenet of ethnomusicology and anthropology, as well as for some scholars in the field of neuroscience, is that whatever is internal to the organism is linked to the individual history and environment of the organism (e.g. Maturana and Varela, 1987; Varela, Thompson, and Rosch, 1991; Edelman, 1992). Phenotypic developments are the result of our involvement in a cultural milieu. All the participants in this study belong to one or another particular musical, social sub-culture of the society in general, and that sub-culture influences their musical preferences. Their individual, physiological reactions to music cannot be separated from their personal histories in interaction with their social context. But in this small, circumscribed study, those full complexities are largely ignored in the effort to empirically support the hypothesis concerning a physiological correspondence between ecstasies and deep listeners, thus violating ethnomusicological best practices. (See Sloboda and Juslin, 2001, p. 71).

[Editor's Note 2: The following appears in the Humanities version only:

Among ethnomusicologists, there is some resistance to incorporating scientific procedures into a research project that is so personal, so interior, so elusive as emotional response to musical listening. Science and scientific methodology may be seen as a threat to cherished beliefs about individual agency, free will, spirituality, and our inner life. We think their fears are misguided and reflect a certain misunderstanding of what science is about.

To paraphrase Albert Einstein:

We don't claim to know truth in science. What we claim is that we have provided the best humanly possible explanation for what we see in the world around us. Science is not about truth. Science is about making our beliefs less false. [1]

Or, to quote the anthropologist, Gregory Bateson, "Science never proves anything. . . . Science only probes" (Bateson, 1979, p. 29-30). [2]

Our use of scientific technology is only a probe. It does not reveal the inner life of our participants. It only gives us some small bits of information about a small physiological component of our emotional inner life. As humanists, when exploring anything as elusive and difficult as ecstasy and music, we need all the help we can get. There is no question that something special happens in the mind/body of religious ecstasies when listening to religious music. Science can help us to penetrate whatever that "something" is. No one is claiming that science provides all the answers, only that science can help us to understand one of the most intractable problems of musical research, i.e. the association of music and ecstasy.]

In her book, *Deep Listeners: Music, Emotion, and Trancing* (2004), Becker posited that there is a fundamental correlation between institutionalized religious trancing and strong emotional responses to music. The following hypotheses were proposed:

1. Trance involves a physiological prerequisite, i.e. the subconscious mediation of the autonomic nervous system (ANS) [3], especially during music listening.
2. Secular deep listeners – people who experience chills or goosebumps, who cry, or who are otherwise deeply moved when listening to their favorite music – are people who also have this biological predisposition to trance, i.e., strong emotional responses to music.

This study was designed to begin to test these hypotheses.

METHODOLOGY

The physiological responses that were examined for this study are galvanic skin response (GSR) and heart rate, with the assumption that emotion affects both. The authors are following the definition of 'emotion' proposed in the forthcoming *Handbook of Music and Emotion: Theory, Research, Applications* (Juslin and Sloboda, in press), that lists physiological arousal as one of the components of emotion.

The term 'emotion' will be used to refer to a relatively intense affective reaction that usually involves a number of sub-components – subjective feeling, physiological arousal, expression, action tendency, and regulation – that are more or less 'synchronized.' The term 'arousal' will be used to refer to an activation of the autonomic nervous system. Physiological arousal is one of the components of an emotional response, but could also occur in the absence of emotion (e.g., due to exercise). (Juslin and Sloboda, in press)

(In this study, all artifacts caused by motor behavior such as adjusting the volume control, were removed from the data).

While it is clear that simply equating GSR and heart rate change with 'emotion' is an oversimplification as well as controversial, we are following the literature in recognizing GSR as a standard measure of emotional arousal involving the sympathetic branch of the autonomic nervous system (ANS) (e.g. Raskin, 1973, p. 126; Bouscein, 1992, p. 18; Witvliet and Vrana, 1996; Tarvainenn et al, 2000, p. 1071; Stern, Ray, and Quigley, 2001, pp. 22-23; Khalfa et al, 2002, p. 145; Chapados and Levitin (2008)[4].

Psychological studies of the relationship between music and emotion usually involve self-reports of the emotion experienced by the participant while listening to music (e.g. Wedin, 1972, p. 241; Goldstein, 1980, p. 126; Pignatiello, Camp, and Rasar, 1986, p. 295; Sloboda, 1991, p. 110; Panksepp, 1995, p. 171; Waterman, 1996, p. 56; North and Hargreaves, 1997, p. 45; Gabrielsson and Wik, 2000, p. 100; Miller and Strongman, 2002, p. 11; Dibben, 2004; Bigand et al, 2005, p. 2; Grewe et al, 2005). The use of GSR with music as the emotional stimulus, as in this study, is more rare (e.g. Zimny and Weidenfeller, 1963; Ketterer and Smith, 1977; VanderArk and Ely, 1992;

Krumhansl, 1997). Although a questionnaire concerning musical preferences was completed by all participants, only the GSR and heart rate of the participants while listening to music are the focus of this study.

Selection of Participants

In this experiment, the participants (n = 60) were divided into five groups: two were “target” groups – those compared with all others. The target groups were the “Pentecostal Ecstasies” and the “Deep Listeners.” The Pentecostal Ecstasies were separated out from the Pentecostals in general, and the Deep Listeners were selfselected as persons profoundly moved by listening to music. The Deep Listeners were mainly recruited from the School of Music of the authors’ university. These are the two populations that are hypothesized to have stronger emotional reactions to music they love than do other groups.

A local Pentecostal church was chosen as a resource for this study not only because the congregation included ecstasies but also because, like most Pentecostal churches, music is a central, ubiquitous aspect of worship. The musical portion of the service is highly participatory, comprises the largest segment of the religious service itself, and is readily acknowledged by parishioners as a path toward deeper spirituality. The confluence of music, ritual, and ecstasy, found so widely across the globe and throughout history, is manifestly enacted in every Pentecostal service (e.g. Abell, 1982, p. 130; Land, 1993, p. 112; Cox, 1995, p. 121; Wacker, 2001, p. 109; Miller and Strongman, 2002).

The three comparison groups include 1) members of the same Pentecostal church who do not trance, called the “Pentecostal Non-Ecstasies,” 2) members of two other Protestant churches, designated as “Other Protestants,” and 3) participants recruited from the general student population of the authors’ university, called “General Students.

	n	Female	Male	African-American	Asian-American	Caucasian	Average Age	Age Range
Pentecostal Ecstasies	10	60%	40%	30%	0%	70%	43.4	23-55
Deep Listeners	14	43%	57%	14%	7%	79%	44.2	19-71
Pentecostal Non-Ecstasies	16	62%	38%	25%	19%	56%	31.8	18-50
Other Protestants	8	63%	37%	0%	13%	87%	40.9	22-54
General Students	12	58%	42%	16%	17%	67%	19.6	18-23

Table 1: The demographics of each of the groups. Each group is ethnically diverse. Except for the General Students group, each group represents a wide age range.

The Pentecostal Ecstasies and the Pentecostal Non-Ecstasies were drawn from an Apostolic Faith Pentecostal church. The authors received permission from the pastor to set up a table in the lobby, with a poster describing the study (“Music and Emotion”), and requesting volunteers. The church is multi-racial with a middle-to-lower-middle-class demographic and about five hundred members. The classification ‘ecstatic’ was made solely on the basis of observation: If, during one of the many church services that the authors attended, participants were seen to trance, they were classified as Pentecostal Ecstasies. Within the church, the particular manifestations of trance include speaking in tongues, “translating” the speaking in tongues of someone else, shaking and trembling with upraised arms, anguished facial expressions, and often the classic collapse onto the ground that signals the end of trance (Rouget, 1985, p. 321). While the possibility exists that the trancing of one or more of the participants who volunteered for this study was missed, generally speaking, those who trance at all do so on a fairly regular basis.

Members of two other local churches were recruited as one of the comparison groups (Other Protestants). The authors received permission from the pastors to set up a table in the lobby of the church advertising this study (“Music and Emotion”) and requesting volunteers. These churches are similar to the Pentecostal church in demographics – working-class and multiracial, though predominantly white – and in their worship music – Christian Rock and soft Gospel. There is, however, no trance component to their services. This group included some people whose GSR graphs indicated strong responses to musical listening, and thus people who, according to Becker’s hypothesis, are potential trancers were ecstatic practices condoned or encouraged in their churches.

The Deep Listeners were recruited from friends and colleagues of the authors at the school of music of their university. An e-mail message was sent to all faculty members of the school of music, and several music school classes were visited. In both cases, the authors asked for volunteers who believed themselves to be “deep listeners” - that is, who had very strong emotional responses, including perhaps tears and chills, to the music they love. (See Goldstein, 1980; Panksepp, 1995; Grewe et al, 2005). The people who responded to the requests were therefore mainly music students and professors, and all self-rated their response to music in the questionnaire as “very emotional.”

The General Student group was recruited by means of signs posted in public places around the university. The sign described the study as about “Music and Emotion.” The participants who responded were all students pursuing undergraduate degrees. The General Student group is mostly comprised of much younger participants than all other groups. It can be argued that emotional attachment to one’s favorite music is likely to be more intense during adolescence than at any other time of one’s life, (e.g. Giles, 1987; Laiho, 2004; Sylvan, 2005; Levitin, 2006, p. 247), and therefore this group would have stronger responses. Indeed, in this study the General Students’ emotional responses were exceeded only by the two target groups, Pentecostal Ecstatics and Deep Listeners.

The groups do not, therefore, have the same criteria for inclusion. The Pentecostal Ecstatics and Pentecostal Non-Ecstatics were designated by the authors based upon observed activities at church. The Deep Listeners were self-selected based upon their declared emotional response to musical listening, while the Other Protestants and General Students group were randomly selected.

It is important to point out that there was no homogeneity within any group. There were persons who responded strongly to musical listening in all groups, as well as persons who did not respond strongly in all groups. The participants were paid differentially according to whether they were friends, students, church people, or faculty associates. While church people and students were reimbursed, it was deemed inappropriate to pay friends and faculty associates.

[Editor’s Note 3: The following section PSYCHOLOGICAL SCREENING appears in the Sciences version only]

PSYCHOLOGICAL SCREENING

To rule out the suspicion that trancers may not be psychologically stable, a psychiatric exam was performed by Dr. Barbara Kamholz, an American Board of Psychiatry and Neurology-certified psychiatrist participating in the project. Nine Pentecostal ecstasies and ten Pentecostal non-ecstasies were examined at the testing site, in private, either immediately following the listening experiment or within a few weeks. Dr. Kamholz used the Brief Psychiatric Rating Scale (an overall measure of psychiatric dysfunction by general affective and psychotic categories), the Hamilton Depression Inventory (to assess depression), the Mini Mental State Examination (to assess cognition), and the Schedule for the Assessment of Negative Symptoms (SANS, to assess the more subtle aspects of psychosis). The participants were told that these tests were to establish a “psychological profile.” Some of these individuals had some prior acquaintance with Dr. Kamholz by virtue of contacts at the church as well as during the music listening experiment. However, each exam was carried out privately and formally, asking brief questions about prior psychiatric contacts and then administering the scales. These findings affirmed that the trance behaviors exhibited by the ecstasies were unlikely to have been due to diagnosable psychopathological conditions. While a few individuals were identified who had affective symptoms such as depression or hypomania, in no case were any found who would meet clinical criteria for depersonalization, fugue, psychosis, multiple personality, or associated disorders. The only outwardly discernible difference between the participants in the Pentecostal Ecstatic category and the Pentecostal Non-Ecstatic category is that the ecstasies are likely to trance during religious services whereas the non-ecstasies do not.

Musical Examples

PARTICIPANT-SELECTED MUSIC

All participants were asked to bring in two favorite songs or pieces of approximately five minutes each. Everyone is likely to respond more strongly to music with which they are familiar than to music with which they are not familiar (Gregory and Varney, 1996; Miller and Strongman, 2002; Levitin 2006, p. 236). “It is notoriously difficult to elicit very strong emotions in listeners when the pieces have been experimenter-selected” (Rickard, 2004, p. 373). The advantages of participant-selected versus experimenter-selected music thus often outweigh the advantages of the more uniform approach of using only experimenter-selected music (e.g. Thaut and Davis, 1993; Blood and Zatorre,

2001, p. 11818; Rickard, 2004, p. 373). In this study, both participant-selected music and experimenter-selected music (as a control) were called for.

The musical preferences of the participants were quite diverse and were consonant with the social group to which they belonged. Participant-selected musics were copied into a computer and subsequently categorized by the authors, both of whom are familiar with a wide range of musical genres. Categories such as Rock/Alternative or Rap/R&B were conflated in order to avoid having a category of one or two examples. The exception is the category of “children’s music” which could not be conflated with any other category.

	n	Contemporary Christian	Classic	Pop	Rock/Alternative	Rap/R&B	Gospel	Electronic	New Age	World	Children’s	Jazz
Pentecostal Ecstasies	20	30% (6)			15%(3)		40%(8)			10%(2)		5%(1)
Deep Listeners	28		57%(16)		18%(5)					18%(5)		7%(2)
Pentecostal Non-Ecstasies	32	63% (20)	3%(1)		16%(5)	3%(1)	16%(5)					
Other Protestants	16	50%(8)	13%(2)		6%(1)		13%(2)		13%(2)		6%(1)	
General Students	24			17%(4)	50%(12)	13%(3)		13%(3)	8%(2)			

Table 2: The genres of music selected by each participant group. All three church groups, Pentecostal Ecstasies, Pentecostal Non-Ecstasies and Other Protestants included a substantial percentage of religious music in their selections. Only the Deep Listeners category included a substantial percentage of classical music, while Rock/Alternative music was selected by a substantial percentage of the General Students category.

CONTROL MUSIC

For the first control, a work by the minor early-Classical composer Sammartini was chosen. The authors were seeking a neutral control to contrast with the participant-selected musical examples.

The second control example was chosen from pieces that had been the favorite music of earlier participants. (See also Blood and Zatorre, 2001, p. 11819). The rationale for this procedure was to suggest that the physiological response to music is not inherent in the music itself, but rather resides in the relationship between a specific listener and the music. These pieces engendered an intense reaction in the participant who had initially brought in each piece. One’s response to musical stimuli is a complex of emotional reactions relating to familiarity, to texts, to previous musical associations, to previous situational associations, as well as to what may be called purely musical or structural considerations (Meyer, 1956; Sloboda and Juslin, 2001, p.95; Levitin, 2006, p. 217-240).

Patrick Juslin and Daniel Västfjäll (2008) stress the importance of considering the underlying mechanism that generates an emotion when listening to music. The authors suggest a minimum of six possible underlying mechanisms:

1. *Brain stem reflex* is defined as “a process whereby an emotion is induced by music because one or fundamental acoustical characteristics of the music are taken by the brain stem to signal a potentially important and urgent event . . . sounds that are sudden, loud, dissonant, or feature fast temporal patterns that induce arousal or feelings of unpleasantness in listeners.”
2. *Evaluative conditioning* is defined as a musical piece or genre that has been repeatedly paired with another stimulus. For the church-goers who brought in religious music, this implies that the memoried relationship to positive religious experience is an important “underlying mechanism” for their emotional reactions.
3. *Emotional contagion* is defined as “a process whereby an emotion is induced by a piece of music because the listener perceives the emotional expression of the music, and then ‘mimics’ this expression internally.”

4. *Visual imagery* “refers to a process whereby an emotion is induced in a listener because he or she conjures up visual images (e.g. of a beautiful landscape) while listening to the music.”
5. *Episodic memory* “refers to a process whereby an emotion is induced in a listener because the music evokes a memory of a particular event in the listener’s life.”
6. *Musical expectance* “refers to a process whereby an emotion is induced in a listener because a specific feature of the music violates, delays, or confirms the listener’s expectations about the continuation of the music.”

Only numbers 1, 3, and 6 in this list refer to features inherent in the music. Numbers 2, 4, and 5 depend upon extra-musical factors, and numbers 3 and 6 minimally require a culture-specific understanding of musical syntax. Juslin and Västfjäll are careful to point out that these six factors (there may be many more) do not necessarily operate singly, but may be combined in the musical listening of any given individual. Thus, the fact that one of our control examples was an emotional stimulant to one person and a neutral control for another is to be expected.

The Experimental Session

After completing a questionnaire (not analyzed here) concerning musical preferences and emotional reactions to music, and the requisite university consent form, the participant was given headphones while sitting on a comfortable couch looking out a window with a pleasant view. This spatial arrangement was intended to minimize the effect of having the experimenters and the equipment in the same room as the participant. All participants were requested to sit quietly so that motor behavior would not be a factor in the GSR.

After an initial quiet period of 2-3 minutes, the following musical excerpts were played, allowing a one-minute period of silence between each excerpt:

1. Control 1: 3rd movement from Symphony in F major, J-C 38, by Giovanni Battista Sammartini
2. Participant Selection 1: First of the participant’s favorite pieces
3. Control 2: Favorite music of another participant
4. Participant Selection 2: Second of the participant’s favorite pieces

Materials

The participants’ GSR was measured using Ag-AgCl₂ electrodes attached to the index finger and the middle finger (Stern, Ray, and Quigley, 2001, p. 211-213). Heart rate was measured using a pulse photoplethysmogram transducer attached to the thumb [5]. The electrodes and transducer were connected to a BIOPAC MP100 system and recorded on a Macintosh computer using the AcqKnowledge software program.

[Editor’s Note 4: The following paragraph and figure appear in the Humanities version only]

Galvanic skin response is the measurement of a small electrical current between two electrodes attached to the fingertips of the participant. In response to ANS (autonomic nervous system) arousal, the moment-to-moment activity of the sweat glands in the hand causes changes in the relative conductance of a small electrical current between the two electrodes. These changes in the small electrical current are what we recorded in our graphs.



Figure 1: Joshua Penman with GSR electrodes attached to his index and middle finger, and a pulse transducer attached to his thumb.

Analysis

GSR INDEX

The GSR was recorded as an AC signal, thereby measuring only changes in conductance. This means that when conductance was steady, the GSR signal was flat at zero. When the participant's GSR changed, the graphical output reflected these changes by peaks and troughs. For ease of calculation, the changes in GSR were measured in units of $1 = .2 \mu\text{mhos}$ [6]. Because participants' responses to the music were distributed over the whole listening period, we found it most productive to treat the participants' GSR recordings for each given example as a unit, calculating the GSR Index, which assigns a single value for the integrated GSR reading. To compute these values, we first calibrated each recording by setting the baseline to zero. We then removed the system noise using a digital lowpass filter with a cutoff frequency of 2 Hz. Afterwards, we rectified the AC signal by taking the absolute value of the recording and then calculated the area between the curve and baseline by integration. The GSR Index was then calculated by dividing this integral by the length of the excerpt. The GSR Index is thus an aggregate measure of the strength of a given participant's response to one piece of music [7].

GSR Recording of one Piece

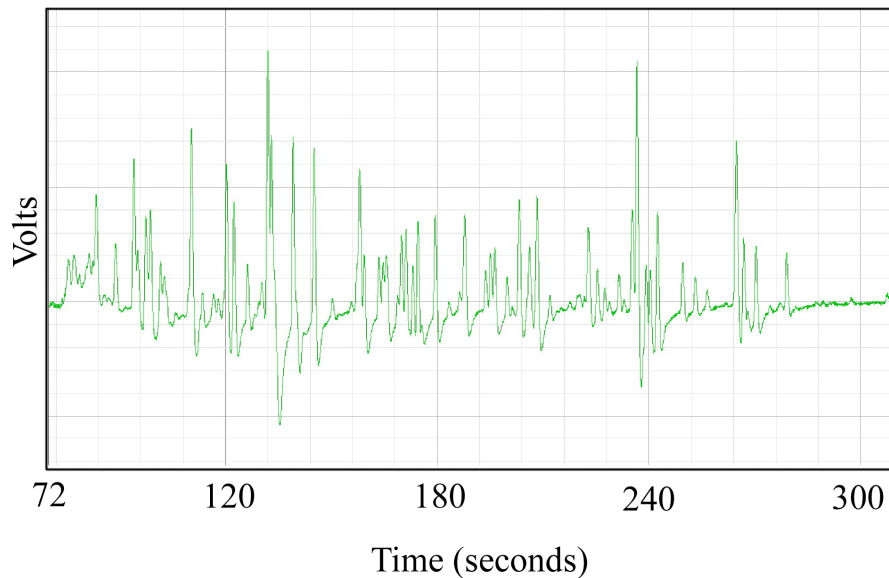


Figure 2. The calibrated and low-pass filtered GSR recording of one of our participants while listening to one of her self-selected pieces. Notice the lack of habituation that would result in a GSR line with diminishing peaks.

Contrary to the literature that stresses the habituation effect of emotional responses with GSR (e.g. Eisenstein, Eisenstein, and Bonheim, 1991; Aramaki, Kira, and Hirasawa, 1997; Toyokura, 1998; Tarvainenn et al, 2001, p. 1071), we found no general diminution of response across time, either within particular examples, or across successive examples. Earlier studies that found habituation were not dealing with extended musical listening but with exposure to sounds and images presented as short, isolated events. When listening to moving music, one's interest, attention and emotional responses do not diminish after a few minutes. Based upon GSR Index for participant-selected music, two participants were discarded as outliers, as their values were more than three standard deviations above the mean. One outlier was in the General Students group with a GSR Index of 31.8, and the other was in the Other Protestants group with an GSR Index of 29.0.

HEART RATE

For each excerpt, the mean and standard deviation of the participant's heart rate were calculated. This was done using the "Find Rate" function of the AcqKnowledge software program that translates a pulse recording into rate data. It was necessary to discard fairly large periods of artifacts due to the susceptibility to errors of pulse photoplethysmogram measurements. Thus, the heart rate data comes from only 55 participants. Four of the participants whose data was not used are in the General Students group; one is in the Pentecostal Ecstasics group.

RESULTS

GSR Index

The GSR Index for the two participant-selected pieces and the GSR Index for the two control pieces were averaged for each participant. The assumption behind this decision was that the participant would display a similar profile to both of his/her selected pieces and likewise, a similar profile to both of the control pieces. This turned out to be the case: There was not a statistically significant difference between the GSR Index for the two participant-selected pieces (paired $t(59)=.45$, $p=.654$), nor for the two control pieces (paired $t(58)=.61$, $p=.541$). These findings emphasize again the importance of familiarity in musical preferences.

The graphs for GSR Index for participant-selected music indicate that the highest readings were in the Pentecostal Ecstasics group and the Deep Listeners group [8]. The average GSR Index for Deep Listeners for the control music is higher than all other groups, and is, in fact, little different from their self-selected music.

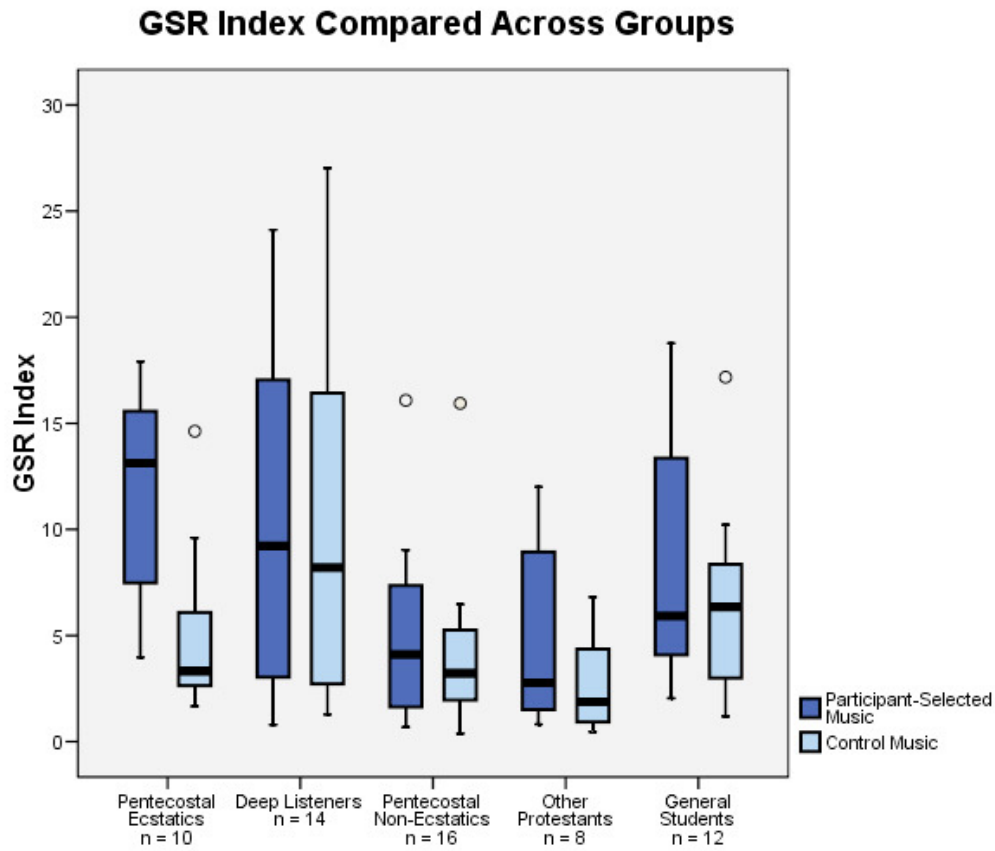


Figure 3: Statistical analysis of GSR index values across groups. The dark horizontal line represents the median value for the group, the boxes represent the values for the middle 50% of subjects, and the “whiskers” represent the full range of responses – except for the circles which represent single subjects.

[Editor’s Note 5: the following paragraph was restricted to endnote [8] in the Humanities version]

Statistical significance was revealed by a one-way ANOVA completed for GSR Index for participant-selected music across the groups ($F(1, 61) = 2.83, p = 0.033$). The following comparative differences between groups in GSR Index for participant-selected music are statistically significant by LSD: Pentecostal Ecstasics vs. Other Protestants ($p = 0.018$); Pentecostal Ecstasics vs. Pentecostal Non-Ecstasics ($p = 0.018$); Deep Listeners vs. Pentecostal Non-Ecstasics ($p = 0.025$); and Deep Listeners vs. Other Protestants ($p = 0.026$). The p-values for Pentecostal Ecstasics showed marginal significance on the Tukey test as well.

If we subtract the GSR Index for control music from the GSR Index for participant-selected music, we see that the Pentecostal Ecstasics display a unique profile [9]. Compared to all other groups, Pentecostal Ecstasics responded more strongly to their own musical selections than to the control music.

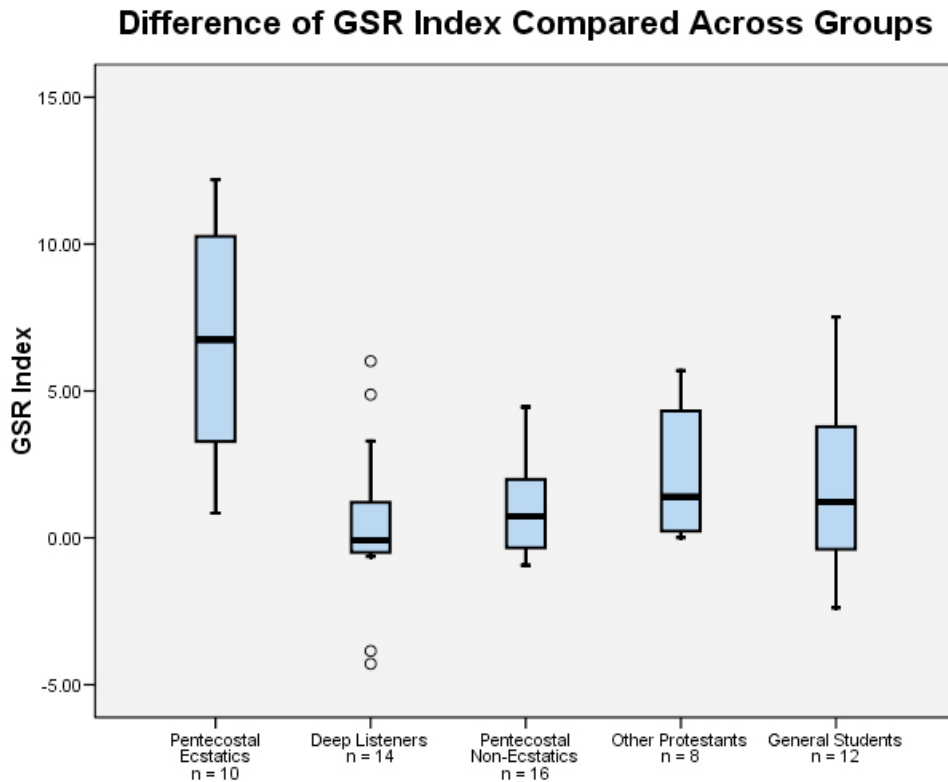


Figure 4: GSR Index for participant-selected music minus GSR Index for control music, indicating the strong preference for participant-selected music by the Pentecostal Ecstasies.

[Editor's Note 6: the next two paragraphs were restricted to endnote [9] in the Humanities version]

Statistical significance was revealed by a one-way ANOVA completed for the difference between GSR Index for control and participant-selected music across the groups ($F(1, 61) = 8.926, p = 0.001$). In this measure by the Tukey test, the Pentecostal Ecstasies group is significantly different from all other groups ($p = .008$ for Other Protestants, $p = 0.001$ for General Students, $p = .0001$ for Pentecostal Non-Ecstasies and Deep Listeners).

A similar finding is reported in Miller and Strongman's study (2002) comparing emotional responses of Pentecostals and non-Pentecostals to four musical selections, two of which were religious music and two secular. In their study, the Pentecostal group and the non-Pentecostal group reported similar responses to the secular musical examples, but the Pentecostals significantly reported more positive emotional evaluations of the religious music. In this study, the difference between the GSR Index of the Pentecostal ecstasies to their music (mostly religious) and the control music was far greater than that difference for all the other groups.

This measurement also highlights the fact that many in the Deep Listeners category, unlike the other categories, responded strongly to the control examples. It may be very difficult to find any music that those in the Deep Listeners group would not respond to.

INTENSITY LEVEL (IL)

In order to determine if GSR Index was correlated with features such as tempo, loudness, register and timbre that could be construed as increasing "powerfulness," the authors devised the measurement IL (Intensity Level). IL is a subjective measurement of how "intense" each piece of music was, combining features of tempo, loudness, register and timbre [10]. Both authors have extensive musical backgrounds and thus feel qualified to make such an evaluation.

For each selection, the authors independently came up with an intensity rating on a nine-point scale. The ratings arrived at by the authors were usually the same, and only twice did they differ by more than one point. These subjective ratings were averaged to calculate the Intensity Level (IL) score for each piece. Most musical examples from all groups were in the mid-range, with a few at either end of the continuum.

- Listed below are typical examples of the ratings:
 Level 1: “Only Time,” by Enya
 Level 2: “When I Fall in Love,” by Chris Botti
 Level 3: “I Won’t Last a Day without You,” by David Osborne
 Level 4: “Michele,” by The Beatles
 Level 5: “Water Night,” by Eric Whitacre
 Level 6: “On the Nickel,” by Tom Waits
 Level 7: “Stigmatized,” by The Calling
 Level 8: “Bold as Love,” by Jimi Hendrix
 Level 9: “I’m Going Through,” by Aretha Franklin

	Mean IL
Pentecostal Ecstatics	5.35
Deep Listeners	5.31
Pentecostal Non- Ecstatics	5.48
Other Protestants	4.06
General Students	5.33

Table 3: Mean Intensity Level (IL) for each of the five groups of participants.

[Editor’s Note 7: the next paragraph did not appear in the Humanities version]

The correlation, or not, between “powerful” music and strength of emotional response has been tested before (e.g. Zimny and Weidenfeller, 1963; Thaut, 1990, p. 7; Rickard, 2004, p. 371), with results generally indicating stronger response to “powerful” music than to more “calm” music. In this study, it was found that GSR Index is moderately correlated to IL for the participant-selected music [11]. For the first participant-selected piece, the Spearman correlation coefficient between GSR Index and IL is 0.38 ($p=.0042$); for the second piece, it is 0.26 ($p=.048$). Figure 6 is a graph of the IL for each of the first participant-selected pieces.

[Editor’s Note 8: the next paragraph was restricted to endnote [10] in the Humanities version]

The correlation between “powerful” music and strength of emotional response has been tested before with results generally indicating stronger response to “powerful” music than to more “calm” music (e.g. Zimny and Weidenfeller, 1963; Thaut, 1990, p. 7; Rickard, 2004, p. 371).

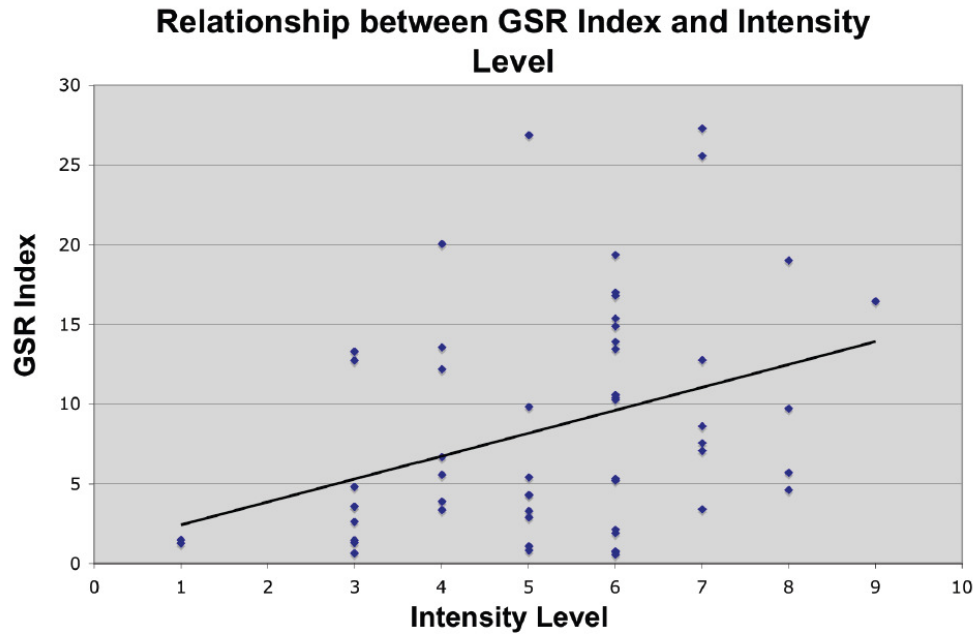


Figure 5: A scatter plot showing the relationship between GSR Index and IL for the first example of participant-selected music. Each diamond represents one piece of music listened to by one participant. A “best-fit” line has been drawn to show the overall trend that the response is greater for more intense music.

Heart Rate

In the literature, musical listening and heart rate measurements have revealed widely differing correlations; sometimes heart rate increases and sometimes decreases with musical listening (e.g. Hodges, 1980, p. 113; Davis and Thaut, 1989, p. 169). In this study, all of the groups demonstrated a greater mean heart rate while listening to self-selected musical examples compared to control examples [12].

Participants average heart rate was lower for their second self-selected piece than for their first self-selected piece. There was a statistically significant difference in participants’ responses to each of their self-selected pieces (paired $t(54)=3.17$, $p=0.002$). However, there was not a significant difference in the mean heart rate for the two control pieces (paired $t(54)=.46$, $p=.649$). For ease of comparison, we chose to average these two heart rates. Again, the Deep Listeners demonstrated the least difference in average heart rate between self-selected pieces and control pieces [13].

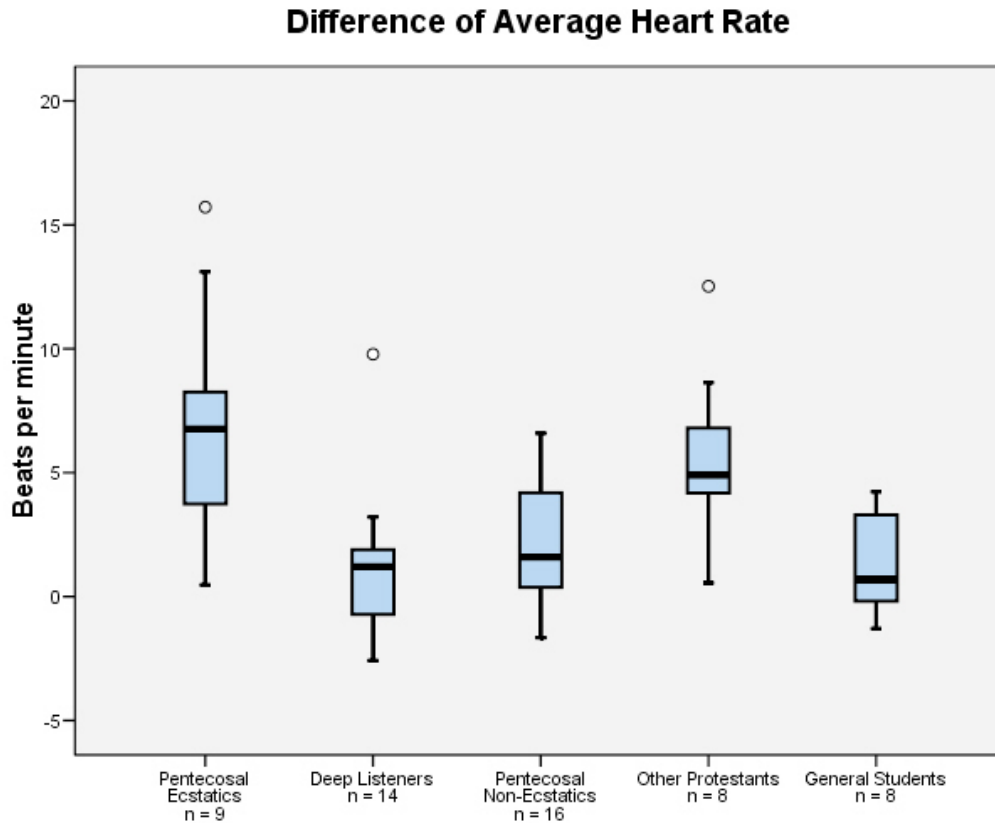


Figure 6: The difference across groups between average heart rate for participant-selected pieces and average heart rate for control pieces.

[Editor's Note 9: the next paragraph and section Heart Rate Standard Deviation do not appear in the Humanities version]

Statistical significance was revealed by a one-way ANOVA completed on the difference of heart rates across the groups ($F(1, 56)=7.497, p=0.001$). In this measure using the Tukey test, Pentecostal Ecstasies are different from all other groups except Other Protestants. The differences are statistically significant in relation to the General Students ($p = .002$), Pentecostal Non-Ecstasies ($p = .003$), and Deep Listeners ($p=.0001$). The increased difference between heart rate for participant-selected pieces and control pieces among the Pentecostal Ecstasies may also be indicative of a stronger emotional response to the familiar pieces and therefore may be related to the difference in GSR Index between participant-selected pieces and control pieces illustrated in Figure 3.

Heart rate also consistently increased across all groups when listening to any music versus the nomusic condition between each selection.

Heart Rate Standard Deviation

The standard deviation of the heart rate recording was chosen to measure the degree of variability of the heart rate during the excerpt in question. The fluctuation of the heart rates of participants during the musical listening trials was much greater in some cases than in other cases. The standard deviations were analyzed on the natural log scale to correct for lack of normality. We observed that participants had consistent responses to the two control and the two self-selected pieces in this measurement as well: there was not a statistically significant difference in heart rate standard deviation (normalized with a log transformation) across all subjects for the two participant-selected pieces (paired $t(55)=1.22, p=.429$) or the two control pieces (paired $t(54)=.26, p=.939$).

The mean of logged standard deviation for the participant-selected pieces and control pieces was calculated, and then the difference between them was calculated. A profile emerged similar to that for heart rate differences – in this measure, the differences were greater for the Pentecostal Ecstasies than for all other groups.

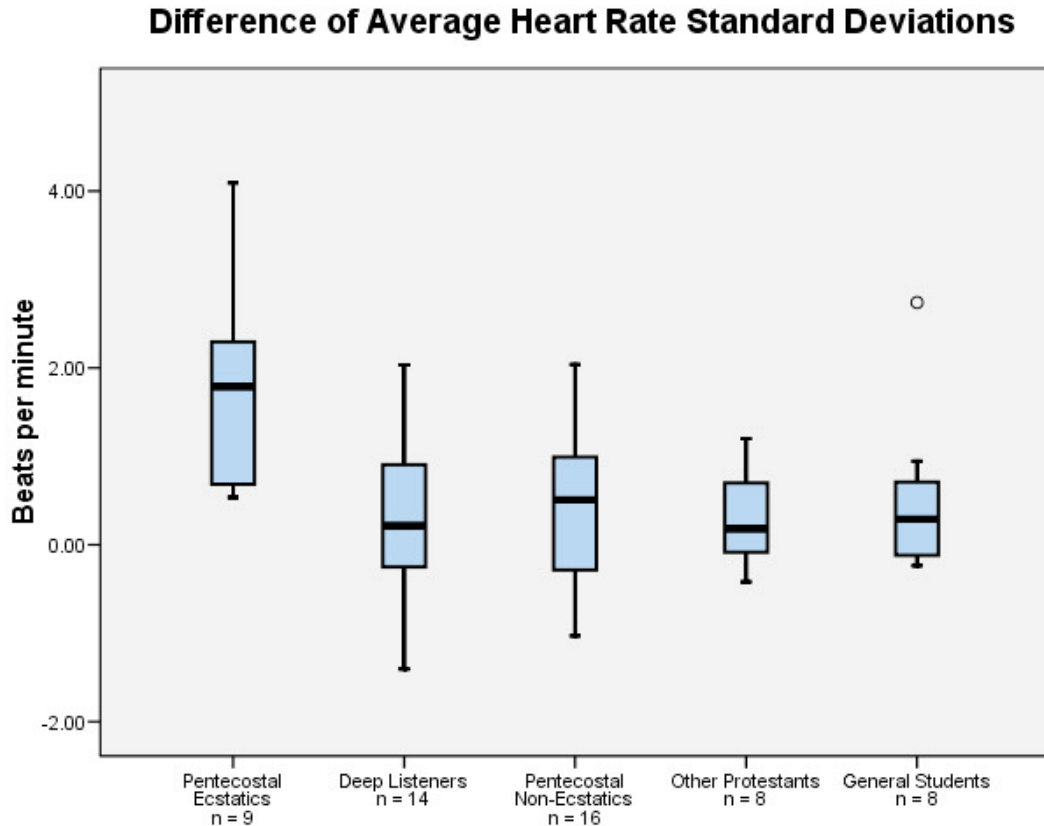


Figure 7: The difference between the average standard deviation of the heart rate for the two participant-selected pieces and the two control pieces.

[Editor's Note 10: the next paragraph does not appear in the Humanities version]

Statistical significance was revealed by a one-way ANOVA completed on the logged difference of heart rate standard deviations across the groups ($F(4.55)=4.275$, $p=0.005$). In this measure using the Tukey test, Pentecostal Ecstasies are different from all other groups, except for General Students ($p=.082$). The differences are statistically significant in relation to the Deep Listeners ($p=.001$), Pentecostal Non-Ecstasies ($p=.005$), and Other Protestants ($p=0.01$).

DISCUSSION

The initial hypotheses of this study predicted that the Pentecostal Ecstasies and the Deep Listeners would have stronger responses to listening to music they love than would other groups. The results support these hypotheses.

Another similarity between ecstasies and deep listeners, not pursued here, is that both often describe their listening experiences in transcendent terms. For example, ecstasies and deep listeners speak of the loss of boundaries between self and other, or experiences of wholeness and unity, or of a nearness to the sacred (e.g. Gabriellson and Lindstrom, 1993, p. 123; Gabriellson and Wik, 2000, p. 101; Gabriellson, 2001, p. 437; Becker, 2004, p. 54).

The strong GSR Index of Pentecostal Ecstatics for their participant-selected examples was largely anticipated by the original hypothesis. However, the results for the differences between participant-selected examples and control examples for GSR Index, heart rate, and the standard deviation of heart rate were more surprising. In each of these three measurements, Pentecostal Ecstatics registered higher values than all other groups, and statistically significant higher values than most other groups (excepting Other Protestants with respect to heart rate, and General Students with respect to heart rate standard deviation). These results seem to suggest that ecstasies have a different physiological response profile and that their unique identity has a strong biological component. It may be that the biological predisposition to ecstasy lies in a strong physiological response to all music (as with the Deep Listeners), but that part of the skill of ecstasy involves responding primarily to one's favorite music – in the case of our participants, religious music from their church. In any case, it seems possible to say that both Deep Listeners and Pentecostal Ecstatics are emotionally labile in relation to music they love.

The Deep Listeners group was the one group in this study that was mostly comprised of musicians, those listeners most likely to be cognizant of formal musical structure. It was also unique in that they responded to the controls almost as strongly as they responded to their own selections. Also unlike the other groups, the Deep Listeners often volunteered remarks on specifically musical aspects of the control pieces.

It is often assumed in music and emotion studies that strong emotional reactions to music are primarily or exclusively in response to some specific moment inherent in the music. Across all groups, self-selected music elicited stronger GSR than did the control music. The high correlation coefficient between the GSR Index of the participants to the first control piece (which none of them knew) and the second implies that it is not exclusively the music per se that produces the response, but rather the subject's relationship to it that is important (Meyer, 1956, p.13; Gabrielsson, 2001, p. 442; Sloboda and Juslin, 2001, p. 95; Levitin, 2006, p. 217-240). This does not imply that musical content is irrelevant, for it is musical content that engenders that relationship in the first place. We observed that musical boundaries, such as the return of a chorus, or a modulation to a higher register, sometimes elicit a GSR peak, a finding consistent with that of other scholars (e.g. Nielzen and Cesarec, 1982, p. 15; Sloboda, 1991, p. 114; Waterman, 1996, p. 58). For most listeners, musical factors, lyrics, and personal memories combine in the complex web of every participant's listening experience.

References to the influence of personality types upon the results of testing for emotional responses to music have sometimes been forwarded in the literature as a confounding factor (e.g. VanderArk and Ely, 1992, p. 1079; Sloboda, 1996; Nyklicek et al, 1997, p. 319; Gabrielsson, 2001, p. 443; Rickard, 2004, p. 385). Do the Pentecostal Ecstatics and the Deep Listeners share some personality traits that might affect GSR readings? It would be hard to make a case for any similarity in personality type either within the Pentecostal Ecstatic group or within the Deep Listener group, or across the two groups.

A case can be made, however, that a physiological predilection for strong GSR while listening to music characterizes both groups. Thus one could hypothesize that the Deep Listener group contains, at least potentially, ecstasies.

Music may provide the catalyst (not the cause) for the strong emotional response that may lead to trancing in religious practice. Religious trance can and does happen without music, but the presence of music that is deeply arousing helps many devotees of different faiths attain a state of religious ecstasy.

This preliminary study gives empirical support for the rationale behind the conjunction of music and religious trance across the world.

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[Editor's Note 11: the Notes only appear in the Humanities version]

NOTES

[1] From an interview with S. James Gates, Jr., Professor of Physics at the University of Maryland. "Speaking of Faith," NPR, Dec. 18, 2005.

[2] Gregory Bateson is the son of William Bateson, 1861-1926, one of the founders of the science of genetics who experimentally proved Gregor Mendel's theory of heredity and published the first English translation of Mendel's work.

[3] The Autonomic Nervous System (ANS) is the part of the peripheral nervous system that acts as a control system, maintaining homeostasis in the body. These maintenance activities are primarily performed without conscious control or sensation. The ANS has far reaching effects upon heart rate, digestion, respiration rate, salivation, perspiration, diameter of the pupils, micturition (the discharge of urine), and sexual arousal.

[4] The Sympathetic Nervous System is a branch of the Autonomic Nervous System, along with the Parasympathetic Nervous System. The Sympathetic Nervous System is always active at a basal level (called sympathetic tone) and becomes more active during times of stress. Its actions during the stress response comprise the "fight-or-flight" response.

[5] A pulse photoplethysmogram transducer records the pulse pressure wave.

[6] The actual unit is 'mho', the unit for electrical conductance, in this case the unit of GSR. The μ symbol in front means 'micro' which is a scale factor (like milli for example) and whose actual value is 10^{-6} or 0.000001. The 's' indicates the plural.

[7] Based upon GSR Index for participant-selected music, two participants were discarded as outliers, as their values were more than three standard deviations above the mean. One outlier was in the General Students group with a GSR Index of 31.8, and the other was in the Other Protestants group with an GSR Index of 29.0.

[8] Statistical significance was revealed by a one-way ANOVA completed for GSR Index for participant-selected music across the groups ($F(1, 61) = 2.83, p = 0.033$). The following comparative differences between groups in GSR Index for participant-selected music are statistically significant by LSD: Pentecostal Ecstasies vs. Other Protestants ($p = 0.018$); Pentecostal Ecstasies vs. Pentecostal Non-Ecstasies ($p = 0.018$); Deep Listeners vs. Pentecostal Non-Ecstasies ($p = 0.025$); and Deep Listeners vs. Other Protestants ($p = 0.026$). The p -values for Pentecostal Ecstasies showed marginal significance on the Tukey test as well.

[9] Statistical significance was revealed by a one-way ANOVA completed for the difference between GSR Index for control and participant-selected music across the groups ($F(1, 61) = 8.926, p = 0.001$). In this measure by the Tukey test, the Pentecostal Ecstasies group is significantly different from all other groups ($p = 0.008$ for Other Protestants, $p = 0.001$ for General Students, $p = 0.0001$ for Pentecostal Non-Ecstasies and Deep Listeners).

A similar finding is reported in Miller and Strongman's study (2002) comparing emotional responses of Pentecostals and non-Pentecostals to four musical selections, two of which were religious music and two secular. In their study, the Pentecostal group and the non-Pentecostal group reported similar responses to the secular musical examples, but the Pentecostals significantly reported more positive emotional evaluations of the religious music.

[10] The correlation between "powerful" music and strength of emotional response has been tested before with results generally indicating stronger response to "powerful" music than to more "calm" music (e.g. Zimny and Weidenfeller, 1963; Thaut, 1990, p. 7; Rickard, 2004, p. 371).

[11] For the first participant-selected piece, the Spearman correlation coefficient between GSR Index and IL is 0.38 ($p = 0.0042$); for the second piece, it is 0.26 ($p = 0.048$).

[12] Both sympathetic and parasympathetic branches of the ANS may be involved in changes in heart rate (e.g. Witvliet and Vrana, 1995, p. 441; Krumhansl, 1997, p. 336; Stern, Ray, and Quigley, 2001, p. 20; Rickard, 2004, p.

371). Parasympathetic impulses would result in lowered heart rate and flattened GSR. This results from listening to music that makes one relaxed rather than aroused.

[13] Statistical significance was revealed by a one-way ANOVA completed on the difference of heart rates across the groups ($F(1, 56)=7.497, p=0.001$). In this measure using the Tukey test, Pentecostal Ecstatics are different from all other groups except Other Protestants. The differences are statistically significant in relation to the General Students ($p = .002$), Pentecostal Non-Ecstatics ($p = .003$), and Deep Listeners ($p=.0001$). The increased difference between heart rate for participant-selected pieces and control pieces among the Pentecostal Ecstatics may also be indicative of a stronger emotional response to the familiar pieces and therefore may be related to the difference in GSR Index between participant-selected pieces and control pieces illustrated in Figure 6.

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