2018

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Journal of Music Therapy, *55*(1), 2018, 109–131
doi:10.1093/jmt/thx020

Musical Tasks and Energetic Arousal

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Background: *Music is widely recognized as a motivating stimulus. Investigators have examined the use of music to improve a variety of motivation-related outcomes; however, these studies have focused primarily on passive music listening rather than active participation in musical activities.*
Objective: *To examine the influence of participation in musical tasks and unique participant characteristics on energetic arousal.*
Methods: *We used a one-way Welch's ANOVA to examine the influence of musical participation (i.e., a non-musical control and four different musical task conditions) upon energetic arousal. In addition, ancillary analyses of participant characteristics including personality, age, gender, sleep, musical training, caffeine, nicotine, and alcohol revealed their possible influence upon pretest and posttest energetic arousal scores.*
Results: *Musical participation yielded a significant relationship with energetic arousal,* $F(4, 55.62) = 44.38$, $p = .000$, *estimated* $\omega^2 = 0.60$. *Games-Howell post hoc pairwise comparisons revealed statistically significant differences between five conditions. Descriptive statistics revealed expected differences between introverts' and extraverts' energetic arousal scores at the pretest,* $F(1, 115) = 6.80$, $p = .010$, *partial* $\eta^2 = .06$; *however, mean differences failed to reach significance at the posttest following musical task participation. No other measured participant characteristics yielded meaningful results.*
Conclusions: *Passive tasks (i.e., listening to a story or song) were related to decreased energetic arousal, while active musical tasks*

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This study reflects ongoing research initiated by the first author in her previous study, "The Effect of Personality Type and Musical Task on Self-Perceived Arousal."

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(i.e., singing, rhythm tapping, and keyboard playing) were related to increased energetic arousal. Musical task participation appeared to have a differential effect for individuals with certain personality traits (i.e., extroverts and introverts).

Keywords: *Musical Tasks, Energetic Arousal, Optimal Arousal, Personality*

Motivating someone to perform a task is a virtually universal challenge. Before one can follow through with any task demand, from paying attention to learn what is required to practicing in order to develop expertise, one must first be oriented to try. Social cognitive theorists have invested considerable effort to facilitate this motivation. Some researchers have stated that the presence of music alone is sufficient to increase arousal levels, while other researchers have found that the presence of music lowers arousal levels to produce a calming effect (e.g., Chuen, Sears, & McAdams, 2016; Jäncke & Sandmann, 2010; Teut, Dietrich, Deutz, Mittring, & Witt, 2014). Many students insist that music-induced arousal helps them study, even as other students wryly admit that music-induced arousal hijacks their focus away from academics and toward the music itself (e.g., Calderwood, Ackerman, & Conklin, 2014; Doelgui, 2013; Reaves, Graham, Grahn, Rabannifard, & Duarte, 2016). Still other studies indicate that subjective factors such as individual preferences moderate arousal, and that these factors are as varied as there are people and types of music (e.g., Hallam & Godwin, 2015; Lundqvist, Carlsson, Hilmersson, & Juslin, 2009). Scholars and clinicians alike need to better understand the relationships between arousal, music, and individual differences to develop better music interventions aimed at improving learning and task performance.

Literature Review

Arousal

Arousal theory has long attempted to explain both why humans are motivated to perform some tasks but not others, and why some people perform well on some tasks while others do not. Within this theoretical framework, arousal is conceptualized as a general physiological readiness to engage in a given behavior (Bernstein, 2016; Sternberg & Sternberg, 2017). The theory posits that individuals seek out experiences that they are motivated to pursue, and that each person has a unique, optimal arousal level that he or she will seek to maintain. The body's desire to achieve and maintain homeostasis that motivates individuals to keep warm, not hot or cold; satiated, not starved or gorged; hydrated, not thirsty or waterlogged; also causes people to keep stimulated, not bored or overwhelmed. Moreover, just as humans have unique predispositions, for example, to be hotter or colder than others in the same conditions and to subsequently seek out more or less heat (or relief from heat), so do people have unique tendencies to be more or less aroused and to subsequently seek out more or less stimulation to achieve homeostasis. Overarousal can result in too much stimulation and inhibit performance, and underarousal can result in too little stimulation to excel (Balk, Adriaanse, de Ridder, & Evers, 2013; Buelow & Frakey, 2013; Zabel, Christopher, Marek, Wieth, & Carlson, 2009).

Personality and Other Participant Characteristics

Many researchers have argued that there are individual physiological differences expressed through personality that lead to differential existing arousal levels and consequently differing arousal needs and preferences (Eysenck, 1990; Feldman, Zayfert, Sandoval, Dunn, & Cartreine, 2013). Eysenck (1990) introduced the idea that personality could be partially conceptualized in terms of the extraversion/introversion continuum. He suggested that extraverts have different physiological needs for arousal than introverts and maintained that extraverts were chronically understimulated and bored. Thus, they constantly sought out stimulation to increase their bodily arousal. Introverts, on the other hand, were chronically overstimulated and excited; thus, they constantly sought relief from stimulation to decrease bodily arousal. Although there is an intuitive logic to Eysenck's position, research does not always bear out his assertion: Actual arousal scores may be higher for extraverts, who do not appear to be underaroused, and arousal scores may be lower for introverts, who do not appear to be overaroused.

Gray's (1975) model of behavioral activation and inhibition seems to bridge Eysenck's theory with empirical data. This theoretical position states that within each individual there exists both a Behavioral Activation System (BAS), which is oriented toward reward-seeking, and a Behavioral Inhibition System (BIS), which is oriented toward punishment-avoiding. According to Gray, extraverts' BAS is highly active and their BIS is fairly quiescent. Introverts, however, demonstrate an opposite pattern of activation, with high BIS responsiveness and low BAS responsiveness. This model helps explain some of the differences in arousal observed between the two personality types (Balk et al., 2013; Buelow & Frakey, 2013; Gray & McNaughton, 2000; Zabel et al., 2009). In addition to endogenous variables such as personality, exogenous variables such as age, sleep levels, novelty, exposure to drug stimulants and depressants, and music have also been correlated with arousal (e.g., Fajkowska, 2015; Meldrum & Restivo, 2014; Mitchell, Knight, Hockenberry, Teplansky, & Hartman, 2014; Obradovic, 2016; Shochat, Cohen-Zion, & Tzischinsky, 2014; Zabel et al., 2009).

Music

Music is a multidimensional construct and a widely recognized exogenous variable that plays an important role in arousal for many people. As a sensory stimulus, music elicits a basic arousal response (Sternberg & Sternberg, 2017). Specific properties of music such as its psychophysical, collative, and ecological properties influence arousal responses (Berlyne 1971; Thaut, 2002). Psychophysical properties of music include sound intensity, dynamics, rate of tempo change, rhythm, frequency or pitch, and timbre. The properties of extreme intensity and energy (i.e., louder sounds, high-pitched sounds, and fast rhythms) tend to increase listeners' arousal. Collative properties of music are structural patterns of melody, harmony, rhythm, and musical form that provide novelty, surprise, conflict, and complexity (Berlyne, 1971; Thaut, 2002). These collative properties determine arousal depending upon listener expectations. Thus, if the new stimulus does not fulfill the listener's expectation, tension will often be elicited (Berlyne, 1971; Meyer, 1956). Ecological properties of music include extramusical events and learned associations such as personal meaning, moods, memories, and private images (Berlyne, 1971; Sternberg & Sternberg, 2017; Thaut, 2002). These musical associations and meanings can influence the listener's arousal (Rickard, 2004). In general, music exists on a continuum from highly stimulating to sedating (Radocy & Boyle, 2012).

Numerous studies have suggested that arousal may function as a mediating factor between music and enhanced cognitive performance (Balch, Myers, & Papotto, 1999; Chabris, 1999; Hetland, 2000a, 2000b; Husain, Thompson, & Schellenberg, 2002; Nantais & Schellenberg, 1999; Schellenberg, 2001, 2004; Steele, Bass, & Crook, 1999; Thompson, Schellenberg, & Husain; 2001) and that music influences arousal (Lim, 2008; Rickard, 2004). Most studies, however, have exclusively examined the effect of music listening, while overlooking the effect of various musical tasks (i.e., musical activities). Musical tasks include listening, as well as performing, composing, and reading, and the synthesized activities that involve all multi-sensory tasks. Music listening is a relatively passive experience, but participation in musical tasks requires more active engagement (Lim, 2008). Furthermore, musical activities can be classified by task difficulty. That is, some musical tasks are more complex, and therefore more challenging, than others.

Cognitive psychologists have postulated that task difficulty (or the perception of task involvement) may affect the arousal level of a task taker, and that the arousal level induced by task difficulty will eventually influence the level of task performance (Anderson, 1990; Eysenck, 1982, 2001; Sternberg & Sternberg, 2017; Wright & Brehm, 1984). For simple and familiar tasks, the relationship can be considered linear, with improvements in performance as arousal increases. For complex, unfamiliar, or difficult tasks, the relationship becomes inverse, with declines in performance as arousal increases (Diamond, Campbell, Park, Halonen, & Zoladz, 2007; Sternberg & Sternberg, 2017). The relationship between musical task difficulty and music-induced arousal should be examined as a first step to use music to affect individual arousal and potentially facilitate other cognitive and occupational tasks.

Study Purpose

Academicians and therapists need to better understand the relationships between arousal, music, and individual differences, especially as these variables may relate to task performance improvements. This study's purpose is to replicate and extend prior research to examine the influences of participation in musical tasks and unique participant characteristics upon energetic arousal (Lim, 2008).

Hypotheses

We hypothesized that participation in a musical task would correlate with increased energetic arousal, or bodily activation, and that more complex tasks would correlate with subsequently greater increases in energetic arousal. We also expected that introverts would be more affected by musical task participation than extraverts, resulting in differentially higher increases in posttest energetic arousal for introverts than extraverts. Finally, we believed it reasonable to anticipate that other participant characteristics would exert a measurable influence over energetic arousal scores. For example, we hypothesized that gender might demonstrate a relationship with arousal, although we could not predict in which direction. We were slightly more confident that increasing age and prior musical training might result in less energetic activation, that exposure to the stimulants caffeine and nicotine would result in more energetic arousal, and that less sleep and alcohol exposure would result in less energetic arousal.

Specific research questions upon which we focused are as follows:

1. Does participation in a musical task correlate with increased energetic arousal?
2. Does participation in more complex tasks correlate with more energetic arousal than does participation in less complex tasks?
3. Are introverts more energetically aroused by musical task performance than are extroverts?
4. Do any additional participant characteristics account for differences in energetic arousal before or after participation in a musical task?

Method

Research Design

We employed a randomized controlled trial research design to examine one dependent variable labeled Arousal, which signified energetic arousal scores, and one between-subjects independent variable, Musical Tasks, to signify the control and four different musical task conditions. In addition, in ancillary analyses we inspected descriptive statistics to explore the possible relationship of participant characteristics including personality; age; gender;

hours of sleep; previous musical training; and exposure to caffeine, nicotine, and alcohol with first the pretest and then the posttest energetic arousal scores.

Participants

A large university in the southwestern United States required all students enrolled in introductory psychology courses to choose from a selection of IRB-approved studies for participation in exchange for class credit. A total of 117 university students, who were neither musicians nor music majors, voluntarily participated in this study. No data were excluded from this study. Participants were healthy, English-speaking adults. Their mean age was 21 years (SD = 3.49), 89 were female, and 80 indicated that they had some form of prior musical training (i.e., they either knew how to play an instrument or had participated in at least one year of musical training). Eighty-nine of the participants were extraverted. The mean number of hours slept the night before data were collected was 6.88 hours (SD = 1.47). Eighty-five participants self-reported that they had not consumed caffeine prior to data collection. One hundred fourteen volunteers self-reported that they had not consumed alcohol prior to data collection, and three declined to respond. One hundred nine volunteers self-reported that they had not consumed nicotine prior to data collection, five reported that they had consumed nicotine prior to data collection, and three declined to respond.

Procedures

A taped recording first described the study's purpose, and then amenable students signed an informed consent form before proceeding with data collection. Participants were randomly assigned to one of the five conditions (i.e., control or four musical tasks) and individually tested. First, they answered brief questions reporting on characteristics such as age, gender, prior musical training, hours slept the night before, and whether they had recently used caffeine, alcohol, or nicotine. Next, participants completed the personality measure, followed by the energetic arousal pretest. Immediately afterward, volunteers participated in the tasks to which they had been assigned. Finally, they completed the arousal posttest. The data collection process was generally completed in fewer than 20 minutes.

Musical tasks. For simplicity's sake, we will refer to this independent variable in terms of five different task conditions: one non-musical task and four musical task conditions. The musical tasks were those described in Lim's 2008 study that we are replicating, with two general exceptions: A control group was added, and the song was changed. The first author composed the song in D major of a ballad form, in duple meter (4/4), with a moderate tempo. The song lyrics were about a fish and did not include any particular emotion or mood (see Appendix A). A board-certified music therapist performed this song with a keyboard accompaniment. The song was recorded onto a compact disc. Each group experienced the song four different times via four phases of the group's assigned task condition. In the non-musical task condition, Control, participants listened to a tape of the spoken lyrics without music. From the simplest musical task condition, Listening, to the most complex musical task condition, Keyboard Playing, the groups' tasks became increasingly more complex. For example, in the listening group, participants only listened to the song. In the singing group, they both listened and sang. In the tapping group, they listened, sang, and tapped. In the keyboard playing group, they listened, sang, and played the keyboard.

Participant flow. Twenty participants individually participated in the Control, or non-musical group, which required listening to the recorded story (spoken song lyrics) four times and reading the typed story. During the first time of listening to the story, the participant listened without the text. During the second, third, and fourth times, the participant read the text while listening to the story. Twenty-five participants individually completed Musical Task 1, Listening, which consisted of listening to the recorded song four times. During the first time of listening to the song, the participant listened without the lyrics. During the second, third, and fourth times, the participant read the typed song lyrics while listening to the song. Twenty-four participants individually completed Musical Task 2, Singing, which consisted of four distinct phases: listening to the song, reading the song lyrics while listening to the recorded song, watching the first investigator's demonstration singing along with the recording, and then singing the song with the lyrics while listening to the recorded song alone. Twenty-two participants individually completed Musical Task 3, Tapping, which consisted of four distinct phases: listening to the song, reading the song lyrics while listening to the recorded song, watching the investigator's demonstration singing and tapping the underlying beat on a hand drum, and then tapping the underlying beat of the song on a hand drum while singing and listening to the song alone. Twenty-six participants individually completed Musical Task 4, Keyboard Playing, which consisted of four distinct phases: listening to the recorded song, reading the song lyrics while listening to the recorded song, observing the investigator's demonstration playing a simple harmonic progression on the piano while singing and listening to the recorded song, and playing a simple harmonic progression on the piano while singing and listening to the recorded song alone.

A color-coded process facilitated participants' keyboard playing the harmonic progression. The song included five different chords (D major, A major, G major, b minor, and e minor) that repeated at predictable intervals. Each chord was associated with a particular color and identified in two places. On the lyric sheet, the color red identified all D-major chords, the color green identified all A-major chords, the color blue identified all G-major chords, the color yellow identified all b-minor chords, and the color orange identified all e-minor chords. On the piano, a colored sticker identified the corresponding keys to be played for each chord. By following the lyric sheet, participants were able to play the correct notes of each chord. The investigator asked the participants to use the index finger of the right and left hands simultaneously to press the two color-coded keys on the piano. They played the first and third note of each chord (e.g., note "G" and "B" for G major chord). The investigator asked the participants to play the keys according to the underlying beat of the song's rhythm structure.

Measures

Personality test. The revised version of the Eysenck Personality Questionnaire (EPQ; Eysenck & Eysenck, 1975) categorizes participants' personality in terms of Extraversion and Introversion. Normally, Eysenck's personality test is used to measure three dimensions of personality: Extraversion, Neuroticism, and Psychoticism; however, we measured Extraversion/Introversion only, using 23 short questions (e.g., Do you enjoy meeting new people? Do you like going out a lot? Do you often take on more activities than you have time for?). The published scoring key for the revised EPQ (Eysenck, Eysenck, & Barrett, 1985) was used for the scoring process. Eysenck, Eysenck, and Barrett (1985) reported that the reliability of the EPQ Extraversion scale was .90 for males and .85 for females. The stability and utility of the EPQ has made it a frequently utilized construct validity indicator for many other studies. Numerous authors have continued to use the measure to validate their own research across many contexts and within many cultures (e.g., Dai et al., 2017; Francis, Ok, & Robbins, 2017; Singh, Pandey, Mahajan, & Kaushik, 2017).

Measurement of arousal. We measured energetic arousal with the Activation-Deactivation Adjective Check List (AD ACL; Thayer, 1978). The AD ACL is a multidimensional test of various transitory arousal states, including energy, tension, tiredness, and calmness. Twenty descriptive adjectives compose the four orthogonal subscales. Only the scores for energetic arousal were retained for analysis in this study. This subscale comprises five adjectives (i.e., lively, active, full of pep, energetic, vigorous) anchored by a four-point Likert-type scale ranging from Definitely Feel to Definitely Do Not Feel.

In his seminal work, Thayer (1967, 1970, 1978, 1989) established the validity of his self-report checklist as a more consistent measure of arousal states than objective physiological measures alone (e.g., skin conductance, heart rate, muscle action potentials, and relative finger blood volume). Thayer found that individual differences obscured the use of pure physiological data; on the other hand, his simple self-report checklist both yielded greater internal consistency and correlated better with the physiological measures than these measures correlated among themselves. Since its creation, the AD ACL checklist has been one of the most widely used instruments to measure arousal across contexts ranging from studies of not only performance but also exercise, nutrition, sleep, diurnal rhythms, drug exposure, and stress (Boyle, Helmes, Matthews, & Izard, 2015). Thayer (1989) has indicated that the energetic arousal scale is the best indicator of general activation. In fact, he has also noted that examining all four dimensions together can actually attenuate the relationships between arousal and other variables of interest. Reliability coefficients for the energetic arousal scale have been reported as .89 and .92 (O'Connor, 2004; Thayer, 1978).

Overview of Statistical Analyses

We used version 22 of International Business Machines Statistical Package for the Social Sciences (IBM SPSS 22) to conduct initially an Analysis of Covariance (ANCOVA) analyzing the influence of the between-subjects independent variable Musical Tasks upon the dependent variable Energetic Arousal while controlling for the pretest scores. ANCOVA is a powerful test that requires that data meet specific assumptions (Shavelson, 1996). Unfortunately, our sample data violated the assumption of homogeneity of variances, calling instead for a more conservative test. We were pleased to find that Welch's ANOVA yielded results highly similar to the ANCOVA. Although we were disappointed to exclude the pretest data from our analysis, inspection of the scatter plot also revealed that our regression slopes among groups clearly were not parallel. Thus, even though we did not find a statistically significant interaction between our pretest and musical tasks, $F(4, 107) = 1.944$, $p = .108$, we were still inclined to conduct a "pick-a-point" analysis of the overall treatment effect rather than attempt to estimate the simultaneous effect of y over the entire length of x (Rogosa, 1980, p. 320).

Next, again in response to our known violation of the assumption of homogeneity of variances, we conducted Games-Howell post hoc tests for unequal variances to explore pairwise comparisons among the five task groups' conditions. Finally, we conducted ancillary univariate ANOVAs to evaluate descriptive statistics and learn more about the whole relationships of participant characteristics with first the pretest and then the posttest arousal scores.

Results

Energetic Arousal and Musical Tasks

The data contained no outliers, as determined by inspection of the box plot. Normal Q-Q Plots demonstrated approximately normally distributed data. As shown in Table 1, descriptive statistics of posttest data revealed generally increasing energetic arousal mean scores as musical tasks became increasingly complex. The Analysis of Covariance reached statistical significance, $F(4, 111) = 29.63$, $p = .000$, partial $\eta^2 = 0.52$). Levene's test, however, produced a significant result ($p = .004$), indicating a violation of the assumption of homogeneity of variances. The more conservative omnibus

Table 1

Posttest Energetic Arousal Descriptive Statistics for Task Conditions

				95% CI	
Group	n	M	SD	LL	UL
Control	20	6.90	2.02	5.95	7.85
Listening	25	7.96	3.02	6.71	9.21
Singing	24	11.79	4.13	10.05	13.53
Tapping	22	12.55	2.34	11.51	13.59
Keyboard Playing	26	15.27	2.65	14.20	16.34

Welch's ANOVA, F(4, 55.62) = 44.38, confirmed a statistically significant difference in energetic arousal scores attributable to the musical task conditions ($p = .000$, estimated $\omega^2 = 0.60$).

Post Hoc Tests

Musical tasks. Overall, mean posttest energetic arousal scores were progressively higher among participants according to the level of task difficulty they were assigned, as demonstrated in Table 1. Moreover, given that we could not assume equal variances, we used Games-Howell pairwise comparisons, which yielded statistically significant mean differences between both of the passive tasks (i.e., the control group and listening) and each of the three active musical tasks (i.e., singing, tapping, and keyboard playing). The most complex task, keyboard playing, yielded statistically significant mean scores that were higher than each of the other music conditions. Cohen (1988) recommended a straightforward method for demonstrating the magnitude of an effect for pairwise comparisons: Cohen's *d* (*d*) (as cited in Gravetter & Wallnau, 2017). For example, between Keyboard Playing and the non-musical Control, there was a large mean difference of 8.37 (99% CI, 5.98 to 10.75), p = .000, $d = 3.55$, and the distance between Keyboard Playing and Listening yielded another sizeable mean difference of 7.31 (99% CI, 4.56 to 10.06), $p = 000$, $d = 0.90$. Furthermore, between Keyboard Playing and Singing, there was a substantive mean difference of 3.48 (99% CI, 0.02 to 6.94), $p = .010$, $d = 1.0$, and the distance between Keyboard Playing and Tapping resulted in another substantive mean difference of 2.72 (99% CI, 0.23 to 5.21), $p = .004$, $d = 1.09$.

In addition, there were statistically significant mean differences between Tapping (i.e., an active task) and Listening (i.e., a passive task) of 4.59 (99% CI, 1.87 to 7.30), $p = .000$, $d = 1.70$, and between Singing (i.e., an active task) and Listening of 3.83 (99% CI, 0.23 to 7.43), $p = .005$, $d = 1.06$. According to Cohen's (1977) frequently cited guidelines for interpreting effect sizes, distances calculated to be greater than .80 indicate a large effect. Given the moderate 0.60 (estimated ω^2) effect size for the omnibus test and the sizeable effect sizes ranging from 0.90 to 3.55 (Cohen's *d*) derived from the post hoc multiple comparisons, it appears reasonable to infer that the independent variable of Musical Tasks exerted a substantial influence upon the dependent variable of energetic arousal in this sample. In other words, task conditions affected the overall energetic arousal scores, and the more complex the musical tasks in which volunteers participated, the greater the positive effect upon their energetic arousal levels.

Participant characteristics. Given that Lim's (2008) original study found that personality did not produce a significant effect, we did not include this variable in our primary analysis. On the other hand, Lim's smaller sample size, along with ample research support that suggests personality and other participant characteristics could be potential influences upon energetic arousal, prompted us to explore these variables in ancillary analyses. The most interesting finding among these investigations was the relationship of personality with the energetic arousal pretest and posttest scores, as shown in Table 2. Initially, we conducted both an ANOVA on arousal change scores with personality as our fixed factor, $F(1, 115) = .423$, $p = .517$, and an ANCOVA with the pretest as our covariate, $F(1, 114) = .366$, $p = .546$, but neither test reached statistical significance.

Closer inspection of descriptive statistics revealed, however, that there were expected differences in pretest energetic arousal scores between introverts (M = 10.07, SD = 3.23) and extraverts (M = 11.96, SD = 3.36) prior to participation in musical tasks, with extraverts being more energetically aroused to begin with and thus yielding statistically significantly higher scores than introverts, $F(1, 115) = 6.80$, $p = .010$, partial $\eta^2 = .06$. This difference, however, was no longer detected between introverts (10.11, SD = 3.73) and extraverts (M = 11.35, SD = 4.37) after musical task participation

Table 2

Energetic Arousal Descriptive Statistics for Task Conditions by Personality

			Pretest arousal		Posttest arousal	
Group	Personality	n	M	SD	M	SD
Control	Introverted	3	7.00	1.73	5.00	0.00
	Extraverted	17	11.71	3.33	7.24	2.02
Listening	Introverted	9	9.67	3.28	9.11	3.06
	Extraverted	16	11.69	4.05	7.31	2.89
Singing	Introverted	7	11.00	3.11	10.29	4.46
	Extraverted	17	11.41	3.36	12.41	3.95
Tapping	Introverted	4	8.25	0.96	11.25	2.06
	Extraverted	18	11.67	3.82	12.83	2.36
Keyboard	Introverted	5	12.80	3.27	13.80	1.30
Playing	Extraverted	21	13.05	2.36	15.62	4.37

$F(1, 115) = 1.84$, $p = .178$, as introverts' overall means rose slightly and extraverted means dropped slightly more. Mean statistics are sensitive to extreme scores, so we looked more closely at the personality means in each musical task condition (see Table 2). Extraverts in our sample tended to yield fairly large decreases in average energetic arousal scores at the posttest in the passive tasks' conditions such as the control and listening, while introverts in our sample tended to yield slightly large increases in average energetic arousal scores at the posttest in the active tasks' conditions, most notably keyboard playing (see Figures 1 and 2). In sum, our inspection of the patterns among mean scores by personality suggested that participation in the musical tasks may have exerted a slight moderating effect upon energetic arousal, in that mean scores for the posttest energetic arousal measure no longer demonstrated statistically significant differences between the two groups following musical task participation. Alternatively, none of the other measured participant characteristics (i.e., age, sex, prior training, personality, sleep, caffeine, alcohol, or nicotine) were statistically significantly related to either the pretest or posttest energetic arousal scores.

Discussion

Our results have provided support for our first hypothesis that participation in a musical task would be related to increases in

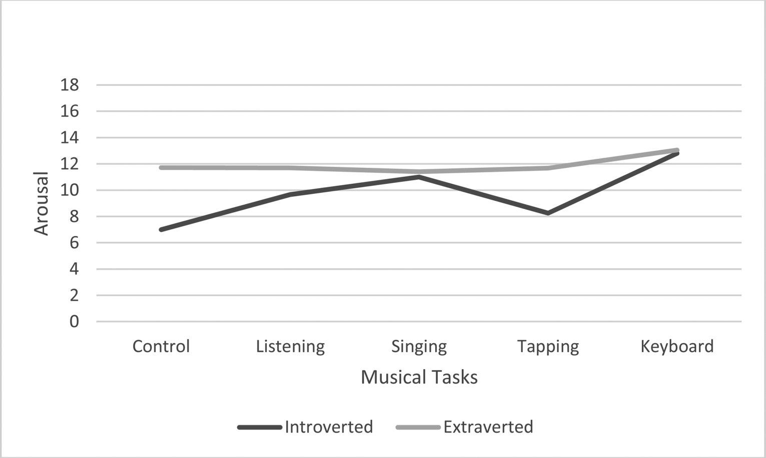

FIGURE 1.
Pretest energetic arousal means by musical task and personality.

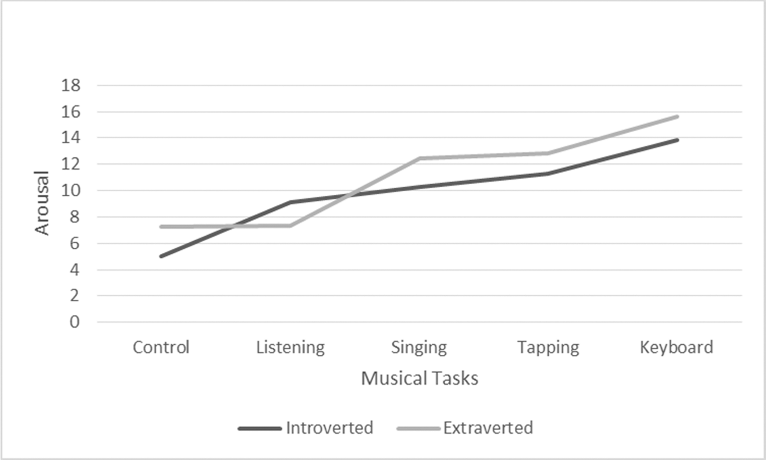

FIGURE 2.
Posttest energetic arousal means by musical task and personality.

energetic arousal; however, closer inspection of the group means reveal some interesting patterns in this sample: While the more complex musical tasks (i.e., singing, tapping, and keyboard playing) did correlate with increases in energetic arousal scores, the more passive tasks (i.e., the non-musical control and listening) actually correlated with decreases in energetic arousal scores. This finding points to the differential effects of music upon arousal, highlighting its multidimensionality as either more active or more passive, more arousing or less. Findings did not support our hypothesis that introverts would be more affected by participation in musical tasks and thus would demonstrate greater posttest increases in energetic arousal than would their extraverted peers. Closer inspection of the patterns among mean scores revealed a much less straightforward conclusion. Expected differences between introverts and extraverts in pretest scores suggested more variability in introverts' pretest arousal scores than those of extraverts, but the powerful influence of engaging in musical tasks may have exerted a reshaping influence upon the mean scores' patterns regardless of personality, smearing out some of the differences detected at the pretest and resulting in posttest scores much more similar despite personality across group assignments. For example, examination of the patterns of mean scores at the pretest and then again at the posttest revealed that extraverts' posttest arousal scores dropped more dramatically than did the introverts in the passive non-musical control and listening groups, resulting in average scores that more closely resembled one another than they did at the pretest. Alternatively, the introverts' posttest arousal scores in the active musical tasks groups, especially tapping, yielded increases to more closely approximate the mean scores of their extraverted peers than they did at the pretest. Thus, the various tasks themselves were suggestive of varying influences upon energetic arousal, not only relative to task complexity but also relative to personality, that ultimately yielded more similar scores across groups after musical task participation regardless of personality (see Table 2; Figures 1 and 2).

On another note, the data did not support our hypotheses that other participant characteristics of interest (i.e., age, gender, musical training, sleep, caffeine, alcohol, and nicotine) would yield significant relationships with either the pretest or posttest energetic arousal scores. These findings were surprising, although there are certainly several plausible explanations for these results. First, the age of our university students enrolled in introductory psychology classes reflects a clear restriction in range that would not logically produce enough variability to see an effect for age (21 years, SD = 3.49). Moreover, our small convenience sample of 117 psychology students did not likely reflect variations indicative of the true population in terms of the other variables either. For instance, even less than our variability in age was the variability in sleep with the well rested (6.88 hours, SD = 1.47), disproportionately represented in our sample. This finding is not consistent with our expectations, as US citizens in general and young people in particular are purported to be notoriously sleep deprived (Meldrum & Restivo, 2014; Shochat et al., 2014). In addition, females ($n = 89$), extraverts ($n = 89$), people with previous musical training ($n = 80$), and people abstaining from alcohol ($n = 114$), nicotine ($n = 109$), and caffeine ($n = 85$) were also over-represented in our study. Caffeine use results were especially surprising, given that only 27% of our sample reported using caffeine prior to data collection, which is considerably lower than the estimated 85% of US citizens who consume at least one caffeinated beverage daily (Mitchell et al., 2014). Finally, our study did not evaluate whether any of these characteristics were typical for our volunteers or unique to the time we collected data. For example, any students who generally enjoyed caffeine, nicotine, or alcohol and had thus developed a tolerance for these drugs, but who then forewent exposure to these prior to data collection, might have experienced adverse withdrawal effects that could possibly have skewed our results.

Limitations and Future Research

Some limitations have likely affected the quality of our results. Perhaps most significant is the relatively small sample recruited, limiting the power of our investigation. Specifically, a larger number of participants could have better accommodated a multivariate exploration of additional dependent variables, allowing for an examination that included tense arousal and helping parse more precisely the differences between positively and negatively valenced arousal. Greater variability in our sample and larger cell sizes may have improved the fit of our data to other models as well, facilitating a closer inspection of the effect of change over time from the pretest to the posttest. Although our moderate to large effect sizes indicated a significant relationship between musical tasks upon energetic arousal within our sample, these findings are difficult to generalize to the population.

Careful fidelity to the standardized procedures, a relatively short time period of data collection required from each participant, the grade incentive for students to participate wholeheartedly, and use of conservative statistical procedures helped safeguard the validity of our study. On the other hand, a possible threat to validity is the increasing complexity of procedures in the musical task groups that were, by design, more complicated. This challenge could have interfered with volunteers' understanding and performance of the tasks. Another threat could be that the same pressure to comply with study requirements in exchange for course credit, which likely produced quality results for our research, may also have skewed our findings, given that neither the general population nor our participants may have applied themselves as diligently to the protocols had no incentives been available. An additional potential threat again derives from the limitations of our sample. We performed multiple tests on data from a relatively small number of participants, and our need to protect against Type I errors not only limited our investigation but also may possibly have led to an increased risk for Type II errors.

Future studies should include larger sample sizes to confirm and build upon our findings. Lim's (2008) study yielded similar results, but there were some differences between this earlier work and our research. In particular, both studies revealed that participation in musical tasks does correlate with arousal, and the role of personality may not exert as powerful an effect as the existing literature would suggest. Closer investigation of the other dimensions of arousal, especially tense arousal, with a larger sample could shed more light on potential differences in positively valenced (i.e., energy) and negatively valenced (i.e., tension) arousal. We need a greater understanding of these two dimensions of arousal to better ascertain what is optimal in terms of practical outcomes. Identifying specific arousal needs in light of individual differences and achievement goals should prove fruitful in exploring how to induce optimal arousal and promote motivation and subsequent task performance. Music appears to be a powerful tool for manipulating arousal levels, and we must conduct more research to elucidate how to wield this tool to facilitate successful treatment outcomes. Therapists interested in facilitating optimal performance could benefit from first inducing optimal arousal levels in their clients. From basic conditioning to academic content acquisition to cognitive restructuring, optimal arousal should facilitate performance. Better understanding of music's role in learning and performance will aid clinicians in the strategic use of music to help clients reach their goals.

Implications and Conclusions

Participation in an active musical task did correlate with increased energetic arousal overall. Generally, the more complex the task, the greater the energetic arousal level. Active musical tasks such as singing, tapping, and keyboard playing were related to increasingly higher energetic arousal levels, respectively. Passive tasks, such as listening to lyrics without music or listening to a song, actually related to decreased energetic arousal levels. Recognizing this distinction could be a first step in practically using musical tasks to help induce optimal arousal levels in clients. Further, although introverts demonstrated less energetic arousal than did extraverts before participating in a musical task, there was no statistically significant difference in energetic arousal after participation. This finding is also potentially useful for future applications.

Although there is still a long way to go, this research holds promise for therapists who work with clients to accomplish stated goals. Regardless of the work to be done, optimal arousal levels should help elicit favorable client outcomes. Thus, clinicians who are able to match clients' arousal predispositions and arousal needs with task demands could theoretically prescribe specific musical task participation to help induce the optimal arousal level required for subsequently successful therapy outcomes. This prospect is well worth exploring, because authentic client success represents a triumph for everyone involved.

Appendix A. *A Beautiful and Smart Snapper*

Music and Lyric by Hayoung A. Lim

D A G D Bm A D
Mr. Schneider drives a red Dodge truck which he bought in 1998 at Springfield, Illinois.
G D A D G D
On Thursday, he went to Lake Conroe to catch some fish with his sons Mike and James.

G A Bm Em A
It was at 3 p.m. when James caught a red snapper with a couple brown spots on his fin and
G A
one black line on the jowl.
D Bm Em A
Mike said to his younger brother “hey, that snapper looks ugly and stupid.
G A D
I will not eat that fish even though mommy cooks it really well.”
D A G D Bm A D
Mr. Schneider then caught a big Prussian carp and shouted to his sons “look, guys.
G Em A
This one is big and strong. Would you eat this, Mike?”
D Bm G A D
Around the sun set, they came back to home and gave Ms. Schneider who was watching
A G D A D
E news all the fish they caught to cook for the dinner at 7:30.
D A G D Bm A D
Her name is Diana and she enjoys cooking fish even though she hates touching the raw
A D
fish and the smells of them.
D G A Em D
She stayed in the kitchen for 40 minutes to prepare a special seasoning for the snapper and
A G Em Bm A D
carp. The seasoning consisted of black pepper, rosemary powder, and minced ginseng.

D A G D Bm A G D
Everybody sat at the dinner table with an excitement of tasting the fishes they caught.
Bm Em G A G A
Diana scooped out the red snapper and put a piece on Mike’s plate.
D Bm Em A Em A G A
James said to Mommy “Don’t give it to Mike. He will not eat it because it is an ugly and stupid
D A G A D
snapper. He will only eat a beautiful and smart snapper!”

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