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The Effects of Auditory Distraction on Memory with Verbal Recall

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THE EFFECTS OF AUDITORY DISTRACTION ON MEMORY WITH VERBAL RECALL

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ABSTRACT

The purpose of this study was to determine the effect of auditory distraction on working memory by using verbal recall with a sentence repetition test of 22 sentences. Participants were randomly assigned to one of four groups: the control group (Group A, n = 20), and three experimental groups (Group B, n=20; Group C, n=20, and Group D, n=20). Participants in each group listened to prerecorded sentences and had six seconds in which to repeat the sentence. While the control group had no additional stimuli present, Group B was exposed to their preferred genre of music in the background, Group C was exposed to their least preferred genre of music, and Group D was exposed to competing speech in the background. Prior to testing, participants reported on music preferences. Following testing, participants hearing music indicated familiarity of the pieces and self-perceived performance based on the distracters. Using a one-way analysis of variance (ANOVA), no statistically significant differences were found among any groups (SCORE x GROUP), $F(3) = 0.587$; $p > 0.05$. The disparity of non-native English speaking participants among groups may have resulted in possible confounding, although overt comprehension of sentences was not being tested. Perceived performance enhancement was evident in the group exposed to their preferred genre of music as a distracter, despite the fact that actual performance was no different from the other groups. Such perceived enhancement lends itself to support an arousal theory of at least self-perceived enhancement. It is theorized that the age of participants (mean age of 23.6 years old) may in fact be an optimal period of resistance to distracters, regardless of type of distracter. Further investigation into more specialized groups with known deficits, such as patients with dementia of the Alzheimer's type with identifiable neurological deficits, may lead to greater differences in auditory distraction using music preference and competing speech.

THE EFFECTS OF AUDITORY DISTRACTION ON MEMORY WITH VERBAL RECALL

Introduction and Review of Literature

Music therapy practice is often dependent upon successful and efficient working memory in clients; however, this is an area rarely addressed explicitly in the music therapy literature. With this idea in the forefront, one may attempt to utilize external, independent variables to maximize the efficacy of working memory. Similar work has been conducted in the realm of background music and its effects on reading comprehension; however, a comparable investigation has not been conducted in the field regarding auditory (as opposed to visual) stimuli (Madsen, 1987). The closest link in the current body of research lies in the area of cognitive neuroscience and associated psychological studies. Although this is an unconventional union with music therapy, the understanding provided by such research brings music therapists into a new dimension of justification for practice.

Generally, results using human participants have proven inconclusive when investigating noise stimuli and performance (Hallam, Price, & Katsarou, 2002). Thus, an investigation into animal literature concerning behavior (using rats in operant conditioning tasks) helps to provide better insight into operant behavior processes (Maes & de Groot, 2003). Studies using rats learning a lever press (discrimination task) indicate that arousal level is key in determining performance outcome, with either under-arousal or over-arousal having detrimental effects (Maes & de Groot, 2003; Hallam, Price, & Katsarou, 2002). External stimuli (such as noise) may in fact act to bring the under-aroused participant up to optimal performance level (Hallam, Price, & Katsarou, 2002). In a study of operant discrimination tasks in rats, the optimal performance outcome occurred when the training condition and test noise condition were the same. Performance declined when the test noise condition differed from the training condition, even after continued exposure to the new condition (Maes & de Groot, 2003). Such results indicate the strength of the environment during training and subsequent influences on long-term performance.

Geffen et al. (1997) has provided a useful definition of working memory, describing it as “the brain processes involved in the temporary maintenance and

manipulation of information selected from current events and previous experience." The use of auditory distractions in research stems from this concept, as an attempt to increase the load on working memory while maintaining adequate accuracy and performance. Further, distracters have a greater influence on working memory when they are closely related to the target stimuli (Geffen et al., 1997). Cairo, Liddle, Woodward, & Ngan (2004) measure the effects of load alone on working memory by breaking the task down into encoding, maintenance, and retrieval, finding a linear increase in brain activity corresponding to an increased load in an item recognition task.

Higginson et al. (2003) also provides useful information in the realm of working memory. The California Verbal Learning Test (CLVT) was used to measure recall through verbal learning and memory, while the Letter-Number Sequencing (LNS) was used to assess working memory. Through studies with patients with Parkinson's disease, it was found that working memory is in fact paramount in recall, and its deficit may be an indicator of executive function failure at large (Higginson et al., 2003). Executive function, associated with the frontal lobe, relates to cognitive abilities such as "inhibition, abstraction, aspects of attention, cognitive flexibility, reasoning, problem solving, planning, sequencing, working memory, modulation of ongoing activity, and simultaneous operation of multiple cognitive processes" (Higginson et al., 2003). Using a sustained attention response task with patients with a traumatic brain injury, Dockree et al. (2004) found that those with damage to the frontal lobes made significantly more errors with slower reaction times. Sustained attention deficits may in turn influence executive function as well. Further detail into the underpinnings of working memory is discussed by Janata, Tillmann, & Bharucha (2002) in the study on music and working memory. Participants were to listen to specific selections with the task of either orienting their attention globally or selectively to targets. Significant differences in bilateral blood oxygen level dependent (BOLD) were found between attending to single instruments/timbres and multiple instruments (polyphonic music). On the neural level, the attentive listening activates areas suspected in executive function (Janata, Tillmann, & Bharucha, 2002). With these concepts on working memory alone established, one may then look to training and its subsequent effects on working memory.

The behavioral notion of training carries into the physiological realm, with event-related potential (ERP) measurements as indicators of change. Using ERPs, one must recognize the various areas of the brain proposed to be specific to various types of memory. It is theorized that the hippocampal region relates to episodic memory, the posterior cortex for semantic memory, and the prefrontal cortex for working memory (Neisser, 2004). Inhibition training exposes participants in a systematic manner to irrelevant signals in an attempt to develop resistance to distractions. Conversely, discrimination training has a lack of distractions to practice discrimination. Melara, Rao, & Tong (2002) characterized distracters as either salient (infrequent and distinct from all other signals) or unattended (similar and within the same rate of presentation as attended signals). The involuntary reorienting (or shifting) of attention to other signals creates changes in physiologic processes, in turn affecting behavior. In one auditory distraction study using duration and location deviants, Roeber, Widmann, & Schröger (2003) used tones of either 200 or 400 ms. They found that both performance (behavioral) and ERP (physiological) measures were affected. Performance was slowed in response to deviants, as well as the first standard following the deviant. ERP measures further indicate that neural processing of sound is affected by rare, irrelevant changes (Roeber, Widmann, & Schröger, 2003). The duration of the standard stimuli also played a role in reaction times. Schröger, Giard, & Wolff (2000) found that when the standard was a short tone, reaction times in the discrimination task were significantly faster than when the standard was a longer tone (351 vs. 380 ms). In another study utilizing tones as the stimuli, Roeber, Berti, Widmann, & Schröger (in press) analyzed task performance by measuring the effects of response repetition and response change. Response repetition in a trial may in fact exacerbate the distraction threefold. Roeber, Berti, Widmann, & Schröger go on to suggest a genuine involuntary attention shifting (measured through ERPs) when faced with a distracter. Such research provides substantial basis for study in the area of auditory distraction and its effect on performance. To further substantiate the connection between physiologic processes and working memory, one may use ERPs in an analysis of memory with more of a language base, as opposed to distractions based on frequencies of varied frequency and length (non-semantic distracters).

Wolach and Pratt (2001) attempted this connection by incorporating phonological and semantic characteristics into a short-term memory task with distractions. It was found that reaction time (behavioral response) increases when distracters are present; however, it should be noted that reaction times are shorter for noise distracters than for lexical distracters. Similar disparities were found in the ERP components. For instance, a significant latency was found in the early component of the noise distracter, indicating earlier processing of lexical stimuli compared to noise stimuli. Further differences in ERP components suggest processing of stimuli based on physical characteristics, such as noise versus phonologic/semantic properties, early in the processing stage. Despite this early differentiation, time is still taken to fully process the distracters (Wolach & Pratt, 2001).

From this study using simple, lexical stimuli, one moves to examine the effects of various auditory distractions using fluent speech. One study incorporating speech as the distraction used both semantically meaningful and irrelevant speech, targeting disparities between young and old adults. Older adults tended to be distracted more by meaningful speech than irrelevant speech, whereas young adults were equally capable of preventing interference from either meaningful or irrelevant speech (Tun, O'Kane, & Wingfield, 2002). This divided attention task with selective listening suggests that factors associated with age have a large impact on memory and recall. Although not conducted, an ERP measure may reveal neural processing differences between semantically meaningful and irrelevant speech, just as differences in processing occur between noise and speech (Wolach & Pratt, 2001).

Thus far, a concrete connection has not yet been made to provide a substantial transfer to the arena of music therapy. The use of music as an auditory stimulus adds another dimension, as it can neither be categorized simply as noise nor as speech. The area of background music as a distraction often involves using music (an auditory processing component) and some type of reading comprehension/memory or arithmetic performance (a visual processing component) (Madsen, 1987; Hallam, Price, & Katsarou, 2002). A concept known as the Yerkes-Dodson law, an arousal theory reflecting that an optimal arousal level is necessary for peak performance, should also be considered in examining musical influences (Hallam, Price, & Katsarou, 2002). Music, unlike white

noise, carries with it many more variables that must be accounted for when assessing its effects. On a basic level, music can be characterized as stimulating or sedative. For individuals who have had more exposure to music, the music may also be associated with emotions and experiences, thus further exacerbating its influence. Hallam, Price, & Katsarou (2002) found that sedative type (calm, relaxing) music increased speed of solving arithmetic problems in children aged 10-12, but did not improve accuracy. Such music, however, did improve word recall from sentences (presented visually). Stimulating music (arousing and aggressive) conversely had an adverse affect on performance. An interesting note in this study was that altruistic behavior was also evaluated, with the sedative music leading to pro-social behavior and the stimulating music having the opposite effect. Thus, music not only can be attributed to influencing performance, but also influenced mood, as evidenced by the varied altruistic states.

Music preference, although not the primary focus of this study, is incorporated to control for preference as a possible confound. Although Hallam, Price, & Katsarou's (2002) study described "calming" and "arousing" music, one must take into account that personal experiences and preferences may result in differing perceptions of such descriptors. Thaut (1989) concluded through his analysis that music does in fact have the ability to evoke emotional reactions and alter mood. The current state of the individual, along with personal musical preference, culture, and arousal needs contribute to the affective response. Furthermore, affective responses are accompanied by measurable physiological responses.

The 1998 study of Gerra and colleagues addresses this physiological dimension. It demonstrated the effect of a particular style of music, techno-music (characterized as fast music produced by electronic instruments and computer generated sounds), on quantifiable changes in hormone levels (through activation of the hypothalamic-pituitary-adrenal axis and noradrenergic system) and reported changes in emotional state. In participants reporting dislike of the music, the techno music had the same physiological response as psychological stress. However other participants with self-reported enjoyment of the music exhibited lower physiologic stress levels from the same music selection.

Continuing on the avenue of stress, al'Absi, Hugdahl, & Lovallo (2002) measured adrenocortical stress responses, as higher levels of cortisol are associated with increased stress. With a mental arithmetic task, participants physiologically responded with high cortisol levels had an increase in errors and decrease in problems completed as compared to participants with lower cortisol reactions. It is interesting to note, however, that this study also used a dichotic listening task (with nonsense syllables as stimuli), in which high cortisol responders performed better than those with low cortisol levels. It is suggested that an increase in cortisol response may decrease resources needed for working memory to function, but provide an increased focus on sensory stimuli (al'Absi, Hugdahl, & Lovallo, 2002).

Rentfrow and Gosling (2003) attempted to refine preference descriptions by creating a more categorical description of music genres via factor analysis. They found that 14 primary genres used in music study of preference (classical, jazz, blues, folk, alternative, rock, heavy metal, country, pop, religious, soundtracks, rap/hip-hop, soul/funk, and electronica/dance), 11 of which are used in the current study, load on four main music preference dimensions: Reflective and Complex, Intense and Rebellious, Upbeat and Conventional, and Energetic and Rhythmic. The great variability and pliability of music preference requires special considerations to be made for preference whenever incorporating music into research.

Prickett & Moore (1991) used familiar (preferred) music paired with verbal material to assess learning and recall in patients with Alzheimer's disease. Results from their study suggest that verbal material paired with music in a song form leads to better recollection than verbal material merely spoken. In a more generic learning task using nonsense syllables, however, Baugh & Baugh (1965) used four genres of music (classical, oriental, jazz, and rock-n-roll) to determine effects on learning. With college students as participants, there was no significant difference between groups, although there was a difference with the rock-n-roll group. This effect is theorized to be the result of familiarity, as rock-n-roll was the genre participants were most exposed to in daily life, regardless of preference. The familiarity component acted as a distracter (as opposed to preference alone), interfering with learning of nonsense syllables.

With an adequate foundation of both physiological and behavioral influences of auditory distracters, a shift can be made to a more specific group of individuals: individuals with Alzheimer's disease. Tests to determine the onset of Alzheimer's disease often rely on the assessment of memory. Some research has found impaired working memory in individuals' with the diagnosis of dementia of the Alzheimer type, as compared to neurologically healthy adults. However, both those with the diagnosis and the healthy group demonstrated adequate abilities to ignore an auditory speech distraction (Belleville, Rouleau, Van der Linden, & Collette, 2003). However, Tun and colleagues (2002) found that older adults typically have reduced performance when there is competing speech (thus demonstrating inconclusiveness when comparing studies in the current body of research). Using a standard aphasia test battery, Murdoch, Chenery, Wilks, & Boyle (1987) determined that language deficit is also a significant indicator in diagnosing Alzheimer's disease.

The aim of this study is to incorporate the body of knowledge concerning auditory distraction with memory by using music (as opposed to tones or irrelevant speech) and aurally presented sentences. Cherry's (1953) cocktail party example describes people as being able to focus on an individual voice when surrounded by multiple voices. Madsen (1987) suggests, however, that concentration may improve with certain music as opposed to noise. As other studies in memory often use noise as the distraction, the purpose of this study is to determine whether music, when set as an auditory distraction to an auditory repetition task, promote concentration, or does it instead hinder the individual's ability to recall accurately? Although implications of this research may influence how working memory is utilized and maximized in adults with dementia of the Alzheimer's type, the objective in the current study is to determine if such a pattern even exists amongst collegiate adults. If demonstrated in the present study, further research is warranted across other populations.

Method

Music preference is utilized in this research design simply to control for preference as a possible confounding variable. In most studies utilizing background music, the researcher decided on music deemed acceptable as stimulating or sedative. However, in the present study eleven genres of music are incorporated in the design.

Another group in this study heard competing speech as the distracter in place of music. Unlike studies using single lines or digits of competing speech (Wolach & Pratt, 2001; Tun, O'Kane, & Wingfield, 2002), the competing speech in this study consisted of two additional layers, reminiscent of the cocktail effect (Cherry, 1953). This group attempted to mimic a real-world situation where multiple instances of background speech are present. Instead of music playing in the background, two separate conversations were playing below the target speech.

Table 1 Demographic chart of participants in each group.

Participant	Group	Age	Gender	Primary Language	Participant	Group	Age	Gender	Primary Language
1	Group A	18	Male	English	41	Group C	20	Male	English
2	Group A	20	Male	English	42	Group C	21	Male	English
3	Group A	26	Male	English	43	Group C	24	Male	English
4	Group A	18	Female	English	44	Group C	31	Male	English
5	Group A	19	Female	English	45	Group C	31	Male	English
6	Group A	19	Female	English	46	Group C	31	Male	English
7	Group A	20	Female	English	47	Group C	42	Male	English
8	Group A	20	Female	English	48	Group C	19	Female	English
9	Group A	20	Female	English	49	Group C	20	Female	English
10	Group A	20	Female	English	50	Group C	20	Female	English
11	Group A	22	Female	English	51	Group C	20	Female	English
12	Group A	22	Female	Korean	52	Group C	21	Female	English
13	Group A	22	Female	Cantonese	53	Group C	22	Female	English
14	Group A	23	Female	English	54	Group C	24	Female	English
15	Group A	24	Female	Spanish	55	Group C	24	Female	Chinese
16	Group A	26	Female	English	56	Group C	26	Female	English
17	Group A	26	Female	Japanese	57	Group C	27	Female	English
18	Group A	26	Female	Chinese	58	Group C	27	Female	Indonesian
19	Group A	27	Female	Japanese	59	Group C	28	Female	English
20	Group A	33	Female	English	60	Group C	28	Female	English
21	Group B	20	Male	English	61	Group D	20	Male	English
22	Group B	20	Male	English	62	Group D	21	Male	English
23	Group B	20	Male	English	63	Group D	31	Male	English
24	Group B	18	Female	English	64	Group D	18	Female	English
25	Group B	18	Female	English	65	Group D	18	Female	English
26	Group B	19	Female	English	66	Group D	19	Female	English
27	Group B	19	Female	English	67	Group D	19	Female	English
28	Group B	20	Female	English	68	Group D	20	Female	English
29	Group B	20	Female	English	69	Group D	20	Female	English
30	Group B	20	Female	English	70	Group D	21	Female	English
31	Group B	21	Female	English	71	Group D	21	Female	English
32	Group B	21	Female	Spanish	72	Group D	22	Female	English
33	Group B	23	Female	English	73	Group D	23	Female	English
34	Group B	23	Female	English	74	Group D	23	Female	English
35	Group B	24	Female	English	75	Group D	23	Female	English
36	Group B	24	Female	Japanese	76	Group D	23	Female	English
37	Group B	25	Female	Korean	77	Group D	27	Female	Japanese
38	Group B	29	Female	English	78	Group D	34	Female	English
39	Group B	29	Female	Spanish	79	Group D	36	Female	English
40	Group B	30	Female	Japanese	80	Group D	48	Female	English

Participants

Eighty participants (students at Florida State University) took part in the study. These participants consisted of both undergraduates and graduate students, ranging in age from 18 to 48 years (with a mean age of 23.6 years) and consisting of 12% males and 88% females. Table 1 illustrates the demographic data for each participant, including age, gender, and primary language.

Sentence repetition task with auditory distractions

A sentence repetition task from the Neurosensory Center Comprehensive Examination for Aphasia was used to assess working memory (Spreen & Strauss, 1998). The test correlates with both the Western Aphasia Battery and the Full Scale IQ, and is also sensitive to aphasia resulting from brain damage (Spreen & Strauss, 1998). The sentences were recorded with a male voice and adjusted for consistent volume and duration between sentences using Samplitude Studio Version 6.04 (2002), a computer music editing software. Twenty-two sentences were structured with six-seconds of silence between each and a two-second warning tone before the next sentence began. Prior to the start of the sentences, the recording provided all directions and instructions to participants.

The sentence repetition test consisted of twenty-two sentences of increasing length, from 1 to 26 syllables. The first 12 and last 6 sentences increased by one syllable, while sentences 13 through 16 increased by two syllables.

Using Samplitude Studio Version 6.04, music was layered under the speaking, with the sentences being approximately ten decibels louder than the distracter stimuli. This was done for each of the music genres (alternative, classical, country, electronica/ dance, folk, heavy metal, jazz, pop, rap/hip-hop, religious, and rock) as well as for the experimental "talking" track. A total of thirteen compact disk tracks were created: one control (with sentences only), eleven music (with as the distracter), and one talking (with speech as the distracter). The stimuli were presented to participants free-field in a sound-sensitive room using an RCA RCD150 player, at approximately 70 decibels (Scale C).

Scoring

Sentence repetition accuracy was recorded by the researcher using a complete printout of the sentences (Appendix D). Errors were indicated as (inaccurate) repetitions, omissions, or additions. Sentences with any error were given a score of zero (0) points, while sentences repeated accurately were given one (1) point. According to the test design, an inaccurate sentence was awarded one point if the subsequent five sentences were repeated correctly. A total possible raw score was twenty-two. Per the original test standardization, adjustments for education and age were applied to each participant's raw score as needed (Spreen & Strauss, 1998). As all participants were either at the undergraduate or graduate collegiate level, no adjustments for education were made. Adjustments for age were made such that those from 18-35 received no additional points, participants from 35-44 received 1 additional point on their score, and participants from 45-64 received 2 additional points.

Groups and music preferences

This study was a between-subjects design, with each participant being randomly assigned into one of four groups. Group A, the control group, had the task of repeating the sentences while no other auditory stimulus was present. Group B, the preferred music group, repeated the sentences while the preferred genre of music (as indicated by the pre-test questionnaire) was playing. Group C, the least preferred music group, repeated the sentences while the least preferred genre of music (as indicated by the pre-test questionnaire) was playing. Group D, the talking group, repeated the sentences while background speech was present (in lieu of music).

Music selections included top songs from commonly accepted genres of music. When a single song was not long enough for the duration of the sentence repetition task, an additional song (of the same genre) was used in the remaining time period. Music selections are indicated in Table 2.

Table 2 Music selections by genre.

Genre	Composer/Artist	Song Title
Alternative	Linkin Park	Breaking the Habit
Classical	Ludwig van Beethoven	Symphony No. 9, Mvt. 1
Country	Keith Urban	Days Go By
Electronica / Dance	Murk	Time
Folk	Norah Jones	Nightingale
Heavy metal	Lamb of God	Ashes of the Wake
Jazz	George Benson	Softly, As In A Morning Sunrise
Pop	Ashlee Simpson	Pieces of Me
Pop	Maroon 5	She Will Be Loved
Rap/Hip-hop	Ciarra, featuring Petey Pablo	Goodies
Religious	MercyMe	Here With Me
Rock	Breaking Benjamin	So Cold
Talking	Sports Talk Radio Broadcast	
Talking	Public Radio Broadcast	

Procedure

Participants were seated three feet from the sound source in a cushioned chair in a sound-sensitive room. A small desk was in front of the participant to allow space to complete the consent form and questionnaires. The compact disk player was also set on the desk. Participants were tested in one session lasting approximately seven minutes. A pre-test questionnaire (Appendix B) was distributed by the researcher to determine age, gender, language, and music genre preference. The researcher selected the appropriate compact disk track (according to group and music preference). Oral instruction was then given by the recording: "Listen carefully, and after you have heard each sentence, repeat it as well as you can. Once again, listen carefully, and repeat the sentence right after you hear it." A post-test questionnaire (Appendix C) was given to participants in the experimental groups following the sentence repetition task to determine familiarity and self-perceived distraction.

Statistical treatment of data

One-way analysis of variance (ANOVA) procedures were utilized to compare the means of each of the groups. Scores on the sentence repetition task and the group condition were used as factors.

Results

There were 20 participants in each of the four groups. Through a one-way analysis of variance (ANOVA), no statistically significant difference was found in the scores among each of the groups (SCORE x GROUP), $F(3) = 0.587$; $p > 0.05$. The complete results of the ANOVA for scores among groups are depicted in Table 3. The mean scores and standard deviations for each group are shown in Table 4. As evidenced by these statistics in, great variability was evident in each of the groups.

Table 3 Results of ANOVA for SCORE x GROUP

	Sum of Squares	df	Mean Square	*F*	Sig.
Between Groups	21.74	3	7.25	.587	.626
Within Groups	938.65	76	12.35		
Total	960.39	79			

Table 4 Descriptive statistics of groups.

	N	Mean	Std. Deviation	Std. Error
Group A Control	20	14.25	4.14	0.93
Group B Preferred Music	20	14.75	3.43	0.77
Group C Least Preferred Music	20	14.95	3.63	0.81
Group D Talking	20	15.70	2.70	0.60
Total	80	14.91	3.49	0.39

Primary language of the participants was also analyzed. While 82.5% of the participants indicated English as their primary language, 17.5% indicated another language as primary. The non-English languages included: Korean, Japanese, Spanish, Cantonese, Chinese, and Indonesian. The overall breakdown of each language can be found in Table 5. Figure 1 illustrates how each language is represented in each of the four groups.

Table 5 Primary languages of participants.

Language	Percent
English	82.5
Korean	2.5
Japanese	6.3
Spanish	3.8
Cantonese	1.3
Chinese	2.5
Indonesian	1.3
Total	*100.0*

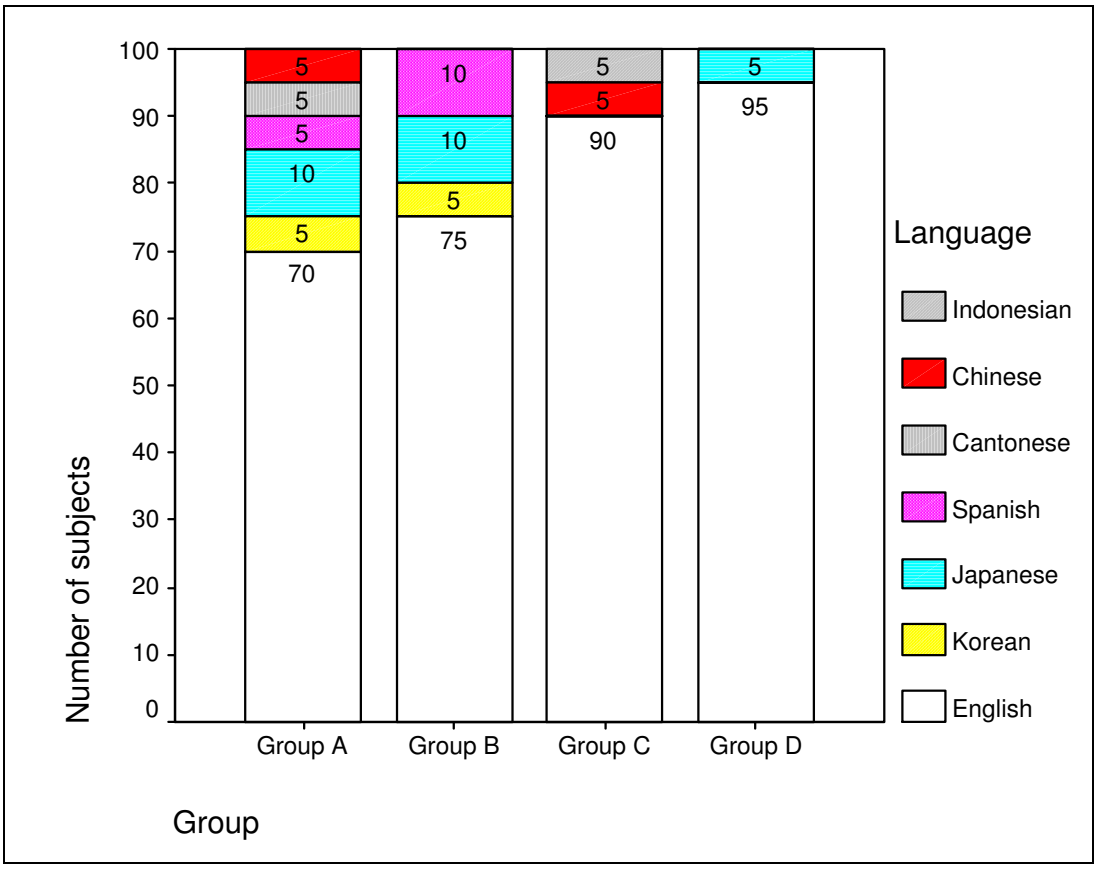

Figure 1 Language breakdown by group.

Although analysis indicated no statistically significant difference among groups, it is worth noting that the mean score for Group A was the lowest, followed by Group B, then Group C, and finally Group D having the highest mean. When looking at Figure 1, however, one may notice a possible correlation with the number of English speaking participants in the groups. Group D, having the highest percentage of English speaking participants, also had the highest mean score on the sentence repetition test. Although English was not the primary language of all participants, all participants did have functional use of the language. Despite this, language may have played a confounding role on performance even though the assessment did not overtly test language comprehension (rather just the recall).

Perceived performance was determined from the post-test questionnaire given to experimental groups B, C, and D. As Figure 2 illustrates, only those in Group B (with the preferred genre of music) responded that their performance was enhanced by the

auditory distraction (58%), whereas most other participants reported that their performance was diminished or not affected. Familiarity to the music distraction was assessed in the post-test questionnaire as well. While 75% of participants in Group B were familiar with the music in the background, only 15% of those in Group C reported familiarity to the music.

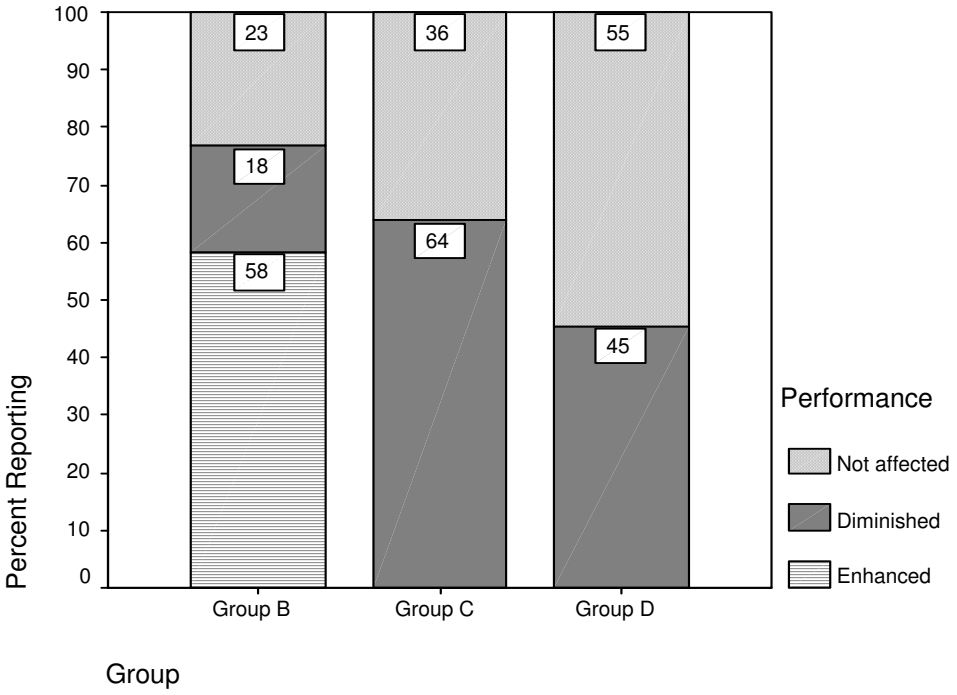

Figure 2 Effect of distractions on perceived performance.

Discussion

An interesting feature of the study is that those participants listening to their preferred genre of music (Group B) tended to feel their performance was enhanced (as reported by 58%), although statistically the performance of Group B did not differ from the remaining experimental groups or the control. This may be a reflection on the arousal theory, but instead of music being qualified as stimulating or sedative, it is thought of as preferred or least preferred. As Hallam and colleagues (2002) found optimal arousal resulting in increased speed, but not accuracy in solving arithmetic problems, accuracy in this verbal recall task was also not influenced. The arousal simply resulted in a psychological response of perceived enhancement. Further study may look to determine if physiologic factors were also influenced. As most other investigations on distraction

occur in the realm of cognitive neuroscience (as opposed to overt behavioral studies), this study could be modified to take into account arousal and activation through cortisol levels, blood oxygen levels, and event-related potential measures (Melara, Rao, & Tong, 2002, al'Absi, Hugdahl, & Lovallo, 2002; Janata, Tillmann, & Bharucha, 2002; Roeber, Widmann, & Schröger, 2003).

This sentence repetition test also increases load on working memory with each subsequent sentence of increasing length. Using the ERP study conducted by Cairo, Liddle, Woodward, & Ngan (2004), one might incorporate the music distraction stimuli to further determine how the distracters affect encoding, maintenance, and retrieval, and how this process changes based on age or brain function (such as Alzheimer's disease).

The body of research has yet to account for non-native English speakers. As this study contained several participants with a primary language other than English, it is possible that both working memory and physiologic functions may be susceptible to this uncontrolled influence. Non-native speakers may experience increased stress in this task, evidenced through increased cortisol levels, thus affecting working memory (al'Absi, Hugdahl, & Lovallo, 2002).

With the overall results lacking a decisive advantage for any one group, possibilities of further study may be considered to determine how distractions may maximize or minimize working memory performance with auditory target stimuli. The group experiencing the competing speech (Group D) is most representative of everyday experiences people encounter – conversing with one person in a crowd of people. As this is the most practiced form of selective attention experienced in daily life, this training, and not the native-language component, may be responsible for the slightly higher mean score. Such results corroborate the training notions put forth by Melara, Rao, & Tong (2002). While this study was designed to determine if a difference in working memory existed due to various forms of auditory distraction in collegiate students (as opposed to looking as a specified population with a known deficit), it may be the vary nature of this population to be resistant to such distracters, as suggested by Belleville, Rouleau, & Can der Linden (2003). If a study with a similar design was done with individuals with dementia of the Alzheimer's type, the group with the background talking (competing speech distracter) may in fact be most impaired. Then the effect of music may be more

accurately assessed as either an enhancement or detriment to performance. This may occur despite the fact that music when appropriately paired with speech (not as a distracter) can enhance learning (Prickett & Moore, 1991). Whenever using music, however, one should take into account not only physical characteristics of the music, but the preferences of the individuals. In one population, preferred music may cause the most distraction due to familiarity, whereas least preferred music may be easiest to block out due to lack of interest or enjoyment. Such considerations have not been widely addressed in research literature, but certainly warrant investigation due to their implications across therapeutic, rehabilitative, and educational fields.

APPENDIX A: Informed Consent / FSU Institutional Review Board Approval Letter

Dear participant,
This informed consent form describes the research being done by Mitra Gobin, MT-BC, a graduate student in the music therapy department at Florida State University. "The effects of auditory distraction on memory with verbal recall" is designed to study whether additional auditory stimuli, namely music, acts as an enhancement or hindrance in sentence memory tasks.

Your participation will involve filling out a questionnaire of general information, including age, music preference, and music experience. You will then be instructed to listen to pre-recorded sentences and repeat them to the best of your ability. The total time commitment for the entire experiment should not exceed 20 minutes.

There are no foreseeable risks or discomforts for you in choosing to participate in this study. You will not receive any physical benefits for participation in this project. Your participation will provide the data necessary to further assess the role of memory and distraction with auditory stimuli and how music therapy may enhance cognitive research on memory. You have the right to withdraw from the experiment at any time without prejudice, penalty, or loss of benefits.

The results of the research may be published. Identifying information will not be used or revealed and will remain confidential, to the extent allowed by law. Identifying information will be destroyed at the completion of all data analyses.

If you have questions concerning this research study, or to request results of the completed study, please contact Mitra Gobin, MT-BC, via e-mail at mdg@musician.org, or Dr. Jayne Standley (Director of Music Therapy at Florida State University) at 850-644-4565.

If you have any questions about your rights as a participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Committee, Institutional Review Board, through the Vice President for the Office of Research, at 850-644-8633.

Thank you for your time.

Sincerely,
Mitra Gobin, MT-BC
mdg@musician.org

I, _____, *(please print name clearly)* have read and understand this form and give my informed consent to participate in the above study.

_____ _____

Signature *Date*

Florida State
UNIVERSITY

Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2763
(850) 644-8673 · FAX (850) 644-4392

APPROVAL MEMORANDUM

Date: 9/13/2004

To:
Mitra Gobin
401 W. Park Ave #302
Tallahassee, Fl 32301

Dept.: **MUSIC SCHOOL**

From: **John Tomkowiak, Chair** John Tomkowiak M.D.

Re: **Use of Human Subjects in Research**
The effects of auditory Distraction on Memory with verbal recall

The forms that you submitted to this office in regard to the use of human subjects in the proposal referenced above have been reviewed by the Secretary, the Chair, and two members of the Human Subjects Committee. Your project is determined to be Exempt per 45 CFR § 46.101(b) 2 and has been approved by an accelerated review process.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approvals, which may be required.

If the project has not been completed by **9/9/2005** you must request renewed approval for continuation of the project.

You are advised that any change in protocol in this project must be approved by resubmission of the project to the Committee for approval. Also, the principal investigator must promptly report, in writing, any unexpected problems causing risks to research subjects or others.

By copy of this memorandum, the chairman of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols of such investigations as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Protection from Research Risks. The Assurance Number is IRB00000446.

Cc: Jayne Standley
HSC No. 2004.626

APPENDIX B: Pre-test questionnaire

ID: _____ *Date:* _____

Age: _____ ☐ Male ☐ Female

Major: _____

If any, what instruments do you play proficiently? _____

_____

Is English your primary language? ☐ Yes. ☐ No.

If "No", what is your primary language? _____

Classification: ☐ Freshman ☐ Sophomore ☐ Junior ☐ Senior

☐ Master's ☐ Doctoral

Please rank your listening preferences 1-11 ***(1=most preferred, 11=least preferred)***

_____ Alternative

_____ Classical

_____ Country

_____ Electronica/Dance

_____ Folk

_____ Heavy metal

_____ Jazz

_____ Pop

_____ Rap/Hip-hop

_____ Religious

_____ Rock

APPENDIX C: Post-test questionnaire

ID: _____ *Date:* _____

If you heard music, were you familiar with the piece?

☐ Yes. It was:

Composer/Artist: _____

Title: _____

☐ Yes, I somewhat recognize the selection.

☐ No, I am not familiar with the selection.

Was the additional music/talking a distraction in the sentence repetition test?

☐ No, it was **not distracting**.

☐ Yes, it was **somewhat distracting**.

☐ Yes, it was **very distracting**.

Do you feel your performance was affected by the additional music/talking?

☐ Yes, my performance was **enhanced**.

☐ Yes, my performance was **diminished**.

☐ No, my performance was **not affected**.

APPENDIX D: Sentence repetition score form

SUBJECT I D# : _____	
1. Look.	
2. Come here.	
3. Help yourself.	
4. Bring the table.	
5. Summer is coming.	
6. The iron was quite hot.	
7. The birds were singing all day.	
8. The paper was under the chair.	
9. The sun was shining throughout the day.	
10. He entered about eight o'clock that night	
11. The pretty house on the mountain seemed empty.	
12. The lady followed the path down the hill toward home.	
13. The island in the ocean was first noticed by the young boy.	
14. The distance between these two cities is too far to travel by car.	
15. A judge here knows the law better than those people who must appear before him.	
16. There is a new method in making steel which is far better than that used before.	
17. This nation has a good government which gives us many freedoms not known in times past.	
18. The friendly man told us the directions to the modern building where we could find the club.	
19. The king knew how to rule his country so that his people would show respect for his government.	
20. Yesterday he said he would be near the village station before it was time for the train to come.	
21. His interest in the problem increased each time that he looked at the report which lay on the table.	
22. Riding his black horse, the general came to the scene of the battle and began shouting at his brave men.	
TOTAL SCORE:	

APPENDIX E: Raw Data

Group	Gender	Age	Raw score	Adjusted Score	Primary Language	Class	Preferred Music	Least Preferred Music	Familiarity with music selection	Self-reported distraction	Self-reported performance
A	Female	23	18	18	English	Master	Alternative	Heavy metal	No music.	No music.	No music.
A	Female	26	5	5	Japanese	Master	Rock	Religious	No music.	No music.	No music.
A	Female	22	18	18	English	Senior	Religious	Heavy metal	No music.	No music.	No music.
A	Female	33	14	14	English	Master	Jazz	Rap / Hip-Hop	No music.	No music.	No music.
A	Female	24	11	11	Spanish	Master	Religious	Electronica / Dance	No music.	No music.	No music.
A	Female	22	12	12	Cantonese	Master	Folk	Heavy metal	No music.	No music.	No music.
A	Female	18	14	14	English	Freshman	Rock	Religious	No music.	No music.	No music.
A	Male	26	14	14	English	Doctoral	Alternative	Religious	No music.	No music.	No music.
A	Female	20	15	15	English	Senior	Alternative	Heavy metal	No music.	No music.	No music.
A	Female	20	18	18	English	Senior	Religious	Rap / Hip-Hop	No music.	No music.	No music.
A	Female	26	11	11	Chinese	Master	Pop	Heavy metal	No music.	No music.	No music.
A	Female	26	19	19	English	Doctoral	Classical	Heavy metal	No music.	No music.	No music.
A	Female	27	7	7	Japanese	Master	Classical	Heavy metal	No music.	No music.	No music.
A	Female	20	13	13	English	Junior	Alternative	Rap / Hip-Hop	No music.	No music.	No music.
A	Female	19	15	15	English	Sophomore	Rock	Rap / Hip-Hop	No music.	No music.	No music.
A	Female	19	19	19	English	Sophomore	Classical	Electronica / Dance	No music.	No music.	No music.
A	Male	18	20	20	English	Freshman	Jazz	Heavy metal	No music.	No music.	No music.
A	Female	22	11	11	Korean	Sophomore	Religious	Heavy metal	No music.	No music.	No music.
A	Male	20	19	19	English	Junior	Jazz	Electronica / Dance	No music.	No music.	No music.
A	Female	20	12	12	English	Junior	Jazz	Country	No music.	No music.	No music.
B	Female	25	10	10	Korean	Master	Heavy metal	Classical	Yes, somewhat recognize song.	Not distracting.	Enhanced.
B	Female	24	12	12	Japanese	Master	Classical	Country	Yes, somewhat recognize song.	Somewhat distracting.	Diminished.
B	Female	29	18	18	English	Doctoral	Classical	Rap / Hip-Hop	Yes, correct identification of song.	Somewhat distracting.	Diminished.
B	Female	20	21	21	English	Senior	Rock	Rap / Hip-Hop	Yes, somewhat recognize song.	Somewhat distracting.	Not affected.
B	Female	20	12	12	English	Junior	Pop	Rap / Hip-Hop	Yes, correct identification of song.	Very distracting.	Diminished.
B	Female	30	8	8	Japanese	Senior	Pop	Heavy metal	No.	Very distracting.	Diminished.
B	Female	20	12	12	English	Junior	Alternative	Rap / Hip-Hop	Yes, somewhat recognize song.	Somewhat distracting.	Diminished.
B	Female	23	18	18	English	Master	Jazz	Country	No.	Somewhat distracting.	Diminished.
B	Female	29	17	17	Spanish	Doctoral	Classical	Heavy metal	Yes, somewhat recognize song.	Somewhat distracting.	Not affected.
B	Female	21	19	19	English	Senior	Classical	Country	Yes, correct identification of song.	Somewhat distracting.	Diminished.
B	Female	19	14	14	English	Junior	Rock	Heavy metal	Yes, somewhat recognize song.	Very distracting.	Diminished.
B	Female	24	16	16	English	Master	Religious	Electronica / Dance	No.	Somewhat distracting.	Diminished.

Group	Gender	Age	Raw score	Adjusted Score	Primary Language	Class	Preferred Music	Least Preferred Music	Familiarity with music selection	Self-reported distraction	Self-reported performance
B	Male	20	14	14	English	Junior	Pop	Jazz	Yes, correct identification of song.	Somewhat distracting.	Diminished.
B	Female	21	17	17	Spanish	Junior	Rock	Heavy metal	No.	Very distracting.	Diminished.
B	Female	18	12	12	English	Freshman	Pop	Electronica / Dance	Yes, correct identification of song.	Somewhat distracting.	Diminished.
B	Female	18	13	13	English	Freshman	Pop	Electronica / Dance	Yes, correct identification of song.	Somewhat distracting.	Diminished.
B	Male	20	17	17	English	Junior	Electronica/ Dance	Country	No.	Somewhat distracting.	Diminished.
B	Male	20	16	16	English	Junior	Classical	Electronica / Dance	Yes, somewhat recognize song.	Somewhat distracting.	Diminished.
B	Female	23	11	11	English	Senior	Alternative	Folk	Yes, somewhat recognize song.	Somewhat distracting.	Diminished.
B	Female	19	18	18	English	Sophomore	Rock	Country	Yes, somewhat recognize song.	Somewhat distracting.	Diminished.
C	Female	27	14	14	English	Master	Rap / Hip-Hop	Heavy metal	No.	Very distracting.	Diminished.
C	Female	22	17	17	English	Senior	Rock	Heavy metal	No.	Somewhat distracting.	Diminished.
C	Female	28	11	11	English	Doctoral	Pop	Heavy metal	No.	Somewhat distracting.	Diminished.
C	Female	28	12	12	English	Master	Classical	Religious	No.	Somewhat distracting.	Diminished.
C	Male	31	12	12	English	Doctoral	Rap / Hip-Hop	Electronica / Dance	No.	Somewhat distracting.	Diminished.
C	Male	31	22	22	English	Doctoral	Classical	Rap / Hip-Hop	No.	Somewhat distracting.	Not affected.
C	Female	20	15	15	English	Junior	Classical	Rap / Hip-Hop	No.	Somewhat distracting.	Diminished.
C	Female	24	9	9	Chinese	Master	Classical	Alternative	No.	Somewhat distracting.	Diminished.
C	Female	24	20	20	English	Master	Rock	Rap / Hip-Hop	No.	Somewhat distracting.	Diminished.
C	Male	21	12	12	English	Senior	Classical	Religious	No.	Very distracting.	Diminished.
C	Female	27	11	11	Indonesian	Master	Classical	Heavy metal	No.	Somewhat distracting.	Diminished.
C	Female	26	13	13	English	Master	Classical	Religious	No.	Somewhat distracting.	Diminished.
C	Female	19	20	20	English	Junior	Religious	Rap / Hip-Hop	No.	Very distracting.	Diminished.
C	Female	21	13	13	English	Senior	Country	Heavy metal	No.	Somewhat distracting.	Diminished.
C	Male	31	16	16	English	Doctoral	Classical	Rap / Hip-Hop	Yes, somewhat recognize song.	Somewhat distracting.	Diminished.
C	Male	42	16	17	English	Master	Classical	Rap / Hip-Hop	Yes, somewhat recognize song.	Not distracting.	Diminished.
C	Female	20	12	12	English	Junior	Folk	Religious	Yes, somewhat recognize song.	Somewhat distracting.	Diminished.
C	Female	20	20	20	English	Junior	Country	Heavy metal	No.	Very distracting.	Diminished.
C	Male	20	17	17	English	Junior	Electronica/ Dance	Religious	No.	Somewhat distracting.	Diminished.
C	Male	24	16	16	English	Senior	Pop	Heavy metal	No.	Very distracting.	Diminished.
D	Female	23	11	11	English	Master	Religious	Country	No music.	Somewhat distracting.	Diminished.
D	Female	23	15	15	English	Senior	Pop	Electronica / Dance	No music.	Somewhat distracting.	Diminished.

Group	Gender	Age	Raw score	Adjusted Score	Primary Language	Class	Preferred Music	Least Preferred Music	Familiarity with music selection	Self-reported distraction	Self-reported performance
D	Female	18	20	20	English	Junior	Folk	Religious	No music.	Somewhat distracting.	Diminished.
D	Female	36	16	17	English	Master	Classical	Religious	No music.	Somewhat distracting.	Diminished.
D	Female	21	15	15	English	Senior	Rock	Rap / Hip-Hop	No music.	Very distracting.	Diminished.
D	Female	27	8	8	Japanese	Master	Classical	Rap / Hip-Hop	No music.	Very distracting.	Diminished.
D	Female	19	18	18	English	Sophomore	Classical	Electronica / Dance	No music.	Somewhat distracting.	Not affected.
D	Female	23	15	15	English	Master	Rock	Rap / Hip-Hop	No music.	Somewhat distracting.	Diminished.
D	Female	20	15	15	English	Sophomore	Rock	Heavy metal	No music.	Somewhat distracting.	Diminished.
D	Female	19	17	17	English	Sophomore	Pop	Heavy metal	No music.	Somewhat distracting.	Diminished.
D	Female	34	17	17	English	Doctoral	Country	Rap / Hip-Hop	No music.	Somewhat distracting.	Not affected.
D	Female	21	16	16	English	Senior	Alternative	Religious	No music.	Very distracting.	Diminished.
D	Female	22	15	15	English	Senior	Alternative	Heavy metal	No music.	Somewhat distracting.	Diminished.
D	Female	48	15	17	English	Master	Pop	Heavy metal	No music.	Somewhat distracting.	Diminished.
D	Female	20	16	16	English	Junior	Alternative	Rap / Hip-Hop	No music.	Somewhat distracting.	Diminished.
D	Female	18	16	16	English	Freshman	Classical	Rap / Hip-Hop	No music.	Not distracting.	Diminished.
D	Female	23	19	19	English	Master	Folk	Heavy metal	No music.	Somewhat distracting.	Diminished.
D	Male	20	16	16	English	Sophomore	Alternative	Rap / Hip-Hop	No music.	Somewhat distracting.	Diminished.
D	Male	31	13	13	English	Junior	Classical	Rap / Hip-Hop	No music.	Somewhat distracting.	Diminished.
D	Male	21	18	18	English	Junior	Rock	Religious	No music.	Very distracting.	Diminished.

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BIOGRAPHICAL SKETCH

Mitra David Gobin was raised primarily in Florida, and graduated from C. Leon King High School (Tampa, FL) in 1999 with an International Baccalaureate Diploma. He has successfully completed a Bachelor of Science Degree in Psychology, a Bachelor of Music Degree in Music Therapy, and a Minor in Religion at the Florida State University. His primary music therapy experience and interest lies in hospice and elder care and the associated research to maximize the efficacy of music therapy in these areas.