

## The Effect of Preferred Music on Mood and Performance in a High-Cognitive Demand Occupation

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*Mild positive affect has been shown in the psychological literature to improve cognitive skills of creative problem-solving and systematic thinking. Individual preferred music listening offers opportunity for improved positive affect. The purpose of this study was to examine the effect of preferred music listening on state-mood and cognitive performance in a high-cognitive demand occupation. Twenty-four professional computer information systems developers (CISD) from a North American IT company participated in a 3-week study with a music/no music/music weekly design. During the music weeks, participants listened to their preferred music "when they wanted, as they wanted." Self-reports of State Positive Affect, State Negative Affect, and Cognitive Performance were measured throughout the 3 weeks. Results indicate a statistically significant improvement in both state-mood and cognitive performance scores. "High-cognitive demand" is a relative term given that challenges presented to individuals may occur on a cognitive continuum from need for focus and selective attention to systematic analysis and creative problem-solving. The findings and recommendations have important implications for music therapists in their knowledge of the effect of music on emotion and cognition, and, as well, have important implications for music therapy consultation to organizations.*

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### *Effect of Music on Cognition*

Cognitive skill exists along a continuum beginning with bottom-up processing of pattern recognition to top-down processing employed in creative problem-solving (Reisberg, 2005). Lately, as a consequence of innovations in technology and resulting music-brain studies, researchers and clinicians have neuro-physiological evidence as to how music-based interventions influence cognition.

Such evidence provides support for music-based cognitive rehabilitation. At the time of Purdie's meta-analysis of music therapy in neuro-rehabilitation (1997), 6% of the treatments addressed cognitive rehabilitation. Two music-based cognitive rehabilitation studies have reported benefits for sustained and alternating attention of traumatic brain injury (TBI) patients (Knox, Hiroko, et al., 2003; Wit, Knox, et al., 1994). Additionally, Gardiner (2005) has provided an overview of cognitive rehabilitation principles for neurologic music therapy techniques for TBI. Other studies investigating music-based interventions to facilitate attention include infant responses to maternal singing (e.g., de l'Etoile, 2006), sustained attention capacity for children with Attention Deficit Disorder (e.g., Abikoff, Courtney, et al., 1996; Morton, Kershner, et al., 1990), maintenance of attention in elderly with dementia (e.g., Gregory, 2002) and memory of adults with Multiple Sclerosis (e.g., Sena Moore et al., 2008).

Fewer yet are studies that have examined music-based interventions for the more integrated cognitive abilities, often referred to as executive function skills (Gardiner, 2005). Theoretical models have been proposed to explain the role of music-based interventions to improve attention and enhance coping skill in pediatric patients with cancer (Robb, 2003), and for needed problem solving and decision making skills for relapse prevention in chemical addiction (Lesiuk, 2010).

The purpose of this study is to examine the role of music-based intervention in the context of a high-cognitive demand occupation, namely computer information systems designing. The cognitive requirement emphasized in this paper is referred to as generative processing or creative problem-solving and the underlying mechanism influencing change in cognition is supported by emotion-cognition theory.

### *A High-Cognitive Demand Occupation*

Computer information systems consist of application software created to deliver business, science or educational information to users in an organization. The nature of the business of creating these systems involves complex cognitive processes of working memory, logical analytical thinking, access to manifest and latent knowledge of systems design, and general creative problem-solving. The designers and developers of these systems are also

required to be highly innovative and efficient in the face of constant time pressures and high workloads (personal communication with project managers, 2001–09; Rissler & Jacobsson., 1987; Sonnentag, Brodbeck, et al., 1994; Wastell & Newman, 1993).

In contrast to studies examining self-reports of attitudes, Wastell (1990) studied physiological responses concerned with performance and workload among software engineers who were working against tight deadlines. Interested in the cognitive efficiency of the engineers, Wastell examined the engineers under pressure of high workloads and oppressive schedules, and postulated that working memory and reasoning power might be seriously impaired. Although cognitive prowess (grammatical reasoning, letter substitution) did not show any decline, significant differences were reported in physiological measurements, specifically in catecholamine excretion. The researcher concluded that the price paid for high performance was reflected in the engineers having to mobilize a high level of adrenaline. Longenecker, Schaffer, and Scazzero (1999) found that increased frustration was the leading consequence of stressors for 187 information technology professionals having negative impact on a job that requires “high levels of discipline, focus, and systematic thinking” (p. 73).

An information processing model, alias the Affect Infusion Model, posits that affect or mood is most influential when tasks are complex and require highly generative processing (Forgas, 1998; Forgas & George, 2001). The designing of computer systems for business performance requires developers to generate ideas beyond the information given, otherwise referred to as creative problem-solving, and in the process their moods influence what is retrieved and used from memory.

### *Positive and Negative Affect*

Pleasant mood responses (e.g., positive affect) are reported in several studies to enhance creative problem-solving ability and increase performance on creative problem-solving tasks (Estrada, Isen, et al., 1997; Isen, 2005). The neuro-physiological mechanism of the affect enhancement is explained through a dopaminergic theory (Ashby, Isen, & Turken, 1999). The theory purports that increases of the neurotransmitter dopamine in the anterior cingulate improve several cognitive abilities including long-term

episodic memory, working memory and neural areas of problem solving and cognitive flexibility.

The effects of negative affect on cognition are more complex and unpredictable than effects of positive affect on cognition (Isen, 1987, 1990). One distinction between the two types of affect is that negative affect (e.g., irritability) is more narrowly and specifically represented in memory than is positive affect. Thus, negative affect is less effective as a retrieval cue than positive feelings and may cue a narrower set of information, such as a set of material specifically related to sadness (Isen, 2005).

Despite the asymmetry between the affect states, there is a kind of symmetry between positive and negative affect in the effects produced on cognition. For example, it is a common finding that negative affect can influence cognitive strategies in diminished ways. An early study (Easterbrook, 1959) purported that distress influenced decision making by narrowing attention to a task's most critical cues. The narrowing of one's view is a consequence of arousal directly influencing the allocation of scarce attentional resources. Higher arousal produces narrowing in attention and thus decreases the allocation of processing resources to the decision task (Mano, 1992). Decision makers, under stress, often become hyper-vigilant, scanning information in a hasty, disorganized, and incomplete way. Hypovigilance may also occur in response to adversary workplace stressors, which is characterized by under-reaction and denial.

### *Music, Affect and Cognition*

Sridharan, Levitin, Chafe, Berger, and Menon (2007) examined neural responses of non-musicians as they listened to two entire movements of a baroque symphony. Frontal cortex regions were activated that were responsible for detection of incoming music sounds, for attending to changes in the incoming music information, and lastly, updating working memory with the incoming sensory information. This study provides neural evidence as to how music stimuli are identified and processed, and in behavioral terms, identified as the cognitive processes of attention and working memory, respectively.

Music listening may serve as an anxiolytic treatment, i.e., an anxiety preventative or anxiety reducing measure. Knight and Rickard (2001) explored the effect of sedative music on 87

undergraduates' subjective and physiological stress levels during preparation for a public speaking task. Results indicated that the control group (no music) displayed significant increases in physiological stress, while the experimental group (with music) suppressed significant increases in subjective anxiety, systolic blood pressure, and heart rate. Of interest, the beneficial effect of the music appeared to be more pronounced in participants who were unfamiliar with the music and had no musical training. Further, while participants most highly stressed by the cognitive stress task benefitted most from the anxiolytic effect, modest physiological reactivity was prevented for those participants who did not perceive the task as stressful.

The use of preferred music and radio by way of stereo headsets is one way in which work performance has shown improvement (Oldham, 1995). An analysis of listening habits such as music type selection, duration of listening, and shifting from one music type to another revealed little relation to outcomes such as employees' moods and productivity, job satisfaction, and turnover intentions. However, the mood state of relaxation best explained the relationship between the use of the stereos and productivity. The researcher suggested that familiarity with the music and discontinuous presentation would be most effective in improving performance, turnover intentions, organizational satisfaction, and mood states.

Lesiuk (2000) reported decreased levels of state anxiety when music was used prior to and throughout a computer programming task. Students in an introductory computer programming course were assigned to a group with either (a) no music, (b) music prior to, or (c) music prior to and during a task requiring students to locate syntax and logic errors. Results indicated a statistically significant effect of the music listening on state anxiety levels ( $p < 0.05$ ) for both music groups. Most importantly, the group with music prior to and during the task experienced the least amount of anxiety. While there was no statistically significant difference between groups for the programming task, the group with the most music achieved the highest mean scores in both tasks.

Further evidence of a positive influence of preferred music listening for computer systems designers is found in a statistically significant correlation concerning their daily average music

listening time and negative affect (Lesiuk, Pons, & Polak, 2009). The more negative affect the designers' experience, the more they listen to music to subdue their negative feelings. This interpretation of the positive correlation is based on Sloboda and O'Neill's (2001) finding that in everyday uses of music, most music listening experiences are positive.

The following research questions and study was designed to test the aforementioned conceptual relationships of music stimuli, mood and cognition within the context of a high-cognitive demand occupation.

### *Research Hypotheses*

Hypothesis 1: Listening to preferred music "when and how desired" by the participants will improve their self-reported State mood levels (i.e., State Positive and Negative Affect).

Hypothesis 2: Listening to music will improve the self-reported cognitive performance (i.e., quality-of-work) of the participants.

## Method

### *Participants and Study Design*

Twenty-four participants from a computer company in North America completed a 3-week music listening study in which participant demographics, stress, state positive and negative affect and quality-of-work were measured. Initial surveys of demographics and work stress were given a few days before the start of the study. State Positive and Negative Affect were measured 2 days a week (i.e., Tuesday & Thursday) throughout the 3 weeks. Quality-of-work were administered on alternate days as to limit study interference with the required workday tasks days (i.e., Monday, Wednesday, & Friday). Music listening was not permitted during Week 2. Measures were kept to a minimum as to not interfere with the daily work expectations. A final music listening questionnaire was administered at the end of the study.

A music library of 65 CDs was set up in the vicinity of the developers. Style categories of music in the library included Alternative, Classical, Country, Heavy Metal, Light Jazz, New Age, Pop, and a category labeled Other (e.g., Folk, Spirituals, etc.). Developers could listen to music of their own choosing either from their own collections or from the music library. They could

listen to the music within their office cubicle via a personal stereo or with headsets on their computer. For Weeks 1 and 3 participants were simply instructed to "*LISTEN TO THE MUSIC WHEN YOU WANT TO, AS YOU WANT TO*" with a minimum of 30 min of listening daily. There was no music listening during Week 2.

### *Measures*

*Participant demographic questionnaire.* A researcher-designed questionnaire requested information concerning age, gender, years of work experience, education level, years of formal music education, and amount of current daily music listening at work. The purpose of the questionnaire was to collect demographic information to help describe the characteristics of the work culture.

*Narrative work stress questionnaire.* Ivancevich and Matteson's Stress Diagnostic Survey (1988), narrative section only, was administered prior to the 3-week study. Participants were asked, "What is the most stressful part of your job?"

*State mood.* State mood, an individual's experience of short-term emotional fluctuation, either negative or positive, was measured by the *Job Affect Scale* (JAS) (Brief, Burke, et al., 1988). Both State Positive Affect and Negative Affect were scored on a Likert scale (1 = extremely slightly to 7 = extremely strongly). The JAS, originally a 20-item questionnaire, was reduced to 12 items (Oldham, 1995) for the purpose of decreasing the amount of time spent on answering questionnaires during work time. State Positive Affect is defined as the extent to which an individual displays enthusiasm (Watson & Tellegen, 1985). The State Positive Affect items consisted of positively scoring *strong*, *excited*, and *elated* and reverse scoring of *sleepy*, *drowsy*, and *sluggish*. The highest possible score is 42 and the lowest possible score is 6. The higher the score the more intense the affect. State Negative Affect is defined as the extent to which a person reports feeling upset or unpleasantly aroused (Watson & Tellegen, 1985). The State Negative Affect items consisted of positively scoring *scornful*, *hostile* and *nervous* and reverse scoring of *calm*, *relaxed*, and *at rest*. The highest possible score is 42 and the lowest possible score is 6. The higher the score the more intense the affect.

*Cognitive performance.* A researcher-designed self-assessment questionnaire was created in consultation with several systems developers in order to obtain the best possible measurement of quality of computer information systems work. The *Quality-of-Work Questionnaire* 5-item test consisted of responding on a Likert-type scale (1 = not at all, 2 = somewhat, 3 = moderately, to 4 = very much so) to questions assessing computer design life-cycle task performance. The five phases of the life-cycle could include systems analysis, design, development, implementation and maintenance. Participants self-assessed their work quality by responding to items such as *Was the solution creative? Was the solution effective? Did you experience fewer mental blocks than usual? Did you use a new approach in your practices?* and *Are you pleased with the work you just completed?* Items were positively scored, summed, and then divided by 5 to obtain a mean. The higher the score the higher the work quality with a possible range of scores from 5 to 20.

*Music listening questionnaire.* A narrative section followed at the end of the study in which participants indicated their most liked and least liked experience with the music listening.

### *Materials*

Participants were offered one of two types of headsets: ear buds (Jensen stereo ear buds, JB6) or a head set (JVC Stereo headphones, HA-33). Some employees chose to use their own headsets or ear buds. A music library of 65 CDs was supplied by the researcher. Style categories of music in the library included Alternative, Classical, Country, Heavy Metal, Light Jazz, New Age, Pop, and a category labeled Other (e.g., Folk, Spirituals, etc.). Employees could also choose music from their own music libraries or playlists.

## Results

### *Participants*

The participants were mainly computer information systems developers (male = 15, female = 9). The 24 participants were 26 to 55 years of age ( $M = 39.12$ ) with work experience ranging from 1 to 25 years ( $M = 7.99$  years). There was a wide range of formal musical education experience from 0 to 10 ( $M = 2.40$ ,  $SD = 3.44$ ). There was also a wide range of reported daily music



TABLE 1

*Some Narrative Statements from "The Most Stressful Part of My Job Is ..."*


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Meeting demands/commitments on a moving target
Workload, uncertainty about future (outsourcing to be announced)
No control (i.e., often too much needed too soon and it's all very important) of the quantity and timelines of my work
Meeting unreasonable deadlines and accommodating new requests mid-stream
Meetings all day—have to catch up at nights. Long hours—stress from family (not enough time spent with them). Volume of work, feeling behind—never time to exercise
Lack of confidence that I can perform my job adequately
Workload is one but dealing with stressful team members is more stressful.
Is a tough industry
To complete my job on time
Tried to beat the deadline—worked 10–11 hours a day

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listening time at work, from no time spent to nearly the entire day ( $M = 55.76$  min.,  $SD = 84.80$  min.).

### *Work Stress*

In the examination of stress in this information technology group, participants shared what they felt was the most stressful part of their jobs. Table 1 presents a few narrative responses to "The most stressful part of my job is ...".

The recurring themes in response to the work stress question addressed time pressures, unrealistic deadlines, volume of work, not knowing how to do something, co-worker problems, client problems, and layoffs of co-workers.

### *Mood*

Figure 1 demonstrates that mood is significantly improved with the presence of music listening. State Positive Affect, reflecting one's degree of positive mood at the time measured, is statistically significantly higher during Weeks 1 and 3 (music weeks) when compared to the no music Week 2. A paired samples *t* test indicates significant differences found between the music and no-music weeks, such that  $p = 0.003$  Week 1 to Week 2,  $p = 0.0001$  Week 2 to Week 3, and  $p = 0.428$  Week 1 to 3. The group's positive affect is significantly lower without the music in Week 2.

Figure 2 demonstrates that mood is significantly improved with the presence of preferred music listening. State Negative Affect,

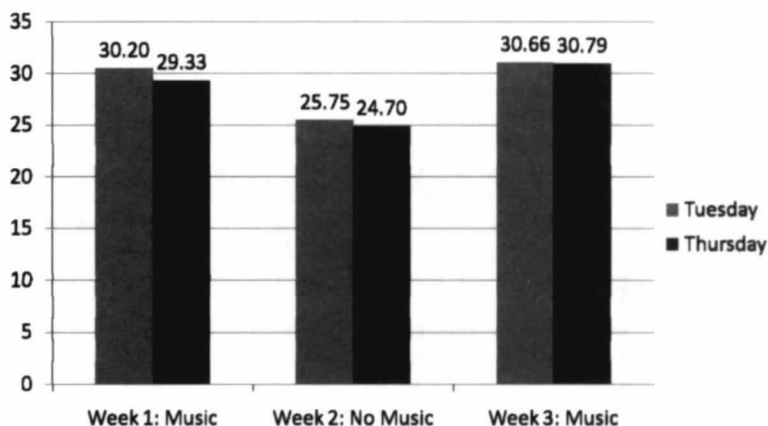


FIGURE 1.

Means of self-reported State Positive Affect measured twice weekly, Weeks 1 through 3.

reflecting one's degree of negative mood at the time measured, is statistically significantly lower during the music Weeks 1 and 3 as when compared to the no-music Week 2. A paired samples *t* test indicates significant differences found between the music and no-music weeks, such that  $p = 0.048$  Week 1 to Week 2,  $p = 0.001$

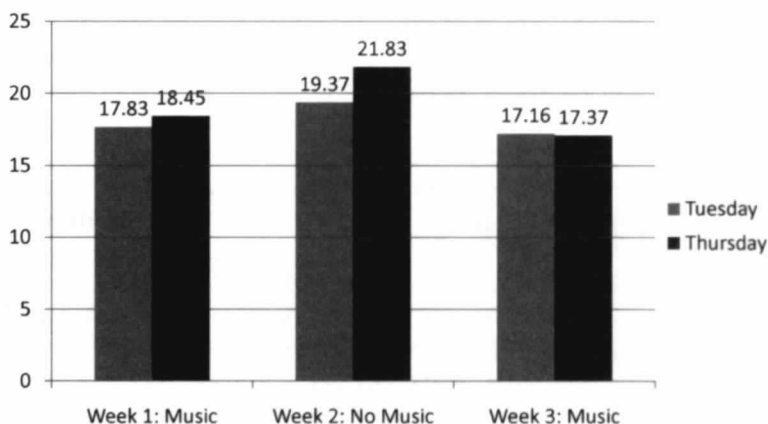


FIGURE 2.

Means of self-reported State Negative Affect measured twice weekly, Weeks 1 through 3.

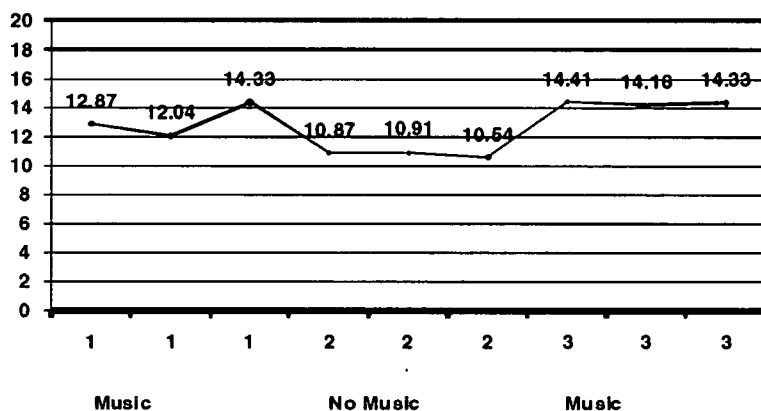


FIGURE 3.

Means of self-reported Cognitive Performance measured three times weekly, Week 1 through Week 3.

Week 2 to Week 3, and  $p = 0.385$  Weeks 1 to 3. The group's mood is significantly more negative in Week 2, the week with no music.

### *Cognitive Performance*

Cognitive performance, as measured by the researcher-designed Quality-of-Work questionnaire, is higher in the music weeks (see Figure 3). The developers are very competent at their design tasks, so improvements in Quality-of-Work are expected to show in very small numerical changes. A paired samples  $t$  test indicates significant differences found between the music and no-music weeks, such that  $p = 0.001$  Week 1 to Week 2,  $p = 0.001$  Week 2 to Week 3, and  $p = 0.001$  Weeks 1 to 3. The group's reported quality-of-work is significantly more negative in Week 2, the week with no music. Additionally, there is a statistically significant difference between Weeks 1 and 3 Quality-of-Work reported, perhaps as a result of having missed the music from Week 2.

### *Music Listening*

A few examples are given below in response to "What was your best experience with the music listening?" Table 2 shows the comments as categorized into themes related to mood, nostalgia, stress relief, and work efficiency.

TABLE 2

*Some Narrative Statements Categorized by Theme from "What was Your Best Experience with the Music Listening?"*

Theme	Statement
Mood	It kept me calm and focused.
	It seemed to put me in a good mood.
	Calming effects. Tension is high lately-this seemed to mellow me out somewhat.
	I felt refreshed at times.
Nostalgia	Kept me in a better mood—more sociable.
	Listening to some stuff I hadn't heard in ages.
	Learning words to songs. Remembering songs.
Relieving stress	Release stress, sadness.
	The music helped me unwind.
	Calming, focus better, feel like I accomplished more—time seemed to move faster.
	When something goes wrong. I find that listening to music helped me let it go, and not dwell on the negative thing that happened.
Work efficiency	Helped me to concentrate.
	Helped me block out surrounding noise (people talking) and focus on the task at hand.
	Feeling like I can accomplish many more things.
	The music reached its climax at the same time I finished a work item. It caused a brief sense of elation followed by contentment
	Just because the music was slower in pace, that didn't make it any less effective in making me more productive.
	Great beat. Made the job feel it was going faster.

Fewer comments were received in regards to participants' "least liked" experiences with music listening. The negative comments that were given reflected the absence of music listening or dissatisfaction of removing the music listening (Week 2), defective or uncomfortable listening equipment, interference with phone calls, and that a particular music selection did not relieve stress. One comment emphasized the significance of music choice for focusing, *"The right type of music allows me to focus on my work and be free of distractions. The wrong type of music annoys me and distracts me from my work."* Additionally, a general comment was given in regards to removing the music in Week 2, *"I found the week when we*

*weren't supposed to listen to music was terrible. I had a hard time getting work done."*

### Discussion

Time pressures, unrealistic deadlines, volume of learning requirements, not knowing how to do something, co-worker problems, client problems, and layoffs of co-workers are themes reported from participants' narrative responses as to the most stressful part of their job. These stressors create psychological and physiological problems for the developers during work hours and, as well, stressors of this kind have adversary affect on cognitive tasks and decision making in the form of decreased attention and missed information (Longenecker et al., 1999; Wastell & Newman, 1993).

The first research hypothesis indicating that preferred music listening will improve state mood levels was supported by the higher State Positive Affect and lower State Negative Affect scores during the music Weeks 1 and 3 ( $p < 0.05$ ). The effect was seen most clearly when music listening was removed from the developers in the second week of the study. Negative mood increased with the removal of music listening but it decreased when music listening was reinstated in Week 3. Additionally, the second hypothesis is supported by the higher self-assessment scores of cognitive performance during the music weeks.

Both the quantitative results and narrative comments reflect the finding that music listening is an anxiolytic treatment in times of stress (Lesiuk, 2000, 2005; Knight & Rickard, 2001). Comments given in regards to the effect of music on stress included that it was calming, and simply that it relaxed and helped participants to focus on the task. These comments reflect an earlier music and workplace study finding that the mood state of relaxation best explained the relationship between the use of the stereos and productivity (Oldham, 1995). Further, music listening may contribute more to those who are highly stressed, but still contribute positively to those who are less stressed (Knight & Rickard, 2001). A comment from a participant of "*When something goes wrong I find that listening to music helped me let it go, and not dwell on the negative thing that happened*" reflects the aid of music listening in altering a negative mood state and its role in altering perception.

While stress and negative affect are not used synonymously in this paper, stress is currently conceptualized by researchers as a

manifestation of negative emotions (Lazarus, 1990). Additionally, professional efficacy, defined by assessing feelings of competence and successful achievement in one's work, is a contributing factor to burnout (Sonnentag et al., 1994), so that when developers produce at a less than optimal performance level they are susceptible to burnout.

As Mano (1992) suggests "Understanding how these conditions [emotion's effects on decision making] operate can enhance our ability to advise professional decision makers (as well as laymen) on the functional and dysfunctional effects of their emotions on their decisions" (p. 217). Music listening experiences provide a suitable way in which to positively influence enduring mood states and in turn, decision environments. Common wisdom recommends simple, but perhaps effective ways of improving decision quality (e.g., *sleep on it, relax and then think it over, let's discuss this in the morning*) (Mano, 1992, p. 242). Such "aids" are targeted at the reduction of the decision maker's arousal, which, in turn, may lead to less drastic or radical decisions (i.e., polarization reduction). Music listening experiences can provide the "time out" needed for quality decision making. The removal of the desired stimulus, music, may indeed have been felt by the developers, thus had an effect on the self-reported Week 2 mood and performance scores.

Forgas and George (2001) suggest that emotional intelligence training in organizations would aid employees in their work-related decisions. By using affect control strategies employees may focus their efforts to avoid or diminish a negative mood and, if needed, tone down a positive mood in order that their judgments are not adversely affected. Empowering employees with knowledge about the effects of mood on work-related thinking would help them to make the appropriate adjustments to their important work-related decisions. In the role of consultant to high-cognitive demand occupations, music therapists may help facilitate employee awareness and identification of daily mood states, and assist with individualized music choice that help alter mood states or meet a desired psychological state. Reuer (2007) posits that music therapists as consultants may address company problems of teamwork, stress management and other human factor issues.

Due to the reliance on self-report measures it is possible that participants may have intentionally guessed at what they thought

the researcher desired and therefore demand characteristics may have been present. Further, a possible confounding effect may have occurred in that moods may influence employees' appraisals of their work performance both in quality and accuracy (Mano, 1992). It is possible that when mood is poor, appraisals of work are also poor. And since the appraisals of quality-of-work in this study were self-assessments it is possible that mood influenced how well one thought one performed.

Greater empirical evidence of the beneficial use of music for mood alteration and quality-of-work in high-cognitive demand occupations is needed and should be addressed empirically by (a) obtaining an objective work performance score, such as expert evaluations of data models, and time spent on a task, and, (b) accounting for music-mood change as reported by individual differences, such as introversion and extraversion. Additionally, measures of stress and/or burnout should be included either for simply describing the work context or as a moderator in the analysis of the relevant constructs and outcome measures. Baron and Kenny (1986) provide a helpful explanation as to framing constructs as mediators or moderators. Lastly, with data from several such empirical studies, a theoretical model depicting the relationship between the aforementioned factors of mood and individual differences, music use, and cognitive outcomes on quality-of-work may be developed. Recommendations stemming from results of the empirical studies and, as well, a proposed theoretical model, would further support music therapy consultation to companies and inform managers in their attempts to provide conditions that enhance their employees' cognitive performance and quality-of-work.

Person-contextual considerations are important, such that the "high-cognitive demand" is a relative term reliant on the skill set of individuals. For example, persons with attention deficits, such as clients with traumatic brain injury, attention-deficit hyperactivity disorder, or with cognitive impairments as a result of chemical addiction, may find scaling the hierarchy of attention skills, or an effective use of working memory to be a "high-cognitive demand." Further, a task-analysis of required cognitive efforts, whether the cognitive emphasis is on attention resources, working memory, or creative-problem solving, helps define a developmental treatment protocol and is a part standard

cognitive rehabilitation (Gordon & Hibbard, 1992). It is yet to be determined whether the music-emotion-cognition process underlying the cognitive demands as presented in this paper may be generalized across all clinical, educational and/or organizational settings.

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