The effect of music listening on work performance

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TERESA LESIUK
UNIVERSITY OF WINDSOR, CANADA

ABSTRACT This study measured the effect of music listening on state positive affect, work quality and time-on-task of computer information systems developers. Effects of music on work performance, in this case, software design, may be explained by increases in state positive affect. Data from 56 (male = 41, female = 15) developers were obtained from four different Canadian software companies. Data were collected in the participants' actual work environments over five weeks. Results indicated that state positive affect and quality-of-work were lowest with no music, while time-on-task was longest when music was removed. Narrative responses revealed the value of music listening for positive mood change and enhanced perception on design while working. Evidence is provided of the presence of a learning curve in the use of music for positive mood alteration. Overall, the study contributes to the development of a model that aspires to elucidate music and workplace interactions; as well, it has implications for organizational practice.

KEYWORDS: *affect, computer software design, creativity, mood, music psychology, productivity, work stress*

Productivity, or 'quality-of-work,' in computer information systems design may be measured by creativity of the software design. Creativity, the ability to produce work that is both novel and appropriate (Sternberg and Lubart, 1999), is adversely affected by stress and certain moods. Mild positive feelings have been found to influence positively the way cognitive material is organized, thus influencing creativity. A beneficial effect of music on task performance may be explained by increases in state positive affect (Isen, 1999; Schellenberg, 2001; Thompson et al., 2001). When music evokes a pleasant mood and an increased arousal state, participants perform better on non-musical tasks. Thus, there is support for an increase in creative problem

solving and task performance by workers, in this case, computer systems developers.

Computer software developers

The designing of computer systems is part of a larger industry known as Information Technology (IT), an industry that is competitive, continually changing, and one that constantly requires creative approaches in software design. The trend to 'downsize' or 'rightsize' is reported to lead to stress for computer developers and detrimental consequences for their design work (Glass, 1997; Wastell and Newman, 1993). Fujigaki (1993) found stress present throughout almost all software work phases of systems development, even taking on different forms in two different phases. During the requirements-definition and design stage (involving planning and designing a software system) stress responses were in the form of high anxiety and depression, while during the coding phase, the stress took on the form of irritability and falling morale. Further, Fujigaki maintains that designing of systems is particularly vulnerable to stress-caused errors. He found that 42 percent of all design faults were directly attributable to programmer stress explaining that 'deep thinking, such as searching for solutions in a huge problem space ... is required in the design phase ... and is easily affected by stress, which causes imperfect investigation' (p. 34).

Music and affect

Past music and affect theories underlie the basic affective responses of individuals who partake in music listening. Present-day theories build on the past theories, and eventually help construct a fuller picture of music listening within a work context. Fiske (1996) eloquently dismantles the common notion that 'music is a language of the emotions.' Shared cultural knowledge of emotions suggests that music communicates knowledge across groups of listeners, but cultural knowledge does not take account of an individual's personal experiences. In his critique of several pertinent music and affect theories (i.e., Kivy, 1990; Langer, 1967; Meyer, 1956), Fiske concludes that mood states following music listening are the result of an individual's unique past experiences. He clarifies the difference between aesthetic response and listener mood state responses to music. That is, mood states occur as a result of individuals projecting their many past experiences and beliefs (with the inherent emotional content) onto their experience of the tonal–rhythmic events presented in music. Conversely, an aesthetic response is the outcome of the listener's relative understanding of tonal–rhythmic pattern interrelationships.

A number of studies suggest that music experiences produce felt peak experiences (Goldstein, 1980; Panksepp, 1995). Sloboda (1991) examined

'peak' experiences to music listening, including measurable emotional responses such as thrills, shivers, laughter, lump in the throat, and tears. Reported peak experiences that coincided with specific musical structures were perceived by the researcher as metaphors. For example, the physical response of tears evoked by endings in the music may be understood as a type of metaphor of either loss or relief. These types of metaphors provide a cathartic outlet, allowing listeners to impose their own 'emotion-stories' on music experiences, and are psychologically beneficial for motivation and self-image. Of importance to the present music and work study, Sloboda reported that repeated listening to a piece of music did not diminish strong emotional responses.

Music may also serve as an anxiolytic treatment, that is, an anxiety preventative or anxiety reducing measure. Knight and Rickard (2001) explored the effect of sedative music on participants' subjective and physiological stress levels following a cognitive stressor involving preparation of an oral presentation. Significant increases in physiological stress were reported for those who prepared the task without music, while the presence of music suppressed significant increases in subjective anxiety, systolic blood pressure, and heart rate.

Further, individuals value their own or 'preferred music' when considering the music that best relaxes them. Following a comparison of five different types of music Stratton and Zalanowski (1984) reported a significant correlation between degree of relaxation and preference for music. Davis and Thaut (1989) reinforced the importance of preference in a study measuring physiological and psychological subjective responses to preferred, relaxing music. Varying types of music chosen by the subjects were effective in reducing anxiety. The researchers concluded that preference, familiarity or past experiences with the music may have an overriding effect on positive behaviour change than the type of music. Additionally, significant within-subject results were reported for the physiological measures, and the researchers concluded that idiosyncratic responses occur in a habitual manner to music preference.

Of relevance to the computer software development community, Lesiuk (2000) reported decreased levels of state anxiety when music was used prior to and throughout a computer programming task. Seventy-two students in an introductory computer programming course were assigned to a group with either (1) no music, (2) music prior to, or (3) music prior to and during a task requiring students to locate syntax in logic errors. Results indicated a statistically significant effect of the music listening on state anxiety levels. 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.

Everyday emotional responses to music are not without a social context

(DeNora, 2001; Hargreaves and North, 1999). Sloboda and O'Neill (2001) investigated everyday emotional responses to music by employing a method known as the experience sampling method (ESM) in which 'real-world' events are studied as they unfold in everyday life. Participants carried pagers during their waking hours and were paged randomly once within every two hours daily for a period of one week. When paged, participants recorded their current activity in a response booklet with the purpose of capturing everyday emotional experiences associated with music. The study reports that 44 percent of all pagings (or 'episodes') involved music. An analysis of recorded emotional responses revealed that music experiences increased positivity, alertness, and focus on the present. The researchers concluded that, in general, music made the participants 'feel better.'

Music and work studies

A number of earlier studies has shown the beneficial effects of music listening on work productivity (Fox, 1971; Kirkpatrick, 1943; Wokoun, 1969). Presenting extraneous environmental stimuli by way of stereo headsets (music and radio) 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. The mood state of relaxation best explained the relationship between the use of the stereos and productivity, and environmental interference most effectively explained the relation between the stereo use and organizational satisfaction. Familiarity with the music and discontinuous presentation were suggested as most effective in improving performance, turnover intentions, organizational satisfaction, and mood states.

Individual differences must be accounted for when investigating the effects of music listening on employee anxiety and work tasks. Individual differences was an important factor in a pre-test post-test control group study carried out with 33 air traffic controllers from the Federal Aviation Association in Longmont, Colorado (Lesiuk, 1992). All controllers completed trait anxiety and extroversion/introversion measurements, as well as a stress diagnostic inventory prior to the formal study. Results showed that whether the group sat in silence or listened to music, their stress levels reduced significantly. However, an interaction effect was exhibited for individuals with high trait anxiety and introversion, who did not demonstrate reduction in anxiety. Further, in a measure of the controllers' perceived activity of air traffic, this particular personality-trait combination perceived a higher level of air traffic activity than other employee personalities.

It is possible that the more individuals listen to or perform music the more likely it is that they will experience increasingly strong emotional responses to

music. Lehmann (1997) calls this emotional sensitivity to music the *training-mediation hypothesis*. He investigated an alternative hypothesis to the emotional sensitivity response to music listening, that of *affect-transfer* in which emotionally sensitive people respond strongly to music. Lehmann (1997) rated musicians and non-musicians according to their emotional sensitivity responses to habitual and situational listening. He found that there were no reliable differences between the two groups in regards to the measurement for affect intensity to everyday life events. While the *affect-transfer* hypothesis was not confirmed, the training-mediation hypothesis was supported revealing that the more knowledge one has of music the more the emotional responsiveness.

Positive affect and task performance

Mild positive feelings can influence the way cognitive material is organized, thus influencing creativity (Ashby et al., 1999; Estrada et al., 1997; Isen, 1999; Schellenberg, 2001; Thaut, 1989). Participants who experienced a positive mood as a result of music-film mood inducement demonstrated better creative problem solving than participants who had a neutral or depressed mood (Isen et al., 1987). The study provides evidence that there is greater integration or perception of relationships among stimuli with people who are feeling mild positive affect (i.e. feeling happy).

Researchers (Thompson et al., 2001) challenged interpretations of a current controversial phenomenon known as the 'Mozart effect.' Lately, as a result of a study showing small increases in spatial reasoning (Rauscher et al., 1993), some popular public thinking has been that 'Mozart makes you smarter' and has even led to government funding to provide classical music compact discs to parents of newborns. Thompson et al. (2001) replicated the study with additional measures of mood and arousal, based on previous findings that very high or low levels of arousal or anxiety inhibited cognitive performance and on other findings that positive mood leads to improved problem-solving tasks. The findings revealed that the 'Mozart effect' was indeed replicated as participants who listened to the Mozart sonata performed significantly better on the spatial-reasoning task than those listening to an Albinoni piece. However, the 'effect' was not attributed to Mozart as such, but to differences in arousal and mood. That is, the participants listening to Mozart scored significantly higher on positive mood and arousal measures, lower on a negative affect measure, and higher on an enjoyment measure than those listening to the Albinoni selection and those who sat in silence. The researchers concluded that enjoyable stimuli induce positive affect and heightened arousal and, that in turn leads to moderate improvements in task performance.

Aim

This study investigated the effect of music listening on the mood and task performance of computer information systems developers. Most music and workplace studies are applied studies with little theoretical prediction about outcomes of organizational behaviour as a result of music experiences. In fact, most music–work descriptions in current music psychology focus on the Muzak effect, presenting a limited view of the interactions that occur between workers and music listening. Further, the need for testing a music and work theory persists despite the challenge of being unobtrusive in work environments. This study focuses on a particular work culture, that of computer information systems development, investigating the role of music and affect within this emotionally dynamic context. While several perspectives of music and affect are relevant in the music–worker relationship, increased short-term positive mood through music listening is emphasized in this article.

Method

PARTICIPANTS

The participants in this current study were computer information systems developers (male = 41, female = 15) from four different companies located in two Canadian cities. The 56 participants were 19 to 55 years of age (M = 32.8 years) with work experience ranging from 6 months to 20 years (M = 6.24 years). There was a wide range of formal musical education experience from 0 to 15 years (M = 1.95 years). There was also a wide range of reported daily music listening time, from no time spent to nearly the entire day (M = 1.72 hours, SD = 2.11 hours).

RESEARCH DESIGN

The study is a quasi-experimental field study utilizing an interrupted time series with removed treatment design. While attempting to capture the natural interactions that occurred between the developers and music listening in the workplace, the researcher had to be sensitive so as to minimize interrupting the participants' assignments and work environment. A background (demographics) questionnaire and a trait affect questionnaire were administered a few days prior to the five-week study. Three dependent variables consisting of State Positive Affect, Quality-of-Work and Time-on-Task were measured twice a week, two days apart, with days alternated throughout the five weeks. State Positive Affect is defined as the extent to which an individual displays enthusiasm for life (Watson and Tellegen, 1985). A daily music log was also administered for each day of weeks 2, 3, and 5 for participants to record their state mood prior to and following listening, the amount of time spent listening, and their music selections. Figure 1 illustrates the design and administration of the dependent variables.

Baseline	Week 2	Week 3	Week 4	Week 5
Baseline M W	Music on T TH Music log	Music on W F Music log	Music off M W	Music on T TH Music log

FIGURE 1 *Study design and administration of State Positive Affect, Quality-of-Work, Time-on-Task and music log.*

For the first week of the study (the baseline week), participants were instructed to do what they normally did in respect to music listening. For example, if they usually listened to music at work, they would continue to do so. State Positive Affect, Quality-of-Work and Time-on-Task were measured twice in that first week, once on Monday afternoon and once on Wednesday afternoon.

At the beginning of the second week the 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). 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 their personal stereo or with headsets on their computer. Participants were simply instructed to 'Listen to the music when you want to, as you want to.' The same directions were given for week 3.

At the beginning of week 4 the music library was removed. Participants were given the statement '*This fourth week please do not listen to music'*, and asked to confirm by their signature that they had not listened to music each day. At the beginning of the fifth week the music library was reinstated along with the questionnaires.

MEASURES

Trait positive and negative affectivity were measured by a 25-item true/false questionnaire developed by Watson and Tellegen (1985). The trait measure reveals stable and consistent differences in individuals' general affective level. The measure consists of 14 negative affect (NA) items and 11 positive affect (PA) items scored by the number of 'true' responses. For example, the statement 'I always seem to have something pleasant to look forward to' if marked as true, would be awarded one point towards PA, reflecting the extent to which a person feels enthusiastic, active, and alert. Watson, Clark and Tellegen (1988) report that the *Positive and Negative Affect Schedule* (PANAS) scales, upon which this questionnaire is based, are highly reliable (coefficients ranging from .84 to .90). Of note, positive and negative affect are not opposite ends of a continuum; they repeatedly emerge as distinct factors that

are independent of each other (George and Brief, 1992). Although this measure comprises both negative and positive affect responses, this article reports the results of the trait positive affect.

State mood, an individual's experience of short-term emotional fluctuation, either positive or negative, was measured by the *Job Affect Scale* (JAS) (Brief et al., 1988). Both State Positive Affect and NA 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. 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. This article reports the state positive affect responses.

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 (see Appendix). The *Quality-of-Work Questionnaire* items consisted of responding on a Likert scale (1 = not at all, 2 = somewhat, 3 = moderately, to 4 = very much so) to questions assessing life-cycle task performance. *Life-cycle tasks*, also referred to as a systems development life-cycle, involve five phases that help organize the creation of a computer information system. The five phases 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?* Items were positively scored, summed, and then divided by 5 to obtain a mean. The higher the score the higher the work quality (scores could range from 5–20).

A researcher-designed *Time-on-Task* question (inserted in the Quality-of-Work Questionnaire) required all participants to indicate if they completed their life-cycle task in less time (scored as 0), the same time (scored as 5), or needed more time (scored as 10) than their 'intended' time for the task.

Results

TRAIT POSITIVE AFFECTIVITY

Responses from the Trait Positive Affectivity measure are relatively high considering the highest possible score is 11 (M = 7.27, SD = 2.71). No working group norms for comparison purposes were available for this measure. These findings suggest that the developers, on average, are a relatively positive group of participants.

MUSIC LISTENING TIME

Concerning daily average music listening time and trait positive affect, the

TABLE 1 *State Positive Affect response to music listening by week*

	M	SD	*p*
Music 1			
Pre	26.33	4.48	
Post	27.02	4.33	.024
Music 2			
Pre	26.84	3.95	
Post	27.68	4.80	.006
Music 3			
Pre	25.32	4.71	
Post	27.40	4.61	.000

higher the trait positive affect, the more time spent listening to music (r = .328, $p < .05$). However, this finding may be interpreted as the more time spent listening to music, the greater the increase in trait positive affect. There was also a statistically significant negative correlation of age and music listening ($p < .01$), indicating that the older the developers, the less time spent music listening. Analysis of each individual company reinforced this finding, as the mean ages, from companies with youngest to oldest, had respectively less amounts of time spent listening to music.

STATE POSITIVE AFFECT

Table 1 reports the combined companies' State Positive Affect prior to and following music listening for each music listening week.

Table 1 reveals that intra-week, pre to post State Positive Affect increased in each of the three music listening weeks ($p < .05$). The greatest increase of 2.08 points in State Positive Affect occurred in week 5 (music 3), the week following the 'no-music' listening week. These results show that developers benefit in increased State Positive Affect when listening to music.

STATE POSITIVE AFFECT

Figure 2 illustrates the combined companies' descriptive statistics for State Positive Affect week 1 through week 5.

State Positive Affect is highest in week 3 (M = 27.58) and lowest in the 'no music' week, week 4 (M = 25.50). An analysis of variance for trend finds a statistically significant cubic trend $F(55, 1) = 3.66$, $p < .05$. A post-hoc analysis, Wilcoxon Matched-pairs Signed-rank test, indicates a statistically significant difference between baseline and week 3 (music) (p = .040) and between week 3 (music) and week 4 (no music) (p = .004). It appears that music listening is not only beneficial for improving mood from pre to post listening sessions, but also over longer time frames. State Positive Affect

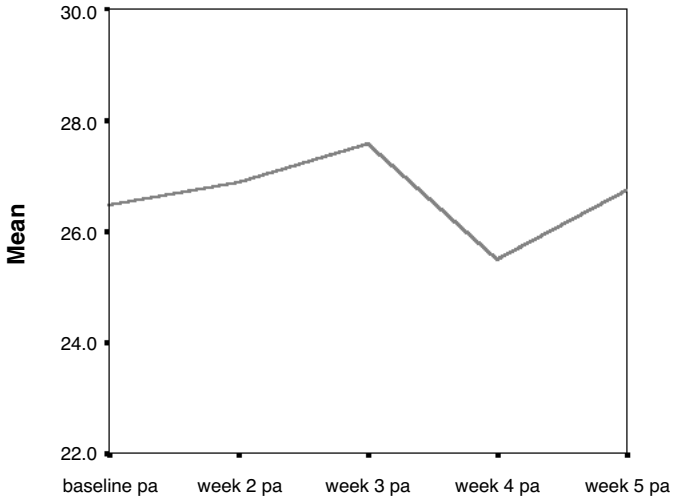

FIGURE 2 *State Positive Affect across five weeks. This line graph represents averaged weekly State Positive Affect, initially measured twice per week in the afternoons, across five weeks.*

increased steadily to the third week of the study. Further evidence of the benefit on mood is observed when the developers' moods drop as a result of the removal of music. Whether or not the music is a pleasant and/or arousing stimulus, it is apparently missed, and once music listening is reinstated, developers' responses suggest they once again benefit. The incremental increase in positive affect from baseline, to week 2 and then again to week 3 suggests that music listening has a positive effect on all music listeners. Why the increase in positive affect over time, bearing in mind the developers retained their normal music listening habits in the baseline week? Perhaps those that were usually non-listeners take time to benefit from the music listening.

QUALITY-OF-WORK

Figure 3 reports the combined companies' descriptive statistics for Quality-of-Work week 1 through week 5.

Figure 3 demonstrates that Quality-of-Work is lowest in week 4, the 'no music' listening week. Quality-of-Work scores drop during the 'no music' listening week ($M = 11.15$), followed by an increase in Quality-of-Work when the music is reinstated in week 5 ($M = 11.74$). An analysis of variance for trends found a statistically significant quadratic trend $F(55, 1) = 6.32$, $p < .05$. The finding of a quadratic trend, as opposed to a cubic trend, as illustrated by the State Positive Affect responses, may be explained by the following. There was a subtle perturbation in responses between the baseline to weeks 2 and 3. Music listening was present in the first three weeks of the study with

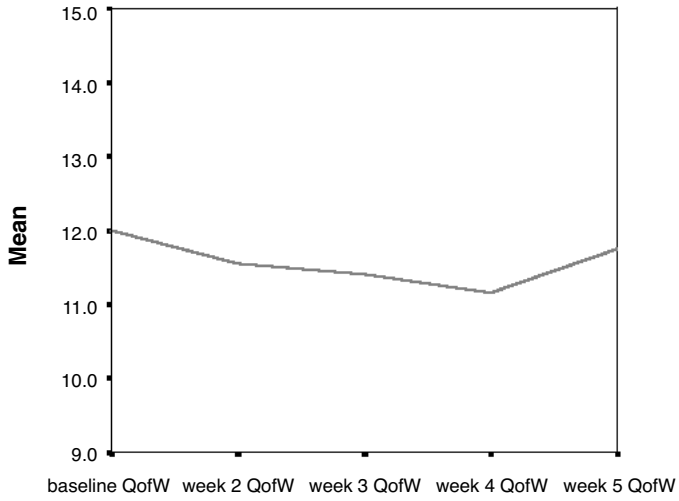

FIGURE 3 *Quality-of-Work across five weeks. This line graph represents averaged weekly Quality-of-Work, initially measured twice per week in the afternoon, across five weeks.*

perhaps more 'permission' to listen in weeks 2 and 3 (as the music library was set up in the companies during those weeks). The effect of the music listening between baseline and the music listening weeks was somewhat weak as many of the developers listened to music during the baseline week. However, the forced condition of 'no music' during week 4, as expected, showed decreased scores with a return to higher levels once the music was reinstated in week 5. A post-hoc analysis indicates a statistically significant difference between the baseline week and week 4 (no music) (p = .020). Evidence that a music listening effect may be present is seen when scores return to near baseline level with the reinstated music, although this effect is realized in evidence of very small numerical changes.

TIME-ON-TASK

Figure 4 reports the combined companies' descriptive statistics for Time-on-Task week 1 through week 5.

The developers spent more time on their tasks than they intended in week 4, the 'no music' listening week (M = 6.61). An analysis of variance finds a statistically significant quadratic trend $F(55,1) = 7.77$, $p < .05$. There appear to be substantial effects of music listening on Time-on-Task. A Wilcoxon Matched-pairs Signed-rank test indicates a statistically significant effect between the baseline week and week 4 (no music) (p = .007); between week 2 (music) and week 5 (music resumed) (p = .041); between week 3 (music) and week 4 (no music) (p = .048); and between week 4 (no music) and week 5 (music resumed) (p = .000).

When music listening is removed in week 4, the Time-on-Task increases

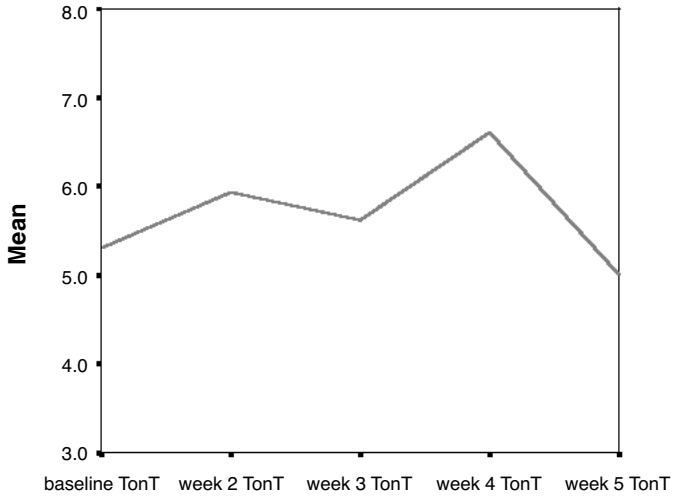

FIGURE 4 *Time-on-Task across five weeks. This line graph represents averaged weekly Time-on-Task, initially measured twice per week in the afternoon, across five weeks.*

significantly as shown when compared to the baseline week, week 3 (music), and week 5 (music). A difference appears between week 2 (music) and week 5 (music) as Time-on-Task is slightly higher during week 2 and lowest when music is reinstated in week 5. The improvement in Time-on-Task when the music is present (weeks 2, 3, and 5) is likely a result of several responses to the music condition. That is, in part or in whole, their state mood is better with the music than without it, and lastly, they may be pacing themselves throughout the workday as a result of the music listening. Their best 'timed' performance occurred in week 5 (music reinstated). This was perhaps a result of returning to preferred working and music conditions.

Discussion

STATE POSITIVE AFFECT

State Positive Affect increased from pre to post listening in each of the three music listening weeks ($p > .01$). Additionally, the findings revealed that State Positive Affect measured over the five weeks increased incrementally from baseline to the first and second weeks of the music listening period. It then fell when the music was removed in week 4 (no music), but rose again when the music listening was reinstated in week 5. These State Positive Affect responses, both from pre and post music listening, and from the longer-term measurements, are consistent with research literature suggesting that mood is improved by music listening whether as a result of aesthetic experience (e.g. Fiske, 1996), peak experience (e.g. Sloboda, 1991), or simply part of everyday life (e.g. DeNora, 2001).

The general hypothesis proposed in this article is that music listening in some work environments evokes positive affect or mild positive feelings, which in turn increase performance on tasks requiring creative output. There is, however, need for further examination of this postulation. For example, does music listening reliably bring about mild positive feeling responses? There is evidence, outside the findings reported here, that this is the case most of the time. That is, Sloboda and O'Neill (2001) reported that everyday music listening rarely resulted in less positivity (i.e. only 13% of the time). Further, people choosing music to 'wallow in' for the purpose of evoking a sad emotional state, may actually be practising *enjoying* 'bad' emotions (Apter, 2001). In other words, sadness is experienced as an enjoyable form rather than a serious unpleasant form. Therefore, even when mild positive affect is not the aim of the individual, it is the result.

Upon separate analysis of State Positive Affect of each participating company, one company's responses to music listening were unequalled. This particular company's participants, considered at the outset a 'low music listening' group, did not show an increase in positive affect until the third week of music listening (week 5 in the study design). This result was unexpected. Does it take time for those unaccustomed to listening to music at work to benefit from the effects of music on mood? Do individuals need time to discover how music affects them and how they can best use that effect in their workplace? This seems to be the case for one novice listener who stated after the 'no music' listening week: 'I plan to continue listening to music at work. I never listened to music before or felt the need. This was a positive experience.'

QUALITY-OF-WORK AND TIME-ON-TASK

Evidence that a music listening effect on the quality of work is present is seen in the significant quadratic trend ($p < .05$). Very small changes in Quality-of-Work scores were reported across the five weeks with the lowest Quality-of-Work score occurring during the 'no music' week, followed by an increase in performance with the resumed music in week 5. Only very small differences in Quality-of-Work scores would be expected in the software design industry as these employees are usually very competent designers demonstrating a high level of performance (company director, personal communication, 2001). Despite the small changes in work performance scores, the findings support the suggestion that state positive affect increases one's ability to relate and integrate divergent material (Estrada et al.,1997; Isen, 1999; Isen et al., 1987; Thompson et al., 2001). This applies to the computer software developers' need for integrating divergent materials when designing and developing programs for computer information systems. A comment from one participant, 'It [music listening] helped in relaxation, getting around [mental] blocks by changing thoughts instead of getting "tunnel visioned,"' reflects the influence of music listening to alter mood and its role in altering perception of materials; the resulting effect, both resilient and dependable, of

State Positive Affect on cognition and social behaviours has implications for organizational settings.

Additionally, listening to music reduced time on systems life-cycle tasks ($p < .05$). All pair-wise comparisons involving the use of music listening showed that when music was removed there was more time spent on tasks than intended. Individuals are more energized and more alert through perceiving and physically responding to music listening. This synchrony with the music assists in pacing their work tasks, and further, in pacing their work day. The finding harkens back to earlier studies investigating the use of music in tedious work tasks. Wokoun (1969), for example, found that vigilance was improved through music listening by creating and administrating a music program designed to increase tempo at peak fatigue times. Even earlier accounts dating as far back as World War I recorded the effect of music on pacing during work tasks (Glossop, 1961).

THE AMOUNT OF TIME ONE LISTENS TO MUSIC

Contrary to previous findings that the amount of music listening made no difference to mood (Oldham, 1995), this study found a modest but statistically significant positive correlation ($r = .328$, $p < .05$) between music listening time and trait positive affect. This result suggests that the stable trait of positive affect is aligned with music listening and may be interpreted two ways. That is, first, that individuals with a positive affect disposition tend to listen to music while they work, or secondly, that individuals are positively affected over time by music listening. What does this music listening group 'know' that the habitual non-listeners do not 'know'? Possibly, these individuals may be proficient at recognizing their current mood state and the projected, necessary mood state for the context or task they have to tackle (DeNora, 2001). During an informal conversation, a project manager, also an avid music listener, disclosed his music choices for several different development tasks and the certainty of his choices to enhance his work for those tasks. Such participants appear to be knowledgeable music users. Comments of the developers reveal the thinking process involved with practising such knowledge. Examples of comments are, 'It [music] put me in a better frame of mind – it took me to a place I like to be,' and 'Effectively altered your surrounding to suit your mood at the time. If you are tired, you could listen to more upbeat music to wake you up, etc.' IT personnel may find music a reliable cathartic outlet and their responses to particular musical works may even prove to be reliable. Of relevance to the software development industry, employees may experience the same emotional response to a piece of music over repeated listening.

INDIVIDUAL DIFFERENCES

Subgroups of individuals, as a result of personality disposition, may require mood enhancing experiences. As was found in Lesiuk's (1992) study with air

traffic controllers, controllers who were extroverted, with either high or low trait anxiety, experienced anxiety reduction in conditions of both sitting in silence and listening to music. However, those controllers who were introverted with high trait anxiety did not experience anxiety reduction in either condition. As shown in this study, music listening over time was not only beneficial to increasing state positive mood but also trait positive disposition. Many developers habitually listened to music so much so that in the recruiting stage some chose not to participate because of having to go without music listening for the required one week. Perhaps the developers' chronic music listening habits provided a buffer to otherwise anxiety provoking work stressors.

Lehmann's (1997) finding that individuals with greater music training had greater emotional responses, is reflected in this study's finding of a significant positive correlation found between amount of music listening and trait positive affect. Developers who listened to greater amounts of music, considered more knowledgeable than those who usually did not listen, derived greater emotional benefit.

Lastly, a significant correlation was found between trait positive affect and trait-curiosity ($r = .482$, $p = .01$). This is important as curiosity is essential for developers who are regularly required to be creative in designing computer software systems. Music listening may provide an opportunity for developers to align themselves with their optimum creativity.

CHALLENGES OF THE STUDY

No company was chosen as a control for this study. While a control company was considered in the planning of the design, it became evident that each company was very individual. The companies had their own work 'culture' and therefore a control group would serve only as a comparison to another work 'culture.'

There was an absence of a guided listening framework for the developers. The developers could listen to music as they chose during the music listening weeks, but did so without any suggestions or guidelines as to what to listen to when working. For example, if developers were feeling sluggish and in need of more energy, faster tempi music selections could have been suggested. However, in keeping with the exploratory nature of the field study, this consideration will have to be implemented in a future study.

Demand characteristics may have been present. Due to the reliance on self-reports some developers may have intentionally guessed at what the researcher wanted to find. However, it is more likely that the demand characteristics were actually minimized and possibly negated as a result of the researcher's data collection approach. She very openly stated she was interested in the effect of music listening, whatever it was, and that she was really interested in hearing about the work environment and their work life. With this approach the participants seemed to easily report thoughts and feelings about listening to music, about work stresses and even about the study itself.

Further evidence that the demand characteristics were minimized appeared in the differing responses across variables and across companies. The companies seemed to report responses that in the end described their work culture.

Lastly, there was not a random assignment of companies for this study. Perhaps the company directors' approval of investigating music listening in the workplace corresponded with the companies' work ethos. In other words, the permission to listen to music while working provided a ripe context for the beneficial subjective music listening experiences.

THE PROMOTION OF MUSIC LISTENING IN THE WORKPLACE

When music listening in the work environment is encouraged by project directors and the workers are amenable to music listening, then certainly music listening has a positive effect. It was evident from observations of two of the four companies that the project managers influenced, or at least supported the developers' use of music listening. One project director used music avidly to aid him in his programming and designing tasks. Another project director had stacks of music compact discs and a headset at his desk. He also spoke highly of the use of music while programming and was very interested in the outcome of this study. It follows that when music is removed in such music listening work cultures there is a psychological withdrawal of an important stimulus. Developers experience the negative effects of the removal of a stimulus they have come to depend on. The negative effects of removing the music are found in lowered state positive mood responses, slightly lowered quality-of-work, and more time spent on tasks than originally intended.

Furthermore, there are age-related differences in music listening while working. Inferential results revealed a statistically significant negative correlation of age and music listening ($p < .05$), meaning the older the individual the less time spent music listening. Despite the individual work culture and resulting preference for music listening, an important question remains. Should music listening be encouraged in the workplace, even for groups that usually do not listen to music? Perhaps the strongest evidence to an affirmative response is found in the responses of the third company (called Company C). Company C's baseline reflected a non-music listening group. It was also one that was experiencing a substantial amount of stress from the challenges of a merger. The group's initial pre to post listening state mood responses to music actually showed a decrease in positive affect. That particular type of response would not be helpful in any work environment. However, by the last week of the study (the third week of music listening), the developers showed an increase in positive affect. Again, as mentioned earlier, there may be a learning curve of music listening use. The researcher's response to the question, *Should music listening be encouraged in the workplace?*, is that over time, music listening based on workers' choice to listen 'when they want as they want,' is beneficial for state positive affect, quality-of-work, and time spent on a task.

Appendix: Quality-of-Work Questionnaire

Assessment of Quality of Work

Complete the following questions in terms of the work you have done recently.

A. Task (check one):

_____planning
_____requirements gathering/analysis
_____design/development (including coding)
_____testing
_____implementation
_____maintenance
_____other? (_____)

1. In solving the problem, was the solution creative?

1	2	3	4
Not at all	Somewhat	Moderately	Very much so

2. In solving the problem, was the solution effective?

1	2	3	4
Not at all	Somewhat	Moderately	Very much so

3. Considering your 'intended' time on task, did you complete the task in

___the same time _____in less time _____needed more time?

4. Did you experience fewer 'blocks' than usual in the (planning/development/testing) process?

1	2	3	4
Not at all	Somewhat	Moderately	Very much so

5. Did you use a new approach in your (planning/development/testing) practices?

1	2	3	4
Not at all	Somewhat	Moderately	Very much so

6. Are you pleased with the (planning/development/testing) you just completed?

1	2	3	4
Not at all	Somewhat	Moderately	Very much so

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TERESA LESIUK is Assistant Professor of Music Therapy, University of Windsor, Ontario, Canada. Her current course teachings include Theories of Music Therapy, Improvisation in Music Therapy, Psychology of Music and supervising clinical field placements. She completed her PhD at the University of Western Ontario and is continuing to investigate the role of music in high stress occupations (e.g. air traffic control and computer information systems).
Address: School of Music, University of Windsor, Windsor, Ontario, Canada, N9B 3P4. [email: tlesiuk@uwindsor.ca]