SPACE INVADERS: EXAMINING THE EFFECTS OF PORTABLE MUSIC PLAYERS ON PERCEIVED CROWDING

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Abstract

An invasion of personal space occurs when levels of contact with others exceed desired levels of contact and can lead to feelings of crowding, anxiety and stress. The current study investigated whether the use of portable music players (e.g., MP3 players) under conditions of personal space invasion has an effect on level of anxiety, stress after-effects, perceived control, and cognitive processing style. The results indicate that using MP3 players does not affect one's level of anxiety, stress after-effects, and perceived control. However, those who listened to music tended to engage in global cognitive processing. There was also an interaction effect between gender, MP3 player use, and personal space invasion on perceived control. Compared to males, females who listened to music felt that their lives were governed by chance when their personal space was invaded, whereas the opposite was true when their personal space was not invaded.

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1. Introduction

Living in an urban environment has many benefits, such as easier access to healthcare, restaurants, entertainment, and shopping. However, the abundance of businesses and services also means that urban dwellers often find themselves in close proximity to others as they try to navigate through busy city streets and shopping malls. These daily experiences with high population density and crowding can be very stressful and may lead to numerous negative physical and psychological effects (Bell, Greene, Fisher & Baum, 1996). Crowded conditions have been associated with physiological symptoms of over-arousal, such as higher skin conductance levels (Aiello, Epstein, & Karlin, 1975; Aiello, DeRisi, Epstein, & Karlin, 1977), higher blood pressure and pulse rate (Evans, 1979), as well as other problems such as increased negative affect, decrements in task performance, and withdrawal (Sundstrom, 1978).

One of the ways in which people may cope with crowding in the urban environment is by using portable music players (e.g., MP3 players). Qualitative research has found that people employ MP3 players to psychologically set themselves apart from others and to shape the way in which they experience their surroundings (Skanland, 2012; Simun, 2009; Bull, 2005). Although some research has looked at whether listening to music through headphones can alter representations of personal space (Lloyd, Coates, Knopp, Oram, & Rowbotham, 2009; Tajadura-Jimenez, Pantelidou, Rebacz, Vastfjall, & Tsakiris, 2011), no study to date has investigated the utility of MP3 players as a coping tool against the negative effects of crowding. The current study investigates whether

using MP3 players can alleviate the discomfort, anxiety, and stress that are associated with the subjective experience of crowding.

Density Versus Crowding

Population density and crowding are two related terms that are often used in discussions of the effects of personal space violation. High population density refers to a physical state of being in a space with many other people. It is characterized by spatial limitations that impose both physical (e.g., movement) and social (e.g., self-presentation) restrictions that might be inconvenient for the individual (Stokols, 1972). Although high population density has been associated with various aversive consequences, such as reduced task performance and negative affect (Sundstorm, 1978), being in close proximity to others does not always result in these effects. This is because the physical state of high population density is distinct from the psychological state of crowding, with crowding being a subjective experience characterized by distress (Stokols, 1972). In other words, a negative evaluation of a high-density social situation is essential for the experience of crowding to occur (Stokols, 1972). For example, sharing a restaurant booth with six strangers is likely to be perceived as more uncomfortable than sharing the same booth with six friends, so the former is likely to result in greater feelings of crowding. It is important to examine what factors contribute to negative evaluations of high-density situations in order to reduce the experience of crowding, ameliorating the associated negative emotional, cognitive, and physiological effects. Two concepts that might help elucidate this process are personal space, which refers to one's desired level of interaction

with others, and perceived control, which refers to the level of personal control individuals believe they exert over their environment and life circumstances.

Crowding and Personal Space

Altman (1975) relates the experience of crowding to difficulties regulating the level of social contact with others. A person might experience crowding when the achieved degree of social contact with other people exceeds one's desired degree of social contact. One mechanism that is used to achieve a desired level of social interaction with other people is personal space. Personal space refers to the area immediately around our body that we perceive as "our own," and it is expressed as the desired physical distance from others (Altman, 1975). For example, when people wish to limit access to themselves in social situations, they keep more distance between themselves and others. In other words, when a person desires minimal interactions with others, he or she requires more personal space. Many high-density settings—characterized by being physically close to others who are often strangers—disrupt this mechanism. In these types of situations, levels of contact with others exceed desired levels of contact, as others stand or sit too close to us. A large body of empirical work has demonstrated that this intrusion of personal space plays a key role in perceived crowding, resulting in discomfort, anxiety, and stress (Schmidt & Keating, 1979). For example, Baxter and Deanovitch (1970) found that participants reported more anxiety in a projective task when they were seated six inches away from a confederate compared to when the confederate sat four feet away. These results are consistent with a study conducted by Walden and Forsyth (1981), which manipulated invasion of personal space by seating participants in chairs that either

touched one another or were placed 40 centimeters apart. Participants who were seated close to one another reported feeling more crowded, uncomfortable, confined, and restricted than individuals who were seated further apart. Furthermore, the association between personal space intrusion and elevated discomfort has been replicated using measures other than self-report, such as participants' nonverbal behaviour. For instance, Felipe and Sommer (1966) used confederates to invade the personal space of students who were sitting alone in a university library. In the experimental condition, a confederate sat directly next to the student and attempted to move as close to the student as possible without having physical contact. In the remaining conditions, the confederate either sat at various distances from the students without trying to move closer to them or simply observed the student from afar. Students in the experimental condition were reported to frequently display nonverbal signs of discomfort, such as turning away, drawing in their arm and leg, and using objects (e.g., books, purses) as barriers. In addition, significantly more students whose personal space was invaded got up and left the table (70%) compared to those in the rest of the conditions (<27%). In another study, the personal space of participants was invaded in an interview setting (Kanaga & Flynn, 1981). A confederate, who posed as an interviewer, sat across from the participant. The confederate maintained a distance of four feet away from the participant in the control condition. In two additional conditions, personal space was invaded when the confederate leaned towards the participant, resulting in interpersonal distances of three feet and three inches or of two and one-half feet. All interviews were videotaped and subsequently coded by three trained raters for behavioural indicators of stress (e.g., rapid rate of

talking, leaning away from interviewer, twitching). Consistent with past work, stress-related behaviour increased as the distance between participant and confederate decreased. There is also some psychophysiological evidence that invasion of personal space can lead to the experience of stress. The greater the number of passengers sitting directly beside an individual on public transit has been shown to predict higher levels of the stress hormone cortisol, as well as more negative mood and lower levels of task performance (Evans & Wener, 2007).

Crowding and Personal Control

A restricted sense of personal control in high-density situations can also contribute to feelings of crowding (Schmidt & Keating, 1979). For example, one study found that giving individuals the option to leave a high-density room resulted in less crowding-related stress. Participants completed the study in a crowded room, but only a portion of these participants were told that they could leave and complete the study in another room if they wished to. Although no one actually left the room, participants who were given the choice to leave experienced fewer stress-related after-effects than did individuals who were not given this option (Sherrod, 1974). Another study investigated the impact of perceived control on the experience of crowding in elevators. Participants were maneuvered by confederates to either stand in front of the elevator's control panel or on the opposite side of it. Those who stood by the control panel perceived the elevator to be less crowded than did individuals who stood in the opposite position (Rodin, Solomon, & Metcalf, 1978). Importantly, it appears that a sense of control does not have to be space-related in order to reduce perceived crowding. Individuals who tend to feel

that the source of the events in their lives is internal rather than external (i.e., they are in control of their environment and destiny) maintain less distance between themselves and others in high-density settings compared to individuals who generally feel controlled by their environment (Heckel & Hiers, 1977). Altogether, these results suggest that perceived control in high-density situations, broadly conceived, can act as a buffer against the negative experience of crowding.

MP3 Players and Perceived Crowding

Portable music players, such as MP3 players, are increasingly becoming more popular. In 2007, 140 million portable music players were sold worldwide, a 67 % increase from the number sold in 2005 (International Federation of the Phonographic Industry, 2006, 2008). Apple, which holds 78% of the portable music player market, has sold 300 million iPods since the product was launched a decade ago (Macale, 2011). Technological convergence and the advent of the smartphone have made portable music even more accessible and have enabled individuals to listen to music directly from their cellphones. Despite the increasing prevalence of portable music players, little is known about what motivates people to use these devices and how using these devices affects them.

Research suggests that people listen to music to serve a variety of emotional and social needs (Tarrant, North, & Hargreaves, 2000). For example, Lonsdale and North (2011) interviewed 189 undergraduate students and found that the most important reason for music use is mood or emotion management (95.77%), followed by the need for "background noise" (75.66%), musical participation (60.32%), entertainment (57.14%),

distraction (40.21%), reminiscence (34.92%), and social interaction (25.40%). The motivations behind general music consumption might differ from those that underlie the use of portable music players, however.

To date, only a handful of studies have attempted to investigate why people use MP3 players and these employed small samples and qualitative methods. For example, Simun (2009) conducted semi-structured interviews with eight MP3 player users who were recruited at central transport stations in London, UK. The most prevalent theme that emerged was the use of MP3 players to escape the highly dense environment typical of public transportation in an urban centre. The second most common theme was the use of MP3 players to influence how much attention one grants to one's environment. Whereas some people use music to disengage from their environment, others use it to aestheticize and complement their surroundings, which in turn enhances the degree to which these individuals feel connected to the objects and people around them. The third major motivation for using MP3 players was to manipulate moods, thoughts, and memories. In another study, Skanland (2012) conducted semi-structured interviews with 12 individuals who used MP3 players on a regular basis, drawn from an urban area in Norway. The interviews were coded based on three major themes: (1) use of the MP3 player (e.g., choice of music, outdoors versus indoors listening, importance of the MP3 player), (2) self-regulation (e.g., emotional, cognitive, bodily), and (3) coping (e.g., creating boundaries, sense of control, and coping with the urban environment). Only findings pertaining to the use of MP3 players to cope with the urban environment were reported, however, with most participants reporting that MP3 players help them cope with

crowding. According to participants, using these devices allows them to psychologically distance themselves from their surroundings in situations where increasing their physical distance from others is difficult (e.g., public transit during rush hour). Skanland (2012) quotes four participants who state that listening to music through headphones helps them cope with crowding by providing them with a sense of privacy. Along similar lines, participants also reported using MP3 players to block out unpleasant sounds. Quotations from three participants demonstrate that they use MP3 players on the train or on planes to block out background noise and the sounds of other people's conversations. Another motivation for the use of MP3 players seems to be to cope with stress. Two participants are quoted, stating that they use music to regulate their emotions and to relieve stress.

Although no quantitative research has examined why people use MP3 players, the studies outlined above do highlight motivations that are unique to the use of these devices, separate from general music listening. A common thread across these two studies is the use of MP3 players to distance the user from her/his environment by blocking out outside noise and by creating a sense of privacy, particularly in situations characterized by high population density. Taken together, it seems that the use of MP3 players could be related to perceived crowding. However, the nature of this relationship is unclear. Further empirical research is needed in order to examine whether using MP3 players fulfills users' needs, particularly those pertaining to crowding.

To date, little empirical work has been undertaken to explore whether using MP3 players can indeed buffer the user against the negative effects of perceived crowding. Some recent research suggests that listening to music through headphones can alter one's

boundaries of personal space, but the results from these studies are mixed (Lloyd, Coates, Knopp, Oram, & Rowbotham, 2009; Tajadura-Jimenez, Pantelidou, Rebacz, Vastfjall, & Tsakiris, 2011). In a study by Lloyd and colleagues (2009), participants were asked to approach the experimenter and stop at a point at which they felt comfortable. The distance between the experimenter and the participants was subsequently measured and used as an indicator of personal space preference. Participants' exposure to sound was manipulated across three conditions. In the "external sound" condition, participants completed the task while being exposed to background, environmental sound. In the "no sound" condition, the same task was repeated while wearing foam earplugs that blocked out external sound. In the third condition, participants listened to an unfamiliar acoustic music on an MP3 player while approaching the experimenter. When individuals listened to music and wore earplugs, they stood further away from the experimenter than when they listened to ambient sound without headphones. In other words, this study seems to suggest that listening to music through headphones increases the boundaries of one's personal space.

Another recent study examined the effects of music source (i.e., headphones vs. speakers) as well as the emotional valence of the music (positive vs. negative) on personal space (Tajadura-Jimenez et al., 2011). In this study, the experimenter approached the participants. When the participants felt that the experimenter was too close to them, they asked the experimenter to stop. Participants completed this task while listening to positive emotion-inducing music, negative emotion-inducing music, or no music, delivered either through headphones or speakers. When participants listened to

music through headphones, they permitted the experimenter to stand closer to them compared to the neutral condition (no music, no headphones). However, this was only the case for music that was positive in valence. These results suggest that listening to music through headphones reduces the boundaries of one's personal space, but only when the music induces positive emotions.

Several factors could explain the divergent findings of these two studies. First, personal space was assessed differently. Lloyd and colleagues (2009) measured personal space using an approach-distance task, in which participants approached the experimenter and stopped when they began to feel uncomfortable. On the other hand, Tajadura-Jimenez and colleagues (2011) used a stop-distance task, in which an experimenter approached the participants and stopped when participants indicated that they felt uncomfortable. The difference between the two tasks is that as participants approach the experimenter in the approach-distance task, they are aware of their own personal space, as well as that of the experimenter. Therefore, it is possible that these two tasks measure two related, yet different things: the willingness to tolerate the close proximity of a stranger and the willingness to invade the personal space of a stranger. This difference could account for the divergent results that were obtained by these two studies. Another difference between these two tasks is the method by which personal space was quantified. The floor on which the participants walked in the Lloyd and colleagues' (2009) study was marked with various distances, whereas Tajadura-Jimenez and colleagues (2011) asked their participants to close their eyes and used a measuring tape to assess the distance between the participant and the experimenter. Therefore, it is possible that participants in

the former study had a more nuanced awareness of their spatial environment than those in the latter study, which might have influenced their behaviour. The type of music that was used in these studies is another factor that might have contributed to the difference in results. It is unknown whether Tajadura-Jimenez and his colleagues (2011) used music that participants were familiar with. Additionally, the emotional valence of the music varied across the two studies. It is therefore unclear whether the obtained results are a product of familiarity with the music or a result of mood priming. Lastly, Lloyd and his colleagues (2009) used female participants for their study, whereas the sample used by Tajadura-Jimenez and his colleagues (2011) included both males and females. As a result, it is possible that gender differences also contributed to the divergent results.

The primary aim of the present study was to expand our current understanding of the effects of MP3 players on perceived crowding by addressing some of the limitations of past research. The current study employed a naturalistic design in which a confederate who pretended to be another student invaded the participants' personal space by sitting next to them. In addition, the assessment of subjective personal space was executed through a seemingly unrelated task that participants were led to believe measured visual perception. The aim was to limit participants' spatial awareness with the hope that their behaviour and responses to the personal space invasion would be as natural as possible. In addition, participants had access to their own music during the study, which enabled them to choose the songs and musical genres that would best meet their need of coping with the personal space invasion. Moreover, the study employed a split-gender sample

and ensured that a same-gender confederate committed the personal space invasion in order to limit complex cross-gender interaction effects.

A secondary aim of this study was to identify potential mechanisms by which the use of MP3 players might reduce perceived crowding. One way in which MP3 players could reduce perceived crowding is by creating a psychological distance between individuals and their environment. Psychological distance refers to how people, objects, and events are represented in our minds. When people, objects, and events are psychologically distal, they are represented in abstract, schematic terms and are not perceived as being a part of one's self or one's direct experience, in the here and now (Trope & Lieberman, 2006; Bar-Anan, Liberman & Trope, 2006; Trope, Liberman & Wakslak, 2007). Similarly, holistic attention (i.e., global information processing) has been shown to increase perceived distance between the self and observed targets, whereas attention to concrete details (i.e., local information processing) has been shown to reduce perceived distance (Trope & Lieberman, 2006). It is possible that the use of MP3 players elicits a global processing style by reducing auditory input from one's environment, which in turn increases the perceived psychological distance between the user and other people. Recent research by Steidle and colleagues (2011) suggests that darkness leads to a global processing style and to an abstract, holistic representation of people and objects in one's surroundings, presumably because darkness decreases concrete visual information about these targets. For example, participants who completed an abstract reasoning task in a dim room performed better than those who completed the same task in a brightly lit room. In two additional studies, participants who were primed with darkness

displayed more holistic thinking during a matching and a categorization task than did participants who were primed with brightness (Steidle, Werth, & Hanke, 2011). It is possible that the use of MP3 players produces a similar shift in cognitive processing style by reducing concrete aural information about targets in one's environment. Consequently, the presence of these individuals is less salient, thus reducing the likelihood of eliciting feelings of crowding.

A second way in which MP3 players could reduce perceived crowding is by allowing individuals to have control over sound in their environment. As a result, it is possible that people who use MP3 players may feel more in control of their environment and require less distance between them and others compared to those who do not. In other words, listening to portable music may shrink the boundaries of one's personal space, thereby making the close presence of others more tolerable. Although the idea that people use portable media to regulate and control their environment has been suggested by several researchers (Skanland, 2012; Simun, 2009; Oksman & Turtianien, 2004), the present study was the first to empirically examine whether such devices influence the user's perceived control.

The Present Study

The present study examined whether listening to music via headphones can protect individuals from experiencing the stress and discomfort that is associated with perceived crowding. It was hypothesized that:

(1) Individuals who use their MP3 player in a high-density setting will experience less anxiety than individuals who do not use their MP3 player.

(2) Individuals who use their MP3 player in a high-density setting will experience fewer stress after-effects than individuals who do not use their MP3 player.

(3) Individuals who use their MP3 player in a high-density setting will have smaller boundaries of subjective personal space than individuals who do not use their MP3 player.

(4) Individuals who use their MP3 player in a high-density setting will report more perceived control than individuals who do not use their MP3 player.

(5) Individuals who use their MP3 player in a high-density setting will engage in greater global cognitive processing than individuals who do not use their MP3 player.

2. Method

Participants

218 York University introductory Psychology students signed up for the study using the university's Undergraduate Research Participant Pool website and received partial course credit for their participation. Because the study required access to one's own music, participation was restricted to individuals who owned an MP3 player and who were able to bring it to the lab session. There was no formal process to identify individuals who own MP3 players or to disqualify those who do not. The requirement of owning an MP3 player was posted on the study's information page and all 218 participants arrived at the lab with their device.

Materials

Perceived crowding. A single item measure was be used to assess perceived crowding. Participants were asked to indicate whether they felt crowded during the study. Reponses were made on a 5-point Likert-type scale ranging from 1 (*Not at all*) to 5 (*Extremely*).

Anxiety. State anxiety was assessed using the S-Anxiety scale of the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), which is a 20-item scale that measures feelings of anxiety in a specific situation. Responses were made on a 4-point scale, ranging from 1 (*Not at all*) to 4 (*Very much so*). Internal consistency scores for this measure have ranged from .86 to .95, and it is correlated with the Anxiety Sensitivity Index ($r > .82$) (Smeets, Merckelbach, & Griez, 1996).

Stress after-effects. Crowding has been shown to be a stressful experience that results in damaging cognitive after-effects such as a reduction in attentional control (Evans & Wener, 2007; Schmidt & Keating, 1979; Dooley, 1978). Stress after-effects in the form of reductions in attentional control were measured using a computerized version of the Stroop colour-word task (Stroop, 1935). In this task, participants were presented with a series of colour names (red, green, blue, yellow), in which each word was presented in a colour that was either congruent or incongruent with the word's semantic meaning. The participant's task was to identify the font colour of each word by pressing the corresponding key on a keyboard, as quickly as possible. When the word's font colour is incongruent with its semantic meaning (e.g., the word "Red" presented in a blue font), people's automatic reaction to read the word interferes with their ability to identify its font colour. This results in the Stroop effect: delayed reaction time in response to colour-meaning incongruent words compared to colour-meaning congruent words (Balota & Marsh, 2004).

In order to reduce interference from colour-meaning incongruent words, one must inhibit attention to distracting and irrelevant information (i.e., the word's semantic meaning) and consciously direct attention to the relevant information (i.e., the word's font colour) (Heitz, Unsworth & Engle, 2005). Therefore, the reduction in attentional control that is associated with stress after-effects would result in greater interference and a greater Stroop effect (Balota & Marsh, 2004). This effect can be quantified as slower reaction times to incongruent stimuli, expressed as a percent difference of colour-word

congruent reaction times (RT): (incongruent RT – congruent RT)/congruent RT (Lansbergen et al., 2007).

Personal space. Subjective assessment of personal space was measured using a digital version of the Comfortable Interpersonal Distance (CID) scale (Duke & Nowicki, 1972) (Appendix 1). Participants were presented with a diagram representing a round room with eight doors, with a line extending from the centre of the diagram to each door. They were asked to imagine that they were standing in the middle of the room. On each trial, they were asked to imagine that a different person stood at a door: a man, a woman, a black child, their friend, their neighbor, their professor, their mother, and a stranger. Participants were then asked to imagine that the person was approaching them from the door towards the centre of the room, and to use a marker on a slider bar to mark a point on the line at which they would like the person to stop. The task was designed such that the distance between the marker and the centre of the diagram ranged from 0 (i.e., marker was placed at the centre of the diagram) and 100 (i.e., marker was placed by the door), although this number was not visible to participants. Scores were averaged across the 8 targets in order to obtain an index of overall personal space. Test-retest reliabilities for the paper-and-pencil version of this measure in past studies have been reported to range from .78 to .88 (Duke & Mullens, 1973). Validity data indicate that correlations between CID responses and real-life interpersonal distance preferences range from .45 to .76 (Duke & Kiebach, 1974; Walkey & Gilmour, 1979). In addition, males completing the CID have been shown to leave more distance between themselves and same-sex targets compared to females' response to same-sex targets on this measure (Veitch, Getsinger, &

Arkkelin, 1976), which is consistent with findings that males tend to prefer larger interpersonal distance from other males, whereas female pairs tend to prefer smaller interpersonal distance (Aiello, 1987; Barnard & Bell, 1982, Uzzell & Horne, 2006).

Perceived control. Perceived control was measured using the Internality, Powerful Others, and Chance Scales (IPC; Levenson, 1981). This measure consists of 24 items evenly split into three subscales: (1) The Internality subscale, measuring the degree to which individuals believe that they have control over their lives; (2) the Powerful Others subscale, assessing the degree to which individuals believe that other people have control over their lives; and (3) the Chance scale, evaluating the degree to which individuals believe that their life events and circumstances are controlled by chance. Responses were made on a 6-point Likert-type scale, with responses ranging from 1 (*Strongly Disagree*) to 6 (*Strongly Agree*). Internal consistency scores for these subscales have been reported as ranging between .51 and .67 for Internality, .72 and .82 for Powerful Others, and .73 and .79 for Chance. Scores on Rotter's I-E Scale, a measure of locus of control, are positively related to scores on the Powerful Others and Chance subscales (r = .25, r = .56, respectively) and negatively related to scores on the Internality subscale (r = -.41) (Levenson, 1981). Depression and anxiety have been shown to be negatively related to Internality and positively related to scores on the Powerful Others and Chance scales (Holder & Levi, 1988). In addition, pathological gamblers score higher than non-gamblers on the Chance subscale, whereas no significant differences between these groups have been observed with regards to the Internality and Powerful Others subscales (de Stadelhofen, Aufrère, Besson, & Rossier, 2009).

Cognitive processing style. Kimchi and Palmer's (1982) 8-item local-global visual processing task was used to assess cognitive processing style (see Appendix 2 for an example item). On each trial, participants were presented with three large figures (triangles or squares) consisting of smaller shapes (triangles or squares). One of these three figures was positioned above the other two and was referred to as the reference figure. Participants were asked to make a similarity judgment and choose which of the two bottom figures was most similar to the reference figure. Choices could therefore be made based on the global shape of the comparison figure or the local shapes comprising it. Similarity judgments based on global features indicate a global processing style, whereas those based on local shapes indicate a local processing style.

Procedure

Participants signed up online, through the University's undergraduate research participation pool, for a study titled "Music and Visual Attention." All participants were asked to bring their MP3 player to the study. Upon arrival, they were randomly assigned to either listen to music on their MP3 players or not. They were further randomly assigned to a personal space invasion condition or to a no personal space invasion condition. This resulted in four experimental conditions: (1) personal space invasion while listening to music (Music-Invasion), (2) no personal space invasion while listening to music (Music-No Invasion), (3) personal space invasion while not listening to music (No Music-Invasion), and (4) no personal space invasion while not listening to music (No Music-No Invasion).

When participants arrived at the lab they were met by an experimenter and a confederate posing as another student participant (matched for participant gender). The experimenter informed both individuals that they would not be able to complete the study in the lab due to a scheduling conflict. Instead, they were asked to complete the study on a netbook while sitting in the hallway. The experimenter then escorted the participant and the confederate to a row of three linked chairs[1] in the hallway, whose seats were three inches apart. The participant was seated in the chair on the far right and told that s/he will be participating in a study examining the effects of music on visual attention and perception. Participants assigned to the two music conditions were asked to take out their MP3 player and to listen to it throughout the study. Participants assigned to the two no-music conditions were told that they had been randomly assigned to the control condition and were asked to put their MP3 player away. They were also told that the experimenter will be sitting down the hall during the study and that they should call the experimenter over when they reach a password screen. Participants were subsequently given a netbook and began the study.

While participants were reading the consent form, the experimenter asked the confederate to have a seat. In Invasion conditions, the confederate sat in middle seat directly next to the participant. In No Invasion conditions the confederate sat in the seat on the far left with an empty chair between themselves and the participant.

After reading the consent form, participants completed the Kimchi-Palmer task. This task, which involves matching shapes, was presented first to reinforce the study's cover story. The positioning also helped assess any immediate effects of music on local-

global processing style. The Kimchi-Palmer task was followed by the measures of personal space, perceived control, and anxiety, all of which were randomized to avoid order effects. During this time, the confederate completed an unrelated study on their own netbook so as to not arouse suspicion. After completing the aforementioned measures, participants reached a password screen and called the experimenter over. Once the experimenter arrived, the confederate pretended to finish his/her study. The experimenter set up the next part of the study on the participant's netbook and asked the confederate to follow them down the hall for a debriefing. Participants then continued with the study and completed the Stroop task to examine the after-effects of stress, as well as provided information about the music they listened to during the study.

Once the participant was done, the experimenter asked him/her to fill out a brief paper form due to the fact that they had to complete the study in the hallway (Appendix 3). The perceived crowding question was included in this form. Participants were then fully debriefed and asked not to reveal the true goal of the study to their classmates, who might be scheduled to participate in the study in the future.

3. Results

Descriptive Statistics

A total of 19 participants were removed from the analyses. Of these, nine cases were removed due to failure to meet condition criteria. In the Music-Invasion condition, one participant placed her MP3 player on the seat beside her and the confederate was unable to sit next to her without arousing suspicion. Two additional participants in this condition were removed over concerns that the experimental manipulation was not carried out successfully. One of these participants left to go to the bathroom in the middle of the experiment, thus disrupting the experimental protocol. The other participant was observed receiving and checking multiple text messages on her cellphone throughout the study, which might have affected her responses. In addition to being a constant distraction, the participant's use of her cellphone to communicate with another person might have influenced how the participant perceived the invasion of personal space. In the Music-No Invasion condition, two participants were unable to listen to music because they forgot to bring their headphones. Another participant in this condition insisted on sitting on the floor instead of using the chair provided. In the No Music-Invasion condition, one participant placed a piece of paper on the seat beside her and the confederate was unable to sit next to her without arousing suspicion. In the No Music-No Invasion condition, one participant was removed because he listened to music and another participant was removed because a maintenance worker with a floor buffer invaded her personal space.

Additional participants were removed due to knowing the confederate ($N = 2$), guessing the goal of the study based on debriefing responses ($N = 7$), and inattentive responding ($N = 1$). The latter was a participant who verbally expressed frustration over several questionnaires. A visual inspection of this participant's data revealed missing responses to over 10% of these questionnaires, suggesting that the participant might have rushed through this section of the study and answered indiscriminately. The final sample therefore consisted of 199 participants (98 males) between the ages of 18 and 36 ($M = 20.16$, $SD = 2.79$; 15 did not report their age).

In the final sample, there were 49 (24.6%) participants in the Music-Invasion condition, 51 (25.6%) in the Music-No Invasion condition, 48 (24.1%) in the No Music-Invasion condition, and 51 (25.6%) in the No Music-No Invasion condition. Total mean scores and standard deviations for all measures are presented in Table 1 and by experimental condition in Table 2.

Descriptive analyses revealed violations of normality in the data distributions of the Internality scale, the Stroop task, the CID task, and the Kimchi-Palmer task. The normality violations of the first two variables were addressed by removing outliers, which were defined as responses that were more than three standard deviations away from the mean ($N = 4$). The data distributions of the latter two variables were positively skewed and could not be remedied through simple outlier removal. Instead, a logarithmic transformation (log10) was employed to satisfy the assumption of normality underlying the analyses employed in this study. Although the means for both the original and the

transformed data are presented in Table 1 and 2, only the transformed scores were used when correlations and ANOVAs were conducted.

Due to computer error ($N = 13$) and colour-blindness ($N = 1$), Stroop data were not recorded for 14 individuals. As a result, these individuals were excluded from any analyses involving the Stroop task.

Perceived Crowding

As a manipulation check, a Kruskal-Wallis H test was conducted in order to examine whether there was a difference in perceived crowding across the different conditions. A nonparametric test was chosen because the distribution of the data were extremely skewed, a normality violation that outlier removal or transformations could not resolve. The results of the Kruskal-Wallis H test showed that there was no statistically significant difference in perceived crowding between the four conditions ($H(2) = 3.32$, $p = .34$).

Relations Among Dependent Variables

Pearson's r was used to explore how the dependent variables in this study related to one another (Table 3). Levels of anxiety during the completion of the study were positively related to subjective assessments of personal space ($r = .16$, $p = .02$). In other words, individuals who felt more anxious during the study tended to desire more space between themselves and others in hypothetical interpersonal distance scenarios. Anxiety was also related to perceived control, such that individuals who reported more anxiety scored lower on the Internality scale ($r = -.28$, $p < .01$), and higher on the Powerful Others and the Chance scales ($r = .26$, $p < .01$ for both).

Perceived control was related to personal space preferences. Individuals who believed that they had control over themselves and their surroundings (i.e., high scores on the Internality scale) wanted less distance between themselves and hypothetical social targets (r = -.15, p =. 04). Conversely, those who believed that an external source influenced their life events (i.e., high scores on the Powerful Others and the Chance scales) tended to need more interpersonal distance (r = .22 and r = .19, respectively, ps < .01).

Main Analyses

A series of 2 x 2 factorial ANOVAs was conducted to examine the influence of the interaction between music and personal space invasion on anxiety, stress after-effects, subjective personal space, perceived control, and cognitive processing style. The primary aim of the current study was to investigate whether using MP3 players could ameliorate the associated negative emotional and cognitive effects of perceived crowding. We expected that among individuals whose personal space was invaded, those who used MP3 players would feel less anxious than those who did not use their MP3 players. Specifically, individuals in the Music-Invasion condition were expected to score lower than individuals in the No Music-Invasion condition on the STAI, which measures the degree of experienced state anxiety. However, our analyses showed that there were no statistically significant differences in anxiety between the different conditions. When anxiety was entered as the dependent variable, the factorial ANOVA revealed that the interaction effect was not statistically significant ($F(1, 195) = 0.21$, $p = .65$, $\eta p^2 < .01$). The main effect of music was not statistically significant ($F(1, 195) = 0.00$, $p = .99$, $\eta p^2 <$

.01), nor was the main effect of personal space invasion ($F(1, 195) = 0.46$, $p = .50$, $\eta p^2 < .01$).

An increase in stress levels is another oft-cited consequence of perceived crowding. It was hypothesized that among individuals whose personal space was invaded, those who listened to music would experience fewer stress after-effects than those who did not listen to music. Specifically, individuals in the Music-Invasion condition were expected to have faster reaction times to incongruent stimuli than individuals in the No Music-Invasion condition on the Stroop task, which measures stress after-effects in the form of reductions in attentional control. Our analyses showed that the interaction between music and personal space invasion had no effect on stress after-effects ($F(1, 179) = 0.00$, $p = .98$, $\eta p^2 < .01$. The main effect of music was not statistically significant ($F(1, 179) = 1.22$, $p = .27$, $\eta p^2 < .01$) and neither was the main effect of personal space invasion ($F(1, 179) = 1.56$, $p = .21$, $\eta p^2 < .01$).

A secondary aim of the study was to examine potential mechanisms that might explain such an effect. One mechanism we were interested in was personal space. We hypothesized that participants who used their MP3 player while in close proximity to the confederate would have smaller personal space boundaries than participants who did not use their MP3 player. Specifically, we expected that participants in the Music-Invasion condition would score lower than participants in the No Music-Invasion condition on the CID, which measures personal space preferences. Subjective personal space boundaries were not affected by the interaction between music and personal space invasion, $F(1, 195) = 0.98$, $p = .32$, $\eta p^2 < .01$. The main effect of music was not statistically significant

($F(1, 195) = 1.74$, $p = .19$, $\eta p^2 < .01$), and neither was the main effect of personal space invasion ($F(1, 195) = 0.23$, $p = .63$, $\eta p^2 < .01$).

In addition, we wanted to examine the possible influence of using MP3 players on perceived control. We hypothesized that participants who used their MP3 players while their personal space was invaded would have greater perceived control over their environment than participants who did not use their MP3 player. In turn, those who listened to music would have smaller personal space boundaries and would be more likely to tolerate the close presence of others around them. It was thus expected that participants in the Music-Invasion condition would score higher on the Internality subscale and lower on the Powerful Others and Chance scales of the IPC than participants in the No Music-Invasion, attributing their circumstances to internal sources rather than external sources (e.g., authority figures, fate). Internality was not influenced by the interaction between music and personal space invasion, $F(1, 193) = 2.19$, $p = .14$, $\eta p^2 = .01$. Neither the main effect of music ($F(1, 193) = 0.25$, $p = .62$, $\eta p^2 < .01$), nor the main effect of personal space invasion were statistically significant ($F(1, 193) = 0.32$, $p = .58$, $\eta p^2 < .01$). For the Powerful Others subscale, the interaction effect was not statistically significant, $F(1, 195) = 0.18$, $p = .67$, $\eta p^2 < .01$. The main effect of music was not statistically significant ($F(1, 195) = 0.02$, $p = .88$, $\eta p^2 < .01$), nor was the main effect of personal space invasion ($F(1, 195) = 0.10$, $p = .75$, $\eta p^2 < .01$). A similar pattern emerged for the Chance subscale. The interaction effect was not statistically significant, $F(1, 195) = 0.72$, $p = .40$, $\eta p^2 < .01$. The main effect of music was not statistically significant ($F(1,$

195) = 0.89, p = .35, $\eta p^2 < .01$), nor was the main effect of personal space invasion (F(1, 195) = 2.17, p = .14 , ηp^2 = .01).

Lastly, we proposed that listening to music through headphones could produce a shift in cognitive processing style that would make other people in one's environment seem psychologically distal and reduce the salience of their close presence. We expected that participants in the Music-Invasion condition would be more likely to categorize shapes based on global features on the Kimchi-Palmer task compared to participants in the No Music-Invasion condition. Cognitive processing style was not affected by the interaction between music and personal space invasion, F(1, 195) = 0.42 , p = .52, $\eta p^2 <$ .01. The main effect of invasion was not statistically significant, F(1, 195) = 0.11, p = .74, $\eta p^2 < .01$. However, there was a statistically significant main effect of music, F(1, 179) = 5.72, p = .02, ηp^2 = .03, such that individuals who listened to music demonstrated a more global processing style compared to those who did not listen to music.

Gender

In light of the null findings, we decided to adopt an exploratory approach in order to examine whether individual differences moderate the effects of music and personal space invasion. Specifically, we looked at the role of gender, which has been implicated as an individual difference that affects people's personal space and how they respond to spatial-density. Previous research has demonstrated that males require more personal space than females. Males tend to maintain larger interpersonal distance from other males, whereas female pairs tend to maintain smaller interpersonal distance (Aiello, 1987; Barnard & Bell, 1982, Uzzell & Horne, 2006). In addition, it seems that males and

females respond differently to conditions of high population density. Male members of a same-sex group respond more negatively when placed into a small room with other males than when they are placed into a larger room. Female members of a same-sex group, on the other hand, experience more negative emotions in a larger room than they do in a smaller room (Epstein & Karlin, 1975; Freedman, Levy, Buchanan, & Price, 1972). Males also react more negatively than females to same-sex face-to-face personal space invasions, while females respond more negatively than males to same-sex side-by-side invasions (Fisher & Bryne, 1975).

Thus, gender was examined as a potential moderator on the interaction between music and personal space invasion. A series of 2 x 2 x 2 factorial ANOVAs was conducted to examine the effects of the interaction between music, personal space invasion, and gender on anxiety, stress after-effects, subjective personal space, perceived control, and cognitive processing style. Means and standard deviations are presented in Table 4.

Anxiety. A 2 x 2 x 2 factorial ANOVA was conducted to examine the influence of music, personal space invasion, and gender on levels of anxiety (Table 5, Figure 1). The 3-way interaction between music, invasion, and gender was statistically significant. A post-hoc analysis using Fisher's Least Significant Difference (LSD) test revealed that males felt less anxious than females in the No Music-No Invasion condition, $p = .04$. There were no other statistically significant gender differences in anxiety across the remaining three conditions.

Stress after-effects. A 2 x 2 x 2 factorial ANOVA was performed to examine the effects of music, invasion, and gender on stress after-effects, operationalized using the Stroop task (Table 6). There were no statistically significant main effects or interactions.

Personal space. The influence of music, invasion, and gender on subjective personal space was investigated using a 2 x 2 x 2 factorial ANOVA (Table 7). None of the main effects were statistically significant and this was also the case for the 2- and 3-way interaction effects, indicating that subjective personal space was not influenced by music, personal space invasion, gender, or their interaction. Interestingly, females had smaller personal space boundaries than males in the Music-Invasion condition, whereas the opposite was true in the Music-No Invasion condition (Figure 2). Although these differences were not statistically significant, they are consistent with the pattern of anxiety ratings in these two conditions.

Perceived control. Three 2 x 2 x 2 factorial ANOVAs were conducted in order to explore the effects of music, invasion, and gender on three aspects of perceived control as measured by Levenson's (1982) IPC scales. There was a statistically significant 3-way interaction between music, invasion, and gender when Chance scores were entered as the dependent variable (Table 8, Figure 3). A post-hoc analysis using Fisher's LSD test revealed that males were less likely to attribute the events in their lives to chance in the Music-Invasion condition than in the Music-No Invasion condition, $p < .01$. In other words, in the presence of music constant, males perceived less chance-based control when their space was invaded. The opposite pattern emerged for females, who were more likely to attribute life events to luck or fate in the Music-Invasion condition than in the

Music-No Invasion, $p = .05$. In other words, females experienced more chance-based control when their space was invaded compared to when it was not, in the presence of music. In addition, females scored lower than males on the Chance scale in the Music-No Invasion ($p = .05$), indicating a lesser sense of chance-based control, but scored higher than males on the same scale in the Music-Invasion condition, indicating a greater belief that luck or fate is responsible for what happens to them, $p < .01$.

When Internality scores and Powerful Others scores were entered as the dependent variable, there were no statistically significant main effects, 2-way interactions, or 3-way interactions (Tables 9 and 10). Males in the Music-Invasion condition scored higher than females on Internality (Figure 4). In addition, Males perceived less control by powerful others than did females in the Music-Invasion condition, whereas the opposite was true for the Music-No Invasion condition (Figures 5). Although these differences were not statistically significant, they reveal a pattern of results that is fairly consistent across several related DVs: anxiety, personal space, and three types of perceived control.

Cognitive processing style. A final 2 x 2 x 2 factorial ANOVA was conducted to investigate the effects of music, invasion, and gender on cognitive processing style (Table 12, Figure 7). There was a statistically significant main effect for music, such that participants who listened to music tended to display a more global processing than those who did not listen to music. There were no other statistically significant main effects or interactions.

4. Discussion

The present study examined whether listening to portable music influences the subjective experience of crowding. Specifically, the study investigated how listening to music in a high-density situation affects levels of anxiety and stress after-effects, as well as personal space boundaries, perceived control, and cognitive processing style.

Anxiety

People often experience negative mood states and anxiety in high-density situations. Could the use of MP3 players while in close proximity to strangers protect against increased levels of anxiety? It was hypothesized that individuals who did not listen to music during a personal space invasion condition would experience greater levels of anxiety than those who listened to music. This hypothesis was not supported, as participants' anxiety levels were not affected by listening to music or by others intruding their personal space.

Given that members of female dyads tend to keep less interpersonal distance between each other than do members of male dyads (Aiello, 1987; Barnard & Bell, 1982), it is possible that gender moderates the effects of music and personal space invasion on anxiety. In other words, it could be the case that females experience low levels of anxiety during personal space invasion because they are more likely to tolerate the close proximity of another female. (Recall that in our study all confederates were matched for gender.) As a result, the presence of music would have little influence on levels on anxiety, as they would be low across both levels of the personal space invasion manipulation. Males, on the other hand, tend to desire more personal space when another

male is present, and therefore the close proximity of another male might elevate anxiety. These gender differences could possibly obscure any music-related effects.

When examining whether the effects of music and personal space invasion on anxiety varied between males and females, a 3-way interaction did emerge. Females reported higher levels of anxiety than did males in the No Music-No Invasion condition. Seeing as how this was the control condition for this study, it is possible that these results reflect the general tendency of females to experience more anxiety than males (Feingold, 1994; Lippa, 2010).

Stress after-effects

The effects of high-density situations on stress levels often become apparent when one is removed from these situations. Although anxiety did not vary as a function of music and invasion of personal space, it is possible that the protective effects of music would become evident by examining stress after-effects on cognitive depletion. It was hypothesized that individuals who listened to music while sitting close to a stranger would perform better on the Stroop task than would those who did not listen to music, demonstrating fewer attentional control deficits. However, this hypothesis was not supported, as performance on the Stroop task was not influenced by music, personal space intrusion, or their interaction. Gender also had no effect on Stroop performance.

Subjective Personal Space

It was hypothesized that individuals who listened to music while sitting close to a stranger would have smaller personal space boundaries than those who did not listen to music. In other words, listening to music might shrink one's personal space boundaries,

which in turn might make the close presence of others less distressing. This hypothesis was not supported, as personal space boundaries did not vary as a function of music, invasion of personal space, or their interaction. Furthermore, gender had no effect on personal space boundaries.

Perceived Control

It was hypothesized that individuals who listened to music during a personal space invasion condition would perceive greater control over their environment than those who did not listen to music. This hypothesis was not supported, as participants' levels of perceived control were not affected by listening to music or by having their personal space invaded. However, when examining whether the effects of music and personal space invasion on perceived control varied between males and females, a 3-way interaction did emerge. Compared to males, females felt that their lives were governed by chance in the Music-Invasion condition, whereas the opposite was true in the Music-No Invasion condition.

One potential explanation for these results is that using MP3 players could have influenced participants' perceptions of their ability to behave according to social norms, which in turn could have affected perceived control. Some research suggests that individuals who believe that they are in control of their lives are more socially competent than those who believe that they cannot influence the events in their lives (Lefcourt, Martin, Fick, & Saleh, 1985; Nowicki & Hartigan, 1988; Iskender & Akin, 2010). Social skills training can also promote a belief in an internal source of control (Lons & Sherer, 1984). Although the majority of studies in this area broadly defined the source of

perceived control as being either internal or external, one study by Brosschot and his colleagues (1993) included three sources of perceived control, using Levenson's (1982) Internality, Powerful Others, and Chance model. As expected, self-perceived social inadequacy was negatively related to the belief that what happens in one's life is self-determined. Interestingly, whereas social inadequacy was positively related to the belief that events in one's life are chance-based, it was not related to the perception that these events are governed by powerful others. A possible explanation for these divergent findings is that individuals who believe that their lives are controlled by chance fail to see the link between their behaviour and various social outcomes, thus believing that they are not socially competent. The relationship between perceived social competence and the belief that powerful others control one's life might be more complex. Individuals who hold such a belief might feel that their behaviour could lead to social outcomes, albeit within a limited range. In other words, although they believe that authority figures ultimately have the final say, these individuals might feel that they can influence certain outcomes by following social norms and by behaving in a manner that would satisfy these powerful figures. It could then be the case that preventing people from interacting with others in a socially appropriate manner would increase their perception of chance-based control, as they might begin to perceive that they cannot influence their social environment.

In the context of our study, it is possible that there were gender differences in social norms about acceptable or expected social behaviour as a function of population density. The use of MP3 players might have either aided or prevented participants from

acting according to these social norms, resulting in different levels of belief in chance-based control between males and females at different levels of personal space invasion. In support of this idea, males and females are taught to behave differently under conditions of low and high density. Karlin and his colleagues (1976) suggest that females are socialized to communicate with other females who are in close proximity, and that they cope with the negative consequences of crowding by sharing their distress. On the other hand, males are socialized to maintain more interpersonal space between themselves and other males during social interactions, as well as to cope with crowding-related distress by withdrawing from the situation and reducing communication. This is consistent with a study by Epstein and Karlin (1975), which found that under high-density conditions, members of an all-male group tended to perceive that the group discouraged sharing one's emotions, whereas members of all-female groups tended to perceive that such behaviour was encouraged. Ross and colleagues (1973) also found that members of an all-female group in a small room were more likely to look at each other's faces than did members of an all-female group in a large room. The opposite pattern was observed with males, as members of an all-male group in a small room engaged in less facial regard than did members of an all-male group in a large room. These difference in socialization and subsequent group norms could help explain why members of an all-female group respond more positively when placed into a small room than when they are placed in a larger room, whereas the opposite is true for males (Epstein & Karlin, 1975; Freedman, Levy, Buchanan, & Price, 1972).

In light of this work, it is possible that using MP3 players has differential effects on individuals' ability to behave according to gender-based social norms in high-density situations. For example, in Invasion conditions, female participants would have been expected to communicate with the person sitting next to them, whereas male participants would have been expected to withdraw. Female participants were free to exchange words with the female confederate during the No Music-Invasion condition, but this was not the case in the Music-Invasion condition. Listening to an MP3 player might have impaired female participants' ability to adhere to the social norms appropriate to the situation they were in, which would involve communicating with the female sitting close to them. On the other hand, using MP3 players might have helped the males in our sample to follow social norms and withdraw from the situation.

It is equally possible that using MP3 players has differential effects on individuals' ability to behave according to gender-based social norms in low-density situations. For example, females in the No-Invasion conditions might have found the distance between themselves and the confederate to be too distant for comfortable conversation (Ross et al., 1973), whereas males might have perceived the same interpersonal distance to be ideal for communication. Social norms would thus suggest that females would not feel compelled to communicate with other females under such circumstances, whereas social interaction might be expected between two males. In the Music-No Invasion, female participants might have been able to follow social norms and withdraw from the situation by listening to music, whereas using an MP3 player

prevented male participants from adhering to social norms and communicating with the male confederate.

Cognitive processing style

It was hypothesized that individuals who used their MP3 player in a high-density setting would engage in greater global cognitive processing than individuals who did not use their MP3 player. This hypothesis was partially supported as users who listened to music engaged in more global processing than those who did not listen to music, regardless of the manipulation of personal space invasion. Our results are consistent with qualitative work (Skanland, 2012; Simun, 2009) and anecdotal accounts that using portable music players helps create a sense of distance between users and their surroundings, often referred to as psychological distance. Our study suggests that this phenomenological experience might be the result of a cognitive shift in the way individuals process their environment. It seems that listening to music through headphones triggers a global style of cognitive processing, meaning that objects and people in one's environment are processed holistically. However, further research is required in order to determine whether listening to music through headphones actually makes people feel removed from objects and people in their surroundings.

Limitations

This study has several limitations. For one, it is possible that the manipulation of personal space invasion was not powerful enough to evoke feelings of crowding. The manipulation check revealed that most participants reported not feeling crowded at all (*M*

= 1.32, *SD* = .71) and that there were no statistically significant differences in perceived crowding between the four conditions.

A number of possible explanations could account for the overall low ratings of perceived crowding. First, although participants could not move their chairs, they had sufficient space to move away from the confederate because they sat at one end of the row of seats. In fact, anecdotal accounts by the experimenter confirm that participants assigned to the personal space invasion conditions often turned away from the confederate or shifted their bodies to avoid physical contact. Future studies might consider limiting participants' movement by placing them near a wall or a filing cabinet to limit their opportunity to move away from the confederate. Alternatively, placing a confederate at each side of the participant might be more representative of a high-density situation and might result in greater perceived crowding.

A second reason for the low perceived crowding ratings could be the timing of the administration of the manipulation check. Participants responded to this question at the end of the study, which required them to retrospectively evaluate their feelings of crowding when they sat next to the confederate. These assessments may not have been accurate, making it difficult to discern how participants perceived the personal space invasion across the different conditions. In future studies, participants should be asked to what degree they feel crowded while still sitting next to the confederate, although this has the potential of making participants suspicious and question the cover story. This problem could be potentially circumvented if the crowding rating is obtained in the

context of filler questions allegedly designed to gauge participants' level of comfort with their physical environment (e.g., temperature, lighting) during the study.

Social desirability could be another potential explanation for the low reports of perceived crowding. Participants believed that they were filling out a form that would track whether there was anything unusual in their experience that might have influenced the results. It is possible that participants shied away from evaluating their experience negatively in order to "help" the researcher retain the data.

Another limitation of this study was the location in which it was conducted. Participants completed the study in a hallway that was frequently used by students and staff members. It is possible that despite being in a condition in which their personal space was not supposed to be invaded, participants felt that passersby invaded their personal space and were distracted by the foot-traffic. This introduction of additional variance could have potentially obscured any differences between the experimental conditions. Future studies should strive to use a quiet room where distraction would be minimal.

A final limitation was that we did not account for participants' cultural background. Past research has shown that individuals' personal space preferences vary across cultures. For example, people from Latin American, Asian, and Mediterranean cultures maintain less distance between themselves and other during social interactions than do Northern Europeans or Caucasian North Americans (Remland, Jones, & Brinkman, 1995, Beaulieu, 2004). Given the multicultural nature of the York University student population, our participants likely came from a variety of cultural backgrounds.

Differences in personal space requirements as a function of cultural background could have obscured any music-related effects in our sample, since it is possible that participants from Latin American, Asian, and Mediterranean cultural background did not feel that the confederate invaded their personal space.

Conclusion

In light of the increasing popularity of portable music players, it is important to understand whether they affect the way in which individuals perceive the world around them as they use these devices. Although the findings from this study did not demonstrate that using MP3 players influences users' perceptions of crowding, we did find that listening to music through headphones can affect how people process information. Future research should aim to explore the nature of this cognitive shift towards global attention, as well as any social consequences it might have.

5. Footnotes

1. A three-chair layout was selected based on an online pilot study ($N = 69$) using Amazon Mechanical Turk. Participants were asked to imagine that they are sitting at one end of a row of chairs and to respond to five scenarios in which a stranger appears and sits down at various distances from them. Two of the scenarios involved a row of three chairs and three of the scenarios involved a row of four chairs. They were asked to use a 6-point Likert-type scale ranging from 1 (*Not at all*) to 6 (*Extremely*) to forecast their level of annoyances, distraction, and anxiety, as well as the degree to which they expect to feel that the stranger was close to them. Participants forecasted that they would feel that the stranger was very close if s/he sat directly beside them and that they would feel somewhat annoyed, distracted, and anxious by this experience. When asked to imagine that the stranger sat a seat apart from them, participants predicted that they would feel that the stranger was slightly close to them, as well as not at all annoyed, not at all distracted, and not at all or slightly anxious. Ratings were fairly consistent between the three-chair scenario and the four-chair scenario, suggesting that using three chairs would be sufficient for our manipulation of personal space invasion.

6. References

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Table 1

Descriptive Statistics.

Measure	Mean	SD	Min.	Max
Anxiety	1.84	0.50	1.00	3.30
Personal Space	32.67	12.80	13.63	70.40
Personal Space (Log Transformed)	1.48	0.16	1.13	1.85
Perceived control				
Internality	35.99	3.85	27.00	47.00
Powerful Others	23.73	5.93	9.00	40.00
Chance	24.31	6.04	8.00	40.00
Stress After-Effects	.14	.23	-.59	.77
Processing Style	1.31	.32	1.00	2.00
Processing Style (Transformed)	.11	.10	.00	.30
Perceived Crowding	1.32	0.71	1.00	5.00

Table 2

Means by Experimental Condition for Anxiety, Personal Space, Perceived Control, Stress After-Effects, and Processing Style.

Variable	Experimental condition							
	Music-Invasion		Music-No Invasion		No Music-Invasion		No Music-No Invasion	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Anxiety	1.79	0.48	1.88	0.54	1.83	0.47	1.84	0.49
Personal Space	32.29	11.78	35.50	14.72	31.93	12.47	30.89	11.85
Personal Space (Log Transformed)	1.48	0.16	1.52	0.18	1.47	0.16	1.46	0.15
Perceived control								
Internality	35.61	4.19	36.12	3.48	36.70	4.13	35.58	3.61
Powerful Others	23.35	5.77	23.98	5.92	23.83	6.44	23.75	5.75
Chance	24.43	6.12	24.96	5.44	22.90	6.32	24.88	6.23
Stress After-Effects	0.13	0.25	0.11	0.20	0.19	0.23	0.14	0.22
Processing Style	1.26	.30	1.25	.31	1.34	.33	1.38	.33
Processing Style (Transformed)	.09	.10	.09	.10	.12	.10	.13	.10
Perceived Crowding	1.53	1.04	1.31	0.65	1.27	0.49	1.18	0.48

Table 3

Correlations among dependent variables.

	Anxiety	Personal Space (Log Transformed)	Perceived Control (Internality)	Perceived Control (Powerful Others)	Perceived Control (Chance)	Processing Style (Log Transformed)	Stress after-effects
Anxiety	-	.16*	.28*	.26*	.26*	.07	-.07
Personal Space (Log Transformed)		-	.15*	.22*	.19*	.04	.03
Perceived Control (Internality)			-	-.15*	-.21*	-.03	-.02
Perceived Control (Powerful Others)				-	.60*	-.09	-.03
Perceived Control (Chance)	.				-	-.12	-.06
Processing Style (Log Transformed)							.10
Stress After-Effects							-

Table 4
Means by Experimental Condition and Gender for Anxiety, Personal Space, Perceived Control, Stress After-Effects, and Processing Style.

Variable	Music-Invasion				Music-No Invasion				No Music-Invasion				No Music-No Invasion			
	Males		Females		Males		Females		Males		Females		Males		Females	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Anxiety	1.70	0.38	1.87	0.56	1.94	0.41	1.82	0.63	1.82	0.48	1.83	0.47	1.69	0.46	1.99	0.48
Personal Space	29.60	10.84	34.68	12.27	38.08	17.16	33.37	12.29	30.35	11.77	33.95	13.33	30.49	12.80	31.28	11.09
Personal Space (Transformed)	1.44	0.16	1.52	0.15	1.54	0.20	1.50	0.15	1.45	0.16	1.50	0.17	1.45	0.16	1.47	0.15
Perceived control																
Internality	37.09	3.91	34.31	4.06	36.00	3.09	36.21	3.82	36.78	4.04	36.60	4.35	35.60	3.49	35.56	3.80
Powerful Others	21.22	4.94	25.23	5.88	24.35	6.60	23.68	5.42	22.70	6.89	25.29	5.63	22.96	5.50	24.50	5.99
Chance	21.91	4.60	26.65	6.51	26.78	5.77	23.46	4.76	22.37	5.65	23.57	7.17	24.60	6.64	25.15	5.92
Stress	0.19	0.15	0.08	0.31	0.09	0.24	0.12	0.17	0.19	0.24	0.21	0.23	0.13	0.26	0.16	0.18
Processing Style	1.24	.30	1.37	.33	1.33	.33	1.30	.32	1.34	.34	1.35	.33	1.41	.31	1.36	.35
Processing Style (Transformed)	.05	.06	.13	.11	.08	.10	.09	.09	.11	.11	.12	.10	.14	.10	.12	.11
Perceived Crowding	1.39	0.84	1.65	1.20	1.43	0.84	1.21	0.42	1.30	0.54	1.24	0.44	1.12	0.33	1.23	0.59

Table 5

Examining the Effects of Music, Personal Space Invasion, Gender, and their Interactio on Anxiety.

	df	*F*	*p*	ηp^2
Music	1	0.00	0.99	0.00
Personal Space Invasion	1	0.54	0.46	0.00
Gender	1	1.64	0.20	0.01
Music x Personal Space Invasion	1	0.32	0.57	0.00
Music x Gender	1	0.80	0.37	0.00
Personal Space Invasion x Gender	1	0.00	0.98	0.00
Music x Personal Space Invasion x Gender	1	4.04	0.05	0.02
Error	191			
Total	199			

Note: $R^2 = .04$

Table 6

Examining the Effects of Music, Invasion, Personal Space Gender, and their Interaction on Stress After-Effects.

	df	*F*	*p*	ηp^2
Music	1	1.00	0.32	0.01
Personal Space Invasion	1	1.71	0.19	0.01
Gender	1	0.07	0.80	0.00
Music x Personal Space Invasion	1	0.01	0.91	0.00
Music x Gender	1	0.29	0.59	0.00
Personal Space Invasion x Gender	1	1.11	0.29	0.01
Music x Personal Space Invasion x Gender	1	0.25	0.62	0.00
Error	175			
Total	183			

Note: $R^2 = .03$

Table 7

Examining the Effects of Music, Invasion, Personal Space Gender, and their Interaction on Subjective Personal Space.

	df	*F*	*p*	ηp^2
Music	1	1.56	0.21	0.01
Personal Space Invasion	1	0.25	0.62	0.00
Gender	1	1.13	0.29	0.01
Music x Personal Space Invasion	1	1.31	0.26	0.01
Music x Gender	1	0.11	0.74	0.00
Personal Space Invasion x Gender	1	2.29	0.13	0.01
Music x Personal Space Invasion x Gender	1	0.83	0.36	0.00
Error	191			
Total	199			

Note: $R^2 = .04$

Table 8

Examining the Effects of Music, Invasion, Personal Space Gender, and their Interaction on Perceived Control (Chance).

	df	*F*	*p*	ηp^2
Music	1	0.86	0.36	0.00
Personal Space Invasion	1	2.67	0.10	0.01
Gender	1	0.89	0.35	0.01
Music x Personal Space Invasion	1	0.40	0.53	0.00
Music x Gender	1	0.01	0.92	0.00
Personal Space Invasion x Gender	1	6.70	0.01	0.03
Music x Personal Space Invasion x Gender	1	4.86	0.03	0.03
Error	191			
Total	199			

Note: $R^2 = .08$

Table 9

Examining the Effects of Music, Invasion, Personal Space Gender, and their Interaction on Perceived Control (Internality).

	df	*F*	*p*	ηp^2
Music	1	0.18	0.67	0.00
Personal Space Invasion	1	0.41	0.53	0.00
Gender	1	1.61	0.21	0.01
Music x Personal Space Invasion	1	1.92	0.17	0.01
Music x Gender	1	1.14	0.29	0.01
Personal Space Invasion x Gender	1	2.04	0.16	0.01
Music x Personal Space Invasion x Gender	1	1.69	0.20	0.01
Error	189			
Total	197			

Note: $R^2 = .05$

Table 10

Examining the Effects of Music, Invasion, Personal Space Gender, and their Interaction on Perceived Control (Powerful Others).

	df	*F*	*p*	ηp^2
Music	1	0.08	0.77	0.00
Personal Space Invasion	1	0.10	0.76	0.00
Gender	1	4.94	0.03	0.03
Music x Personal Space Invasion	1	0.39	0.53	0.00
Music x Gender	1	0.05	0.82	0.00
Personal Space Invasion x Gender	1	2.91	0.09	0.02
Music x Personal Space Invasion x Gender	1	1.18	0.28	0.01
Error	191			
Total	199			

Note: $R^2 = .05$

Table 11

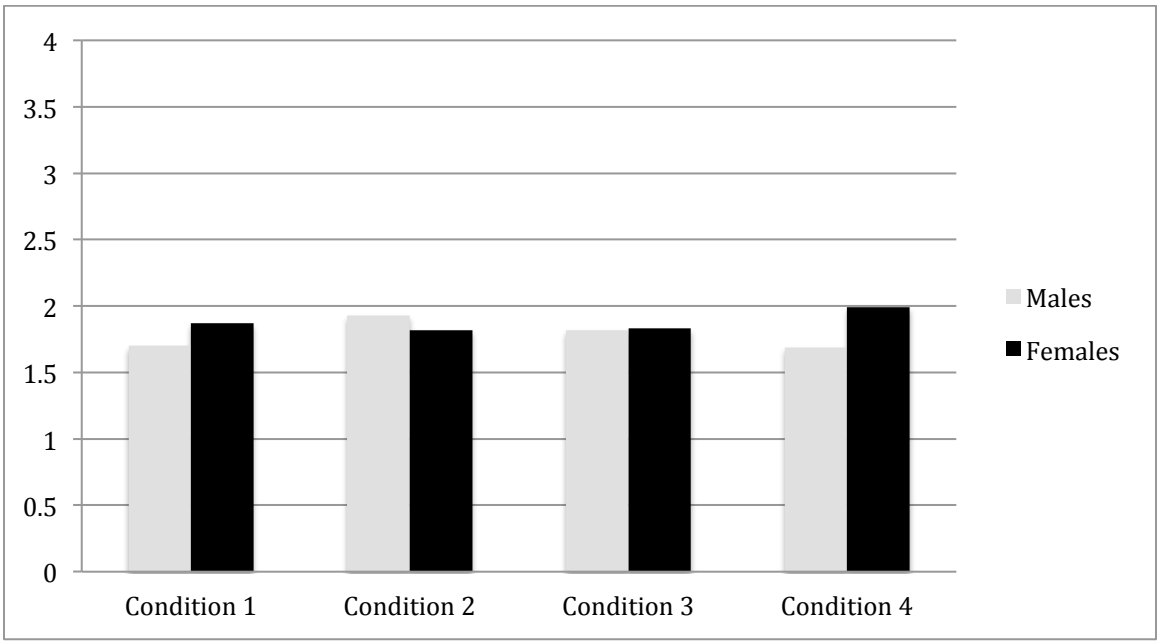
Examining the Effects of Music, Invasion, Personal Space Gender, and their Interaction on Processing Style.

	df	*F*	*p*	ηp^2
Music	1	6.36	0.01	0.03
Personal Space Invasion	1	0.17	0.68	0.00
Gender	1	1.64	0.20	0.01
Music x Personal Space Invasion	1	0.32	0.58	0.00
Music x Gender	1	3.02	0.08	0.02
Personal Space Invasion x Gender	1	3.24	0.07	0.02
Music x Personal Space Invasion x Gender	1	1.16	0.28	0.01
Error	191			
Total	199			

Note: $R^2 = .08$

Figure 1

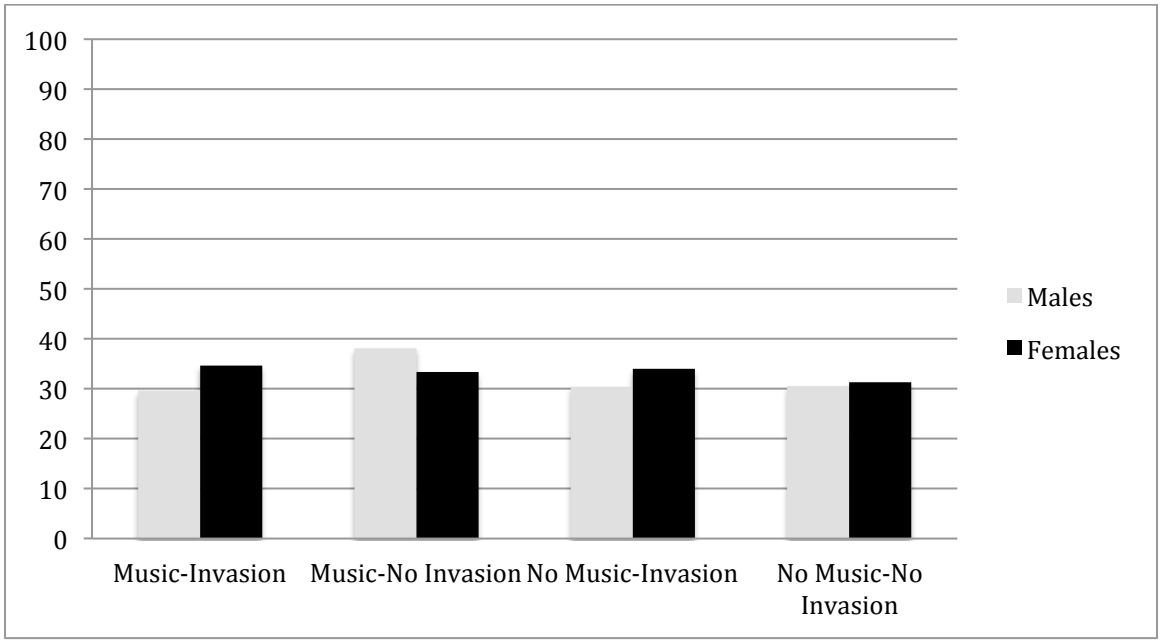
Examining the Effects of Music, Invasion, Personal Space Gender, and their Interaction on Anxiety.



Note: Higher scores represent higher levels of anxiety.

Figure 2

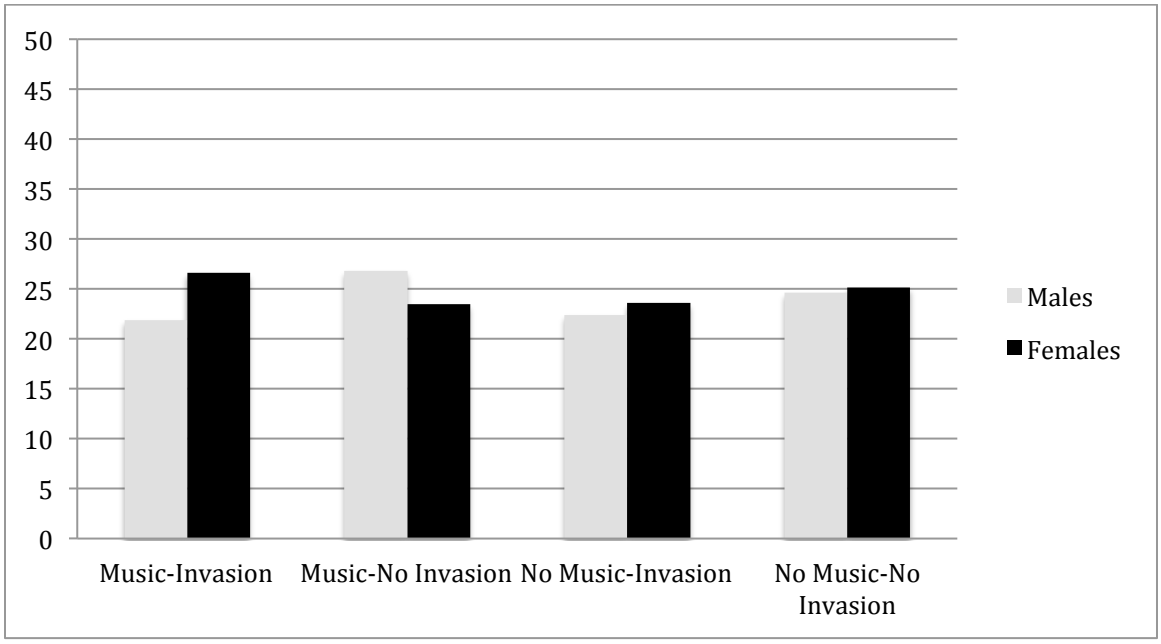
Examining the Effects of Music, Invasion, Personal Space Gender, and their Interaction on Subjective Personal Space.



Note: Higher scores represent greater personal space boundaries.

Figure 3

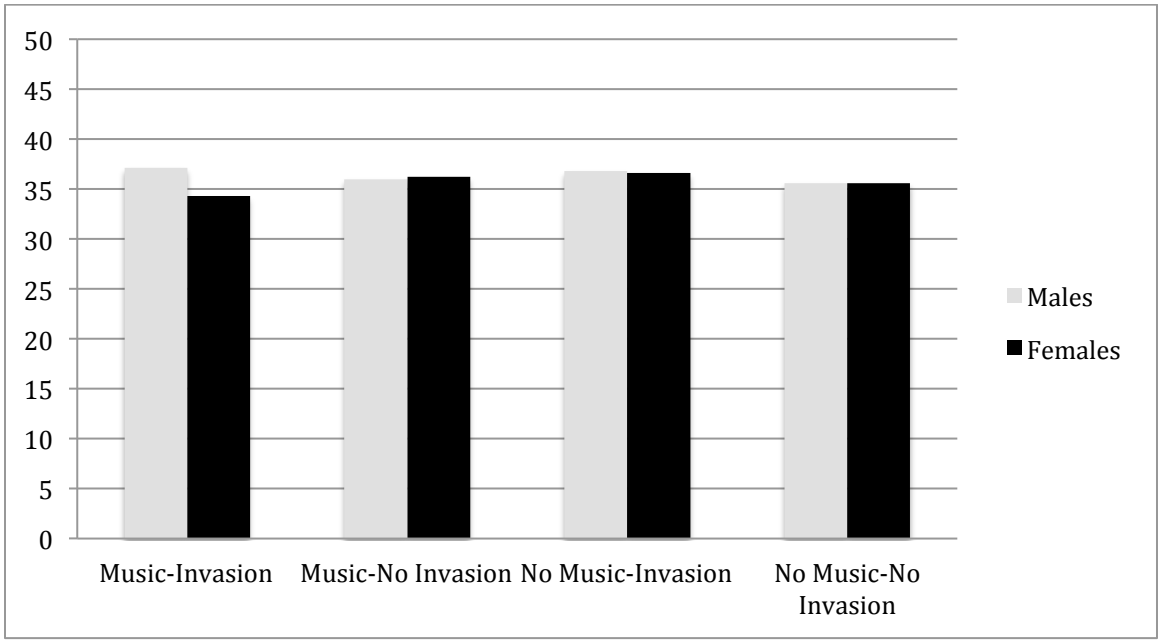
Examining the Effects of Music, Invasion, Personal Space Gender, and their Interaction on Perceived Control (Chance).



Note: Higher scores represent greater endorsement of chance-based control.

Figure 4

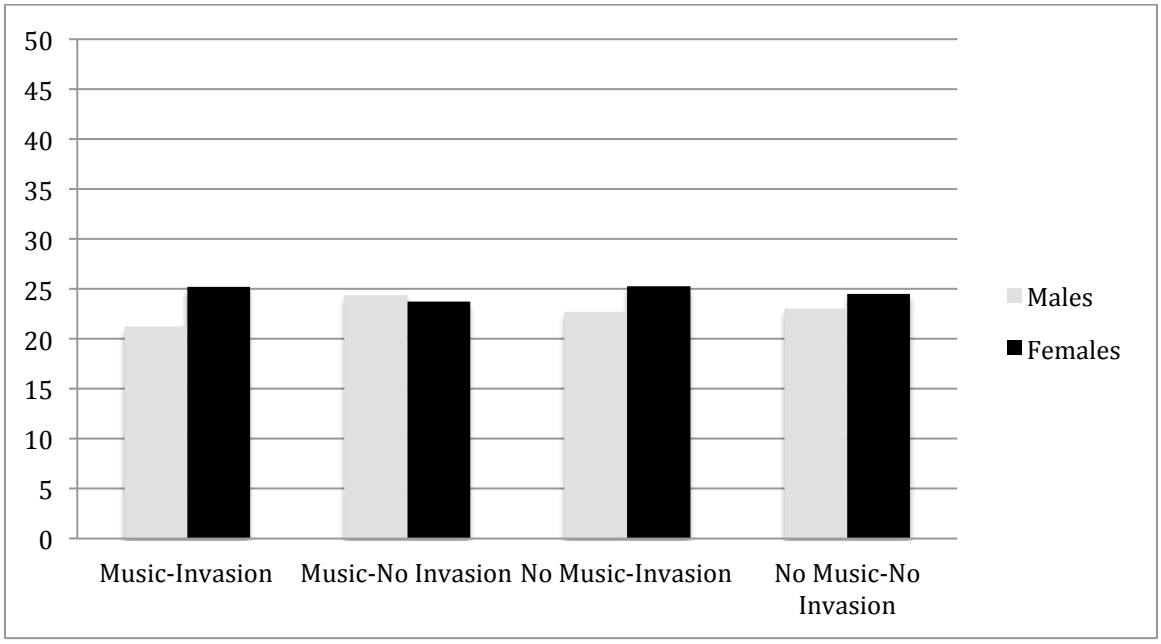
Examining the Effects of Music, Invasion, Personal Space Gender, and their Interaction on Perceived Control (Internality).



Note: Higher scores represent greater endorsement of an internal source of control.

Figure 5

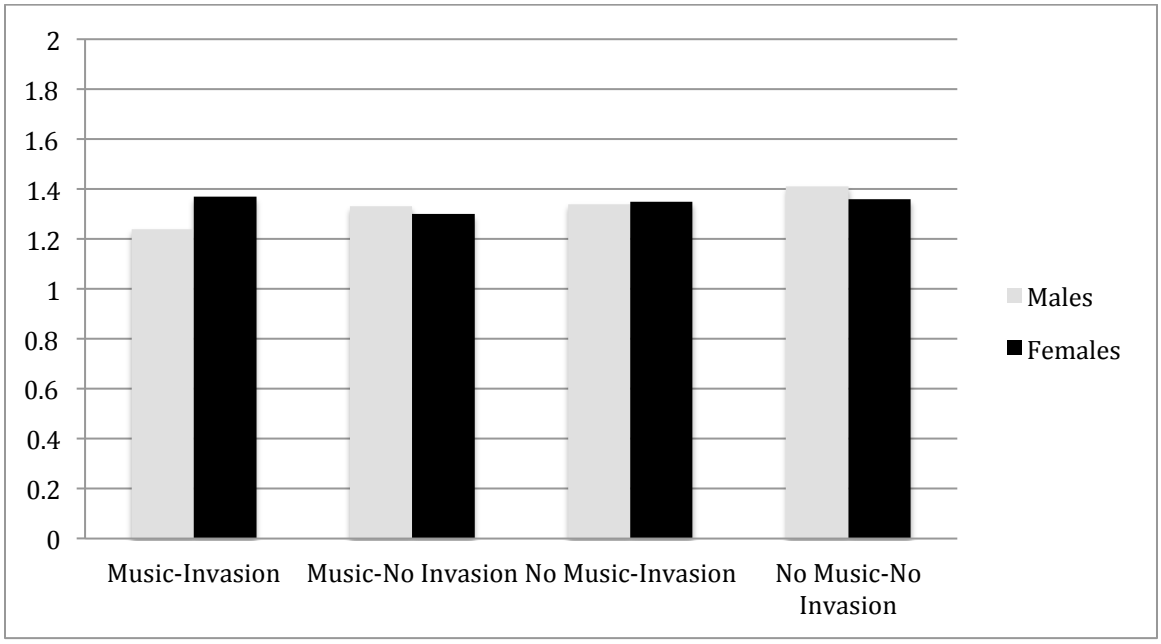
Examining the Effects of Music, Invasion, Personal Space Gender, and their Interaction on Perceived Control (Powerful Others).



Note: Higher scores represent greater endorsement of control by powerful others.

Figure 6

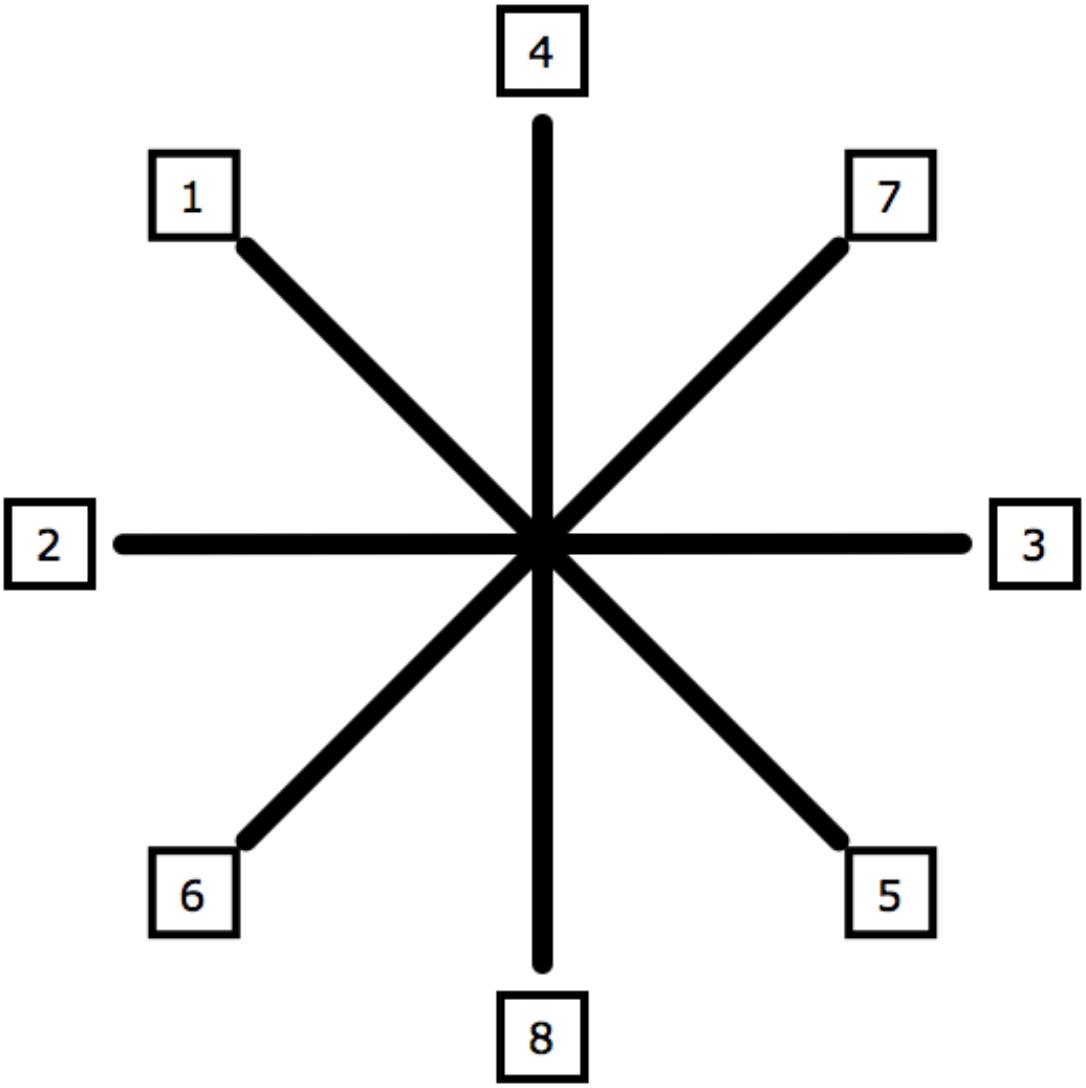
Examining the Effects of Music, Invasion, Personal Space Gender, and their Interaction on Processing Style.



Note: Higher scores represent a greater tendency to engage in local processing.

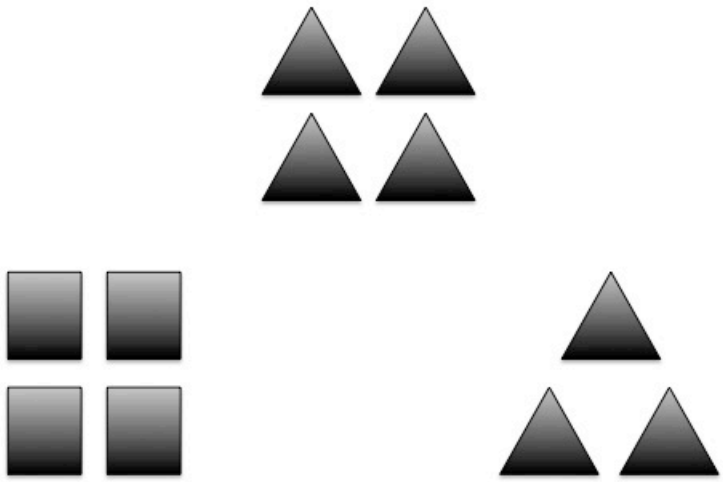
Appendix A

The Comfortable Interpersonal Distance (CID) Task.



Appendix B

The Kimchi-Palmer Task.



Appendix C

Study Tracking Form.

Study Tracking Form

Study Name:_____
Subject ID:_____
Condition:_____

1) How distracted were you by the presence of other participants?

1	2	3	4	5
Not at all	Somewhat	Moderately	Very much	Extremely

2) How crowded did you feel?

1	2	3	4	5
Not at all	Somewhat	Moderately	Very much	Extremely

3) Did any of the other participants use their cell phone during the study?

1	2
Yes	No

4) Did you speak to any of the other participants?

1	2
Yes	No

5) Did you know any of the other participants?

1	2
Yes	No

6) To what extent did you like the other participants?

1	2	3	4	5
Not at all	Somewhat	Moderately	Very much	Extremely

7) To what extent do you think you would like to be friends with the other participants?

1	2	3	4	5
Not at all	Somewhat	Moderately	Very much	Extremely

8) Did the presence of the other participants influence how you responded to questions during today's study?

1	2
Yes	No

Additional comments: