

DISSERTATION

MUSEUM SOUNDSCAPES AND THEIR IMPACT ON
VISITOR OUTCOMES

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ABSTRACT

MUSEUM SOUNDSCAPES AND THEIR IMPACT ON VISITOR OUTCOMES

Consistent with Attention Restoration Theory, restorative experiences can help people recover from the effects of life stresses. Research suggests that noise can interfere with the restorative process or with factors necessary for restorative outcomes, and there is reason to believe that pleasant sounds such as classical music or nonthreatening sounds of nature can enhance restorative outcomes. Research demonstrates that a visit to a museum or park can result in a restorative experience. The impact of extraneous sounds in such settings might depend on the type of sound and the purpose of the setting. The settings for the current study were an art exhibit and a natural history exhibit at The Wildlife Experience, a museum in Parker, Colorado that focuses on various aspects of wildlife. The art exhibit (*Some Like it Hot, Cold Wet, Dry*), displayed paintings, sculpture, and taxidermy about wildlife in four climates, and was frequented by enthusiasts of diverse ages, especially adults. The natural history exhibit (*CritterCam*), contained many different interactive displays based on photos and information gained from cameras mounted on wild animals, focused on wildlife, and tended to attract families with young children. Each day as researchers observed visitors and conducted an exit interview with them ($n = 430$ art, 433 natural history), either no added sounds were piped into the exhibit (control condition), or a soundtrack of either human voices, instrumental classical music,

or natural sounds (birdsong) was piped into the gallery space at a low (approximately 50dB(A)) or high (approximately 60dB(A)) volume level. In general, in the art exhibit natural sounds and classical music yielded the highest dwell times, engagement, satisfaction, and knowledge gain, and human voices, especially louder voices, yielded the worst outcomes. In the natural history exhibit the ambient noise (e.g., children's voices and other crowd noise) somewhat masked the added soundtracks, and there were fewer effects of the added soundtracks; visitors in the control condition (i.e., no added sound) experienced the best outcomes when compared to the other sound delivery conditions, in terms of longer dwell times and lower ratings of noisiness. In terms of dispositional measures, in the art exhibit, extraversion was positively correlated with self-reported knowledge gain, satisfaction, and restoration; and need for cognition was positively correlated with knowledge gain, satisfaction, and dwell time. In the natural history exhibit, extraversion was positively correlated with engagement and knowledge gain; and noise sensitivity was negatively correlated with satisfaction and knowledge gain. Results are consistent with a congruence interpretation: sounds congruent with visitor expectations of an exhibit are more likely to yield a restorative experience.

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DEDICATION

This work is dedicated to Ashley, my wife, companion, and best friend, your encouragement though the years made the difference.

TABLE OF CONTENTS

ABSTRACT.....	ii
TABLE OF CONTENTS.....	vii
LIST OF TABLES	viii
LIST OF FIGURES	x
CHAPTER 1 INTRODUCTION	1
Stress of Everyday Life.....	2
Noise as a Stressor	5
Individual Differences in Response to Noise.....	9
Individual Difference Measures Related to Museum Visitation Outcomes	12
Effects of Noise vs. Music	13
Museums and Parks as Restorative Settings	15
Implications for the Current Project: Restoration Disruption, Person-Environment Fit, and Congruence.....	17
The Current Project.....	23
Hypotheses	24
Predictions for Sounds Played in the Art Exhibit	24
Predictions for Sounds Played in the Interactive Natural History Exhibit.....	25
Hypotheses Independent of Exhibit	25
CHAPTER 2 METHODOLOGY	27
Research Space and Pilot Study.....	27
Participants.....	32
Design	33
Sound Analysis Equipment.....	33
Soundtracks.....	33
Materials	37
Procedure	43
CHAPTER 3 RESULTS	44
Art Exhibit	45
Natural History CritterCam Exhibit.....	51
Perception of Noisiness in the Two Exhibits.....	55
General Analysis of Recording and Potential Masking.....	58

Restorative Experience and Scale Indicators	66
Individual Difference Measures, P-E Fit, and Congruence	70
CHAPTER 4 DISCUSSION	72
Unexpected Findings	73
The Occurrence of Physical Noise Masking.....	76
Environmental Congruence and Attention Restoration Theory.....	77
Implication for Applied Recreation and Museum Studies.....	79
Limitations and Future Directions	80
Conclusion	83
REFERENCES	84
APPENDIX A VISITOR TRACKING SHEET	94
APPENDIX B PRE-PILOT INTERCEPT SURVEY.....	95
APPENDIX C FINAL INTERCEPT SURVEY.....	97
APPENDIX D TEN-ITEM PERSONALITY SCALE – EXTRAVERSION SUB-SCALE	99
APPENDIX E NOISE SENSITIVITY SCALE – SHORTENED VERSION	100
APPENDIX F ROTTER’S LOCUS OF CONTROL SCALE.....	101
APPENDIX G MOTIVATION FOR SENSORY PLEASURE – SHORTENED	102
APPENDIX H NEED FOR COGNITION – SHORTENED VERSION	103
APPENDIX I MEANS AND STANDARD DEVIATIONS FOR OUTCOME MEASURES BY EXHIBIT.....	104

LIST OF TABLES

1. Significant Tukey Post-hoc Comparisons for Sound Condition by Dwell Time in the Art Exhibit	46
2. Significant Tukey Post-hoc Comparisons for Sound Condition by Engagement in the Art Exhibit	48
3. Significant Tukey Post-hoc Comparisons for Sound Condition by Knowledge Gain in the Art Exhibit	49
4. Significant Tukey Post-hoc Comparisons for Sound Condition by Self-report Satisfaction Scores in the Art Exhibit.....	50
5. Significant Tukey Post-hoc Comparisons for Sound Condition by Restoration in the Art Exhibit	51
6. Significant Tukey Post-hoc Comparisons for Sound Condition by Dwell Time in the Natural History Exhibit.....	53
7. Significant Tukey Post-hoc Comparisons for Sound Condition by Perceived Knowledge Gain in the Natural History Exhibit.....	54
8. Significant Tukey Post-hoc Comparisons for Sound Condition by Noisiness Scores in the Natural History Exhibit.....	57
9. Averages and Standard Deviations for A-weighted Decibel Levels of Both Test and Design Level Sounds in Both Exhibits.....	59
10. Correlations among Outcome Measures (dependent variables) and Individual Difference Measures by Exhibit.....	71

LIST OF FIGURES

1. Average Dwell time by Sound Condition within the Art Exhibit.....	46
2. Average Kiosk Engagement by Sound Condition for the Art Exhibit.....	47
3. Average Perceived Knowledge Gains by Sound Condition in the Art Exhibit	48
4. Average Self-report Satisfaction Scores by Sound Condition in the Art Exhibit	49
5. Average Restoration Ratings by Sound Condition in the Art Exhibit.....	50
6. Average Dwell Time by Sound Condition in the Natural History Exhibit.....	53
7. Average Knowledge Gain by Sound Condition in the Natural History Exhibit.....	54
8. Sound Condition by Mean Noisiness Ratings in the Art Exhibit	56
9. Sound Condition by Mean Noisiness Ratings in the Natural History Exhibit.....	57
10. Recorded A-weighted Decibel Ratings for All Conditions within the Art Exhibit	61
11. Lack of Masking by Crowd Noise in Relation to Piped-in Sound in the Art Exhibit	62
12. Recorded A-weighted Decibel Ratings for All Conditions in the Natural History Exhibit.....	63
13. Piped-in Sound Being Masked by Ambient Noise in the Natural History Exhibit.....	64
14. Mean Difference A-weighted Decibel Scores Comparison by Condition for Both the Art and Natural History Exhibit	65

CHAPTER 1

INTRODUCTION

Heritage centers, national parks, and cultural establishments are perceived as places of education, entertainment, and enjoyment. These institutions are embedded in our culture, and their content is as varied as their locations. Regardless of how varied these places may be, they all attempt to inform the public about topics that are part of the human and nonhuman condition. When visiting these locations, guests have assumptions about the setting and what they are going to experience. For example, visitors to national parks may anticipate seeing wide vistas, roaming wildlife, and hearing the sounds of nature, whereas visitors to museums may expect to see unique artifacts and displays in a non-disturbing controlled environment. Often, visitation to these settings is motivated at least in part by a desire to escape the stresses of everyday life, yet the visit itself may be degraded by environmental stressors of a visual and auditory nature that are common in both natural and built recreation settings.

Along with failing to meet basic visitor expectations due to visual or auditory pollutants or other factors, visitors' motivations influence the "visitor experience." Researchers suggest that visitors' motivations regarding why and when to visit an institution are quite diverse (e.g., Falk & Dierking, 2000). Some of the more common and consistent motivations include a motivation to learn and, either directly or indirectly, a

motivation to find and experience a sense of psychological and physiological restoration (Falk & Dierking, 2000; Kaplan, Bardwell, & Slakter, 1993; Packer, 2008).

Considering specific visitor environments to have “restorative” influence on the visitor grew out of early research designed to measure nature’s positive impact on various human factors. Early research settings investigated were quite diverse, covering the impact of gardening (Kaplan, 1973) and benefits of a wilderness experience (Kaplan & Talbot, 1983). In general, a restorative environment is seen as a setting that redirects attention away from everyday experiences, which, in turn, leads to positive psychological outcomes. The current project examines how a variety of natural and human-related sounds in a wildlife museum setting can impact both positive and negative psychological outcomes.

Stress and Everyday Life

Stressors are any perceived force put upon the body that causes harm. Stressors can come from many sources, and they can have a wide range of impacts on the body and on human functioning (Hennessy & Jakubowski, 2008). Researchers have focused on stressors originating from many sources, including minor daily hassles and major life events (Campbell, 1983). Some of the more severe stressors that have received a great deal of focus in psychology include the impact of changes in working conditions, unemployment, marital discord, and death of loved ones.

Although these major factors and other, minor daily hassles (e.g., traffic congestion), have proven to negatively affect our daily functioning (Hennessy & Jakubowski, 2008), there exist other sources of stress that are not as evident, but warrant the same degree of attention. These include stressors originating from our ambient

surroundings, such as stress from heat and noise. Certain temperatures (Bell, 2005), crowding and air pollution (Evans & Stecker, 2004), and precipitation (Howarth & Hoffman, 1984) have all been shown to impact psychological functioning. Although much of this research grew out of the field of environmental psychology, the research findings are now commonplace and are found in a broad array of areas, ranging from the fields of ergonomics (Gawron, 1984) to engineering (Aasvang & Engdahl, 1999).

Regardless of stressor type, the impact on individuals is varied. These impacts can range from the positive (e.g., increased concentration ability) to the negative (e.g., a stressor leads to the non-attainment of a specific goal). Some of the negative and more applied impacts that appear in the literature include lowered cognitive functioning (e.g., task performance; Kjellberg, Ljung, & Hallman, 2008), negative affect (Hygge & Knez, 2001), avoidance behavior (Smith & Curnow, 1966), increased conflict (Ruddell & Gramann, 1994), increased blood pressure (Stokols, Novaco, Stokols & Campbell, 1978), and decreased satisfaction in domains in which the stressor is operating (e.g., workplace and home-life; Kendall & Muenchberger, 2009). Although specific stressor-impact relationships can operate consistently, research suggests that individual differences influence the level of impact the stressor will have.

Glass and colleagues were some of the first to demonstrate the negative impact stressors can have on task performance, suggesting that environmental stressors can impair performance (Glass, Reim & Singer; 1971; Glass, Singer, & Friedman, 1969). Furthermore, researchers showed that an individual's impact from the stressor can be expressed in the form of a lowered tolerance for frustrations and impaired performance on current and subsequent tasks (Glass et al., 1969). Berkowitz (1989) demonstrated the

influence of stressors on frustration quite clearly. He suggested that under the influence of specific stressors, events may delay or even prevent the desired outcome or reward. This can lead to physiological and psychological stress, and ultimately the behavior-reward interruption can lead to frustration (Berkowitz, 1989).

To cope with a stressor, individuals may choose to abandon the goal they are trying to attain, or develop other processes by which the stressor is overcome. For example, if a visitor to a museum exhibit is attempting to learn about a specific topic in the presence of a stressor, the visitor can choose to leave the environment in which the stressor is occurring, leaving goals by the wayside. Alternatively, the visitor may resort to spending more cognitive resources overcoming the stressor to reach the goal of learning. Smith and Curnow (1966) documented the exiting strategy when they found store visitors exited more quickly in the presence of a stressor. Whether or not an individual decides to continue through the impending obstacle or stressor depends upon the degree of motivation (and other variables) that exists within the person.

Researchers have attempted to develop organizational frameworks for environmental stressors. For example, earlier environmental researchers attempted to organize stressors into three categories (Baum, Singer, & Baum, 1981). In any given stress event, the source of the stressor, the actual transmission of the stressor, and the recipients themselves all interact to create the psychological and/or physiological outcome. The recipient of the stressor may act on any of these three categories to manage stress appropriately (Baum et al., 1981). However, if the stressor is too salient, the ability to react efficiently to a given stressor is reduced. In addition, the impact of the stressor is influenced by personal history, personality, and previously developed coping

mechanisms that ultimately influence the future behavior of the individual (Baum et al., 1981).

Although other early reviews meaningfully added to the trajectory of stressor research and parsed out other important dimensions of stressors in general (e.g., daily hassles, ambient stressors, and acute hassles; Campbell, 1983), Baum and his colleagues provided a succinct view into the operation of *environmental* stressors that remain relevant today. Focusing partially on environmental stressors many years later, Evans and Stecker (2004) highlighted the growth of findings within stressor research. More relevant to the current topic, they focused on noise—which is defined as unwanted sound—as a stressor that has implications for motivation (e.g., task persistence) and learned helplessness (i.e., learning not to take a specific action when that action would actually achieve a desired goal). They called for more effort to be placed on moderator variables in the stressor-person-outcome relationship (Evans & Stecker, 2004).

Noise as a Stressor

When investigating research on noise specifically, it is clear that noise should, in fact, be treated as a significant environmental stressor that has broad impacts. Domains include, but are not limited to, fatigue, performance, and affect, in both the lab and applied settings (Bell, Greene, Fisher, & Baum, 2001). Many of these investigations continue to reveal the multi-dimensionality and operation of noise as a stressor, extending the types of factors accounted for while becoming more exacting in method and analysis.

Researching applied impact of noise, Persinger, Tiller, and Koren (1999) investigated the impact that noise had on fatigue. Although utilizing a small sample size, they were able to demonstrate, at a relatively low decibel range (60-65dB), that noise

from a common ventilation system has a large negative influence on fatigue (i.e., 30% of variance accounted for). It is quite telling of the power of noise-related stress that researchers were able to show this impact in an applied setting where unwanted sounds can be quite common (i.e., college lecture hall; Persinger et al., 1999). Although research has demonstrated that noise influences performance (e.g., Hygge & Knez, 2001), and the authors discuss the implications of fatigue on attention (and subsequently performance), only subjective ratings of fatigue were used as evidence of noise impacts (Persinger et al., 1999).

Kjellberg, Ljung, and Hallman, (2008) utilized objective dependent measures to investigate the impact noise had on performance. Looking specifically at performance on a word recall task, they found that background noise (played at 64dB) can impact the quantity of words recalled. The impact was most strongly associated with the recent segment of the recalled list (i.e., a recency effect). Researchers also found that those in the noise condition attempted to answer faster than those not exposed to background noise. These findings demonstrate a clear impact of a common noise occurrence (i.e., background noise), on meaningful objective measures (word recall), at realistic sound levels (64 dB is within the range of conversational speech or the level of typical office noise).

Investigating noise along with other environmental stressors (i.e., heat and light), Hygge and Knez (2001) found that not only does noise impact performance, it also influences affect. Similar to Kjellberg et al.'s (2008) findings, Hygge and Knez (2001) reported that increased task speed came at the expense of increased errors under a moderate-level (54dB) noise condition. They also reported that negative affect was higher

in the noise condition, as measured by the higher recall of emotionally toned words. It should be noted that the impact of noise was highest in the presence of other environmental stressors (e.g., heat), allowing one to see the complex interaction of multiple stressors (Hygge & Knez, 2001). Following up on this investigation, the same researchers tested to see what impact light (i.e., warm versus cold light) and noise would have on long-term memory recall and affect. Although no interaction was found between the two stressors, noise independently impacted word recall after a 130-minute break (Knez & Hygge, 2002). Once again, affect was impacted, as researchers reported an increase in ratings of unpleasantness under noise conditions (Knez & Hygge, 2002).

Specifically focusing on affect and mood in the presence of noise, Aniansson, Pettersson, and Peterson (1983) found that noise impacted two dimensions related to mood. Using the Mood Adjective Checklist and ratings of annoyance during four daily activities (watching a film, group conversation, listening to speech, and reading), researchers discovered that traffic noise played at 55dB had a significant impact on two out of three mood dimensions related to feelings. That is, on the dimension of activation-deactivation (e.g., feeling active or drowsy) and pleasant-unpleasant (e.g., feeling happy or sad), worse ratings were seen in the noise condition (Aniansson et al., 1983). Annoyance, measured independently of mood, also increased under the traffic noise condition.

Although much of the research does suggest that noise impacts human fatigue, mental performance, and affect, findings are not always precise. For example, Gawron (1984) used a high and low noise condition—85dB and 45dB, respectively—to measure the impact of noise on performance and affect. Although the noise in this investigation

exceeded the level seen in the previously cited literature, the researcher found affect was altered by high-level noise (Gawron, 1984). However, through two investigations using performance measures that included mathematics problems, reading comprehension, and vocabulary, the researcher could not find evidence of a noise-performance relationship. At the same time, the researcher was able to clearly demonstrate that noise worsens environmental comfort and noise ratings on scales that had an affective dimension to them (Gawron, 1984). These outcomes suggest that the aftereffects of noise on performance may be independent of affect. Although contrary to somewhat common research trends (see Robinson, 2000), such a suggestion implies there is a complex interplay between noise and human dimensions.

Attempts to further clarify the connection between noise and human factors have led to the development of specific research paradigms to more clearly define the operation of noise in our daily functioning. The Irrelevant Speech Effect has been one of the more heavily cited reasons for the deleterious effects of sound and is often the paradigm within which researchers operate. The Irrelevant Speech (or Sound) Effect refers to the negative impact that is seen in memory recall tasks when a human voice (or external noise) is present in a given environment. Initially posited by Colle and Welsh (1976), evidence for the Irrelevant Speech Effect has since been demonstrated in worksites (Banbury & Berry, 2005), school-type settings (Knez & Hygge, 2002), and under controlled lab settings (Oswald, Tremblay, & Jones, 2000). Generally speaking, the irrelevant speech (or irrelevant *sound*; Bell & Bouchner, 2007) is a type of noise that impacts, for better or for worse, cognitive performance. Although researchers have tended to focus on short-term memory performance tasks, there has been some research

to suggest that long-term memory tasks, as well as non-memory based factors (e.g., Ellermeier & Zimmer, 1997; Knez & Hygge; Oswald et al., 2007) fit within the irrelevant speech/sound paradigm. Additionally, Jones and Macken (1993), suggests that human responses to irrelevant speech can occur regardless of the meaning and level of the noise.

Individual Differences in Response to Noise

Three examples relevant to the current topic demonstrate that irrelevant speech influences concentration (Banbury & Berry, 2005), understanding the meaning of words (Oswald et al., 2000), and distraction and recall (Bell & Buchner, 2007). Bell and Buchner (2007) also provide evidence to support the role of individual differences. In a field study conducted with office workers, Banbury and Berry (2005) found that the Irrelevant Sound Effect led to high rates of reported concentration impairment, with 99% of the sample reporting they felt interrupted by office noise and 57% stating that ‘major deterioration’ of their concentration occurred. The relevance of this particular investigation lies in the realistic noise the researchers tested (e.g., telephones ringing, printers, keyboards, and human voices) and the fact that these noises were tested as part of the ambient (i.e., background) environment. The authors did not find any evidence of habituation (i.e., reduced effects of the noise over time), which suggests that their findings may have implications far beyond the office environment in which their study occurred. Not to be able to acclimatize to noise suggests that with the right person-environment circumstances, seemingly mundane sounds will have an opportunity to impact human behavior. For example, when investigating serial recall with irrelevant sounds, factors unique to the person (i.e., participants’ age) were *the* main predictors of performance differences under the sound condition (Bell & Buchner, 2007). Although

both young and old performed poorly under the noise condition, older individuals performed significantly worse when compared to young participants.

Beyond age, several individual differences interact with noise, including locus of control, intro/extraversion, and noise sensitivity (i.e., the degree to which one emotionally responds to noise in the immediate area). Job (1988) reviewed the results of noise exposure and surveys of social reaction to the noise, and found that 20% or less of the variation in individual reaction is accounted for by noise exposure. Job (1988) stated that noise sensitivity accounts for more variation in reaction to the noise than does the noise exposure itself.

Weinstein (1978) examined the relationship between noise sensitivity and ability to adapt to noise over a longer period in a group of college students. The author found that noise-sensitive students were lower in scholastic ability, perceived themselves as less secure in social interactions (i.e., were introverted), and had a greater desire for privacy, when compared to their less noise-sensitive peers. This suggests that in a museum setting, visitors who are noise-sensitive may also be more likely to seek exhibits in which solitude and privacy are assumed (e.g., an art gallery). In the same study, Weinstein (1978) used correlations with the Common Annoyance scales to demonstrate that those who were bothered by noise were also more likely to be bothered by a wide variety of nuisances.

In addition to noise sensitivity, locus of control can also affect one's interaction with noise (Starnes & Loeb, 2001). Rotter (1966) developed the locus of control concept, describing individuals who believe they have control over their own life outcomes as having an internal locus of control and those individuals who believe their success and

failures are attributed to outside forces (i.e., other people, God, luck, fate) as having an external locus of control. Individuals with internal loci of control tend to demonstrate better cognitive functioning than individuals with external loci of control (Lefcourt & Wine, 1969; Prociuk & Breen, 1977).

It is believed that the difference in cognitive functioning in externals versus internals can be explained by the organizational strategies used by individuals in their efforts to retain and recall information (Starnes & Loeb, 2001). Individuals who use a semantic approach to organizing information retain information better than those who rely upon sensory and perceptual cues (Starnes & Loeb, 2001). Internals use higher-level semantic organizational strategies while externals use lower-level perceptual strategies, thus explaining the difference in cognitive functioning.

Mental performance in noise is affected not only by locus of control, but also by the personality trait of intro-extraversion (Slepcevic & Jakovljevic, 2001). When given a cognitive task (e.g., solving an arithmetic problem), subjects who were extraverted, as revealed by the Eysenck Personality Questionnaire, performed significantly faster in a noise condition compared to a quiet condition (Slepcevic & Jakovljevic, 2001). Additionally, Slepcevic and Jakovljevic found that concentration problems and fatigue were more pronounced in the noise condition, but only among introverted subjects. In the same study, extraverts were also less annoyed by the noise, when compared to introverts. This is congruent with Eysenck's (1967) statement that extraverts perform better in environments with higher levels of stimulation.

Individual Difference Measures Related to Museum Visitation Outcomes

There are other trait measures emerging that are specifically related to museum visitor outcomes. Need for Cognition (NC) and Motivation for Sensory Pleasure (MSP) have been shown to be uniquely related to the visitor experience. Need for Cognition is an established personality construct related to interest in and enjoyment of cognitive endeavors and higher rates of intellectual understanding (Cacioppo, Petty, Fienstein, & Jarvis, 1996). Visitors who score high on NC prefer greater amounts of information included in media presentations (Eisenberger et al., 2010) and tend to be more satisfied with their museum experience (Yalowitz, 2002).

Slightly related to NC, Motivation for Sensory Pleasure is an emerging personality construct associated with a person's disposition to seek out sensory-rich experiences (Eisenberger et al., 2010). Those scoring high on MSP are more likely to remember details specific to the sensory dimensions of a particular museum exhibit (e.g., smell, texture, sound). High MSP individuals have higher dwell times, report more enjoyment with exhibits, and are also more likely to recommend the exhibit (Eisenberger et al., 2010). In regards to the operation of MSP and the impact of noise, recent research suggests that MSP moderates the relationship between noise prevalence and memory scores (Benfield, Bell, Troup, Soderstrom, 2010b). Researchers found that those scoring low on MSP had lower memory scores as noise increased whereas high MSP individuals were not impacted by the noise (Benfield et al., 2010b). Both NC and MSP are unique from other traits in the current investigation in that they have been tested with museum populations and have been shown to relate to the visitor's actual experience and not just to factors associated with the experience.

Effects of Noise vs. Music

Furnham and Bradley (1997) examined the distracting effects of pop music on introverts' and extraverts' performance on cognitive tasks, and found that the introvert group performed worse on immediate recall in a memory test when music was played. The issue of music's effects on performance is of interest, as applied psychologists wish to examine how productivity is affected by playing music at the workplace, and how music affects attention and processing when individuals are completing specific tasks (Furnham & Bradley, 1997).

Moving beyond individual differences and reviewing the literature that followed Furnham and Bradley's (1997) work, researchers have specifically focused on the impact of music on everyday functioning (Cassidy & Macdonald, 2007; Devlin & Arneill, 2003; Furnham & Strbac, 2002). Interested in distinguishing noise from music, Cassidy and MacDonald (2007) found that under certain conditions, background music and background noise have a similar impact on task performance. Although this runs contrary to the view that music can be restorative (Yang & Kang, 2005), there were no significant differences between the noise and music groups in that they both performed significantly worse than those in the silent conditions (Cassidy & MacDonald, 2007). In line with findings previously highlighted, introverts performed worse on a Stroop task, which involves the matching of written color names to a corresponding color and is designed to measure different facets of cognition. Contrary to previous findings, for both noise and music, extraverts demonstrated lower immediate recall, free recall, and delayed recall. These findings provide mixed support for the earlier research demonstrating similarly poor performance for music and noise conditions, especially with introverts (Furnham &

Strbac, 2002). Considering these findings, Cassidy and MacDonald (2007; p. 533) suggest that researchers should consider “environmental, psychological, and social factors, which may be inextricably linked.” This view is somewhat sophisticated in that it recognizes that the impact of sound goes beyond the influence of any one factor (e.g., sound type, personality, type of impact), and that comprehensive approaches should be considered. In many ways this links back to some of the earlier discussed conceptualizations and categorizations of stressors (e.g., Baum et al., 1981).

Viewing sound research in this comprehensive light, one begins to wonder what other complex influences sound can have. When considering unique applied environments (e.g., hospitals) *and* factors beyond those of fatigue, performance, and affect, other important findings emerge from the literature. For example, in a review of health care settings, Devlin and Arneill (2003) discussed the role of the environment in the patient healing process. The authors provided a comprehensive review of several common components of health care environments, such as highlighting the impact of patient-centered care and the built environment (Devlin & Arneill, 2003). They also reviewed conditions of the ambient environment, specifically the impact of noise and music. In regards to noise, Devlin and Arniell (2003) point out that the level of noise (>60dB), type of noise, and amount of different noises, can all impact factors that are important to proper health care (e.g., heal time, staff and patient stress levels, sleep patterns, and identification of emergency signals).

Contrary to the lack of differences found between noise and music and negative impacts (Furnham & Strbac, 2002), Devlin and Arniell (2003) report that music can actually lower anxiety, as measured by heart and respiratory rate, when compared to a no

music condition. The authors go on to discuss the disruption ambient factors can have on feelings of restoration that are in short supply in most health care environments (Devlin & Arniell, 2003). Their findings demonstrate that the presence of sound may not always act as a stressor. In this case, some sounds actually allowed some restoration to take place (Devlin & Arniell, 2003).

Museums and Parks as Restorative Settings

As officially defined by Kaplan and Talbot (1983), restorative environments all share common characteristics. First, a setting that is deemed restorative most likely contains a sense of “being away,” or is separate from one’s day-to-day experience, concerns, and responsibilities. This factor very much involves a sense of escape that a particular environment provides. The second common factor, “coherence” (also termed “extent” in Kaplan’s later work; e.g., Kaplan, Bardwell, & Slakter, 1993), suggests the environment allows an individual to “get lost” in terms of time and place. The setting also implies that a degree of exploration can, and should, occur (Kaplan et al., 1993; Kaplan & Talbot, 1983). Third, restorative environments contain a level of “fascination” for the individual. The visitor to a particular setting should find it interesting and engaging, while at the same time the experience allows visitors to use less directed attention and mental effort to achieve their goals (Kaplan et al., 1993). Finally, the restorative environment is “compatible” with the motivations and desires of the individual. Any unwarranted or unwanted disruptions (e.g., unwanted or unnecessary noise) can interfere with motivation and limit the degree to which this “compatibility” factor operates. Compatibility highlights the need and importance of the fit between one’s environmental expectations and what the environment actually provides.

Much of the literature stemming from this early research discusses the operation of these four factors within an attention restoration framework (Kaplan & Kaplan, 1989). Attention Restoration Theory (ART) suggests that attention focused toward a specific topic leads to fatigue; and to recover from this fatigue, an environment that contains the aforementioned factors should be sought out to lessen the fatigue. Research demonstrates that restorative environments, through attention restoration, have numerous positive impacts, including increased attentional capacity (Berto, 2005), faster decline in blood pressure, and increased positive affect (Hartig, Evans, Jamner, Davis, & Garling, 2003), increased positive emotions (Hartig, Book, Garvill, Olsson, & Garling, 1996), increased emotional well-being (e.g., relaxation, calmness, comfortableness; Korpela, Hartig, Kaiser, & Fuhrer, 2001), and decreased arousal and aggression (Bell et al., 2001).

Although natural settings (or settings with natural elements; Ulrich, 1984) seem to perform better in regards to restoration outcomes, built environments are shown to have restoration potential, as well (Kaplan et al., 1993; Scopelliti & Giuliani, 2004). For example, Kaplan et al. (1993) demonstrated that visitors to museums can experience a sense of restoration. Although the researchers identified some limitations, Kaplan et al.'s (1993) investigation remains a strong extension of the restoration literature and led to the museum being seen as a potential restorative environment (Hein, 1998).

The social, cognitive, and behavioral processes behind restoration and education in varied environments, as well as the role of visitors' expectations, have been a major catalyst for research initiatives established by the National Park Service, the U.S. Forest Service, and numerous other research groups and academic labs. Although not always *directly* related to restoration, the research that has grown out of these initiatives is quite

rigorous, covering topics ranging from air pollution, park over-crowding, and trail use (Manning & Freimund, 1999), to human valuation of park policies (Jakubowski, Bell, Brown, & Daniel, in prep). Additionally, researchers have attempted to cover a variety of real-world settings, providing this field with a distinct applied feel. Research into human-environment interaction has been conducted in natural environments (e.g., national, state, and local parks and recreation areas), virtual environments (e.g., websites, gaming consoles) and built environments (e.g., hospitals, dormitories, zoos, and museums).

Although prior research has a strong foundation, there is still a need for more interaction between recreation and psychological research. Mace, Bell, and Loomis (2004), call for a larger incorporation of social-environmental psychology into park and recreation research. Following this, it seems recreation researchers are becoming more savvy to the multi-dimensional nature of research and the role psychologists play. For example, acoustic specialists for the National Park Service (NPS), in conjunction with environmental psychologists at Colorado State University (CSU), have begun a comprehensive investigation into the impact noise has on human physiology, human performance, and ratings of scenic beauty. It is through this collaboration that common theoretical ground begins to emerge (e.g., Benfield, Bell, Troup, & Soderstrom, 2010b).

Implications for the Current Project: Restoration Disruption, Person-Environment Fit, and Congruence

In light of Devlin and Arniell's (2003) findings that music can have favorable effects in health settings, it can be argued that sound can either act as a stressor, leading to negative outcomes (e.g., lower performance, increased stress), or act positively as a catalyst for restoration and other desired outcomes. Perhaps outcomes are decided, in

part, by whether individuals perceive restorative elements (e.g., a natural vista) in a given context and the degree to which they feel ambient sounds are adding or detracting from their restorative goals. This view suggests that people are aware when a particular sound does not match (or interferes with) other factors that are related to restoration (e.g., fascination, escape, serenity). For example, hearing a bird song when viewing a scenic vista is not completely unexpected nor does the sound interfere with the expectations of the setting. However, hearing human voices or aircraft over-flights in this setting would be considered unexpected and even interfering with the progression of restorative feelings. This perspective fits well with Benfield et al.'s (2010) finding that the presence of human caused sounds lowered ratings of serenity and overall scenic beauty.

Another explanation for the impact of sound that is related to restoration involves looking beyond the sound itself. Research suggests that the impact of sounds (and other environmental stressors) may be more about the degree to which the sound is expected, and matches, a specific environment. Environmental psychologists employ two constructs relevant to this matching notion. Some investigators suggest that much of the research conducted on environmental stressors can best be understood and explained by looking at the person-environment fit (*P-E fit*), or the matching between the person (including his or her unique characteristics, perceptions, assumptions and experiences) and the environment (Furnham & Walsh, 1991; Holland, 1973). Individual difference measures such as locus of control, intro/extraversion, noise sensitivity, NC, and MSP, would be relevant to P-E fit. The second matching construct is *congruence*, or the degree to which components of a setting (including sounds) are consistent with the behaviors and experiences its designers and managers intend to support. Generally speaking, lack

of congruence leads to negative outcomes, such as increased frustration (Sutherland, Fogarty, & Pithers, 1995) and heightened strain (Pithers & Soden, 1999), whereas congruence leads to positive outcomes including increased well-being (Lachterman & Meir, 2004). Evidence for congruence theories has been found in diverse contexts, ranging from the workplace (Lachterman & Meir, 2004; Sutherland et al., 1995), to educational settings (Pithers & Soden, 1999). Focusing noise-stressor research within a model of person-environment fit and congruence, one can see that the impact of noise on restoration can become more about how well an individual's expectations and presuppositions fit within a given environmental context (and not just about the sound itself), and how well the sounds in the setting are congruent with the intended outcomes.

Recasting ambient stressor research within a framework of restoration (and similarly, P-E fit and congruence), one begins to see that the factors at play in the noise literature, in part, revolve around the disruption that unwarranted or unexpected noise can have on restoration. As previously discussed, restoration research has shown a direct link between experiencing nature and positive outcomes (Kaplan & Talbot, 1983; Ulrich, 1984). Research stemming from this early work has led to breakthroughs in environmental stress research, and has altered how environmental psychologists view the impact of stressors in everyday functioning. Furthermore, citing the Kaplans' (and Ulrich's) early work, researchers began to focus more and more on applied settings that are perceived as settings for restoration (e.g., parks, museums, gardens, and certain public spaces). In a demonstration of the growth of restoration research, Hartig, Evans, Jamner, Davis, and Garling (2003) compared urban environments to natural recreation areas and found that those exposed to nature had steeper declines of blood pressure, higher rates of

happiness, and better performance on visual-spatial tasks. It should be noted that Hartig et al.'s (2003) investigation combined a “view from the window” phase (as seen in Ulrich, 1984), with an outdoor recreation setting phase (i.e., walking on a nature trail) and found a restoration effect in both settings. Van den Berg, Koole, and Van der Wulp (2003) reported similar findings in regards to the relationship between viewing nature and mood and concentration.

Highlighting concepts related to restoration and noise impacts specifically, Yang and Kang (2005) examined specific sound environments, or soundscapes, at 14 different sites within five different countries. Evaluating guests in a mix of residential, tourist, commercial, and cultural public spaces, they discovered that in the presence of specific sounds, higher ratings of comfort are seen (Yang & Kang, 2005). Related specifically to restoration, natural water sounds led to higher ratings of comfort among visitors to the various sites (Yang & Kang, 2005). The crux of the restoration findings related to the impacts of noise is that noise has the *potential* to interrupt *any* given restorative environment and interfere with any given restorative activity (Wallenius, 2004). In fact, Wallenius (2004) stated that, “annoyance and activity interference may be a more suitable measure of noise stress than the technical measures of noise level” (p. 174).

It is within the framework of restoration-interruption that research on recreation settings finds its place in the current soundscape topic. Since recreation settings are seen as places of restoration (Hull & Michael, 1995; Scopelliti & Giuliani, 2004), the influence of noise within these specific environments needs careful consideration. This consideration is warranted due to the fact that a majority of noise impacts within recreation settings can ultimately interact with restoration activities (e.g., napping, bird

watching) or personal factors (i.e., perception, affect, goal attainment) that limit the ability to be restored in a given context. Mace, Bell, and Loomis (1999) investigated the impact helicopter noise had on park landscape assessment. Comparing a natural sound condition to a helicopter noise condition, helicopter noise was found to negatively impact several dimensions that are arguably related to restoration (Mace et al., 1999).

Participants exposed to helicopter sounds showed poorer ratings on a series of landscape assessment scales, when compared to the natural sound conditions, with ratings of tranquility and solitude being significantly worse in the presence of helicopter noise. Ratings of “naturalness” were also worse in the presence of helicopter noise. Considering common conceptualizations of tranquility and solitude, and the fact that there were lower ratings of naturalness in the noise condition, the relevance of noise impacts in recreation settings and on restoration was demonstrated further (Mace et al., 1999). Pair these findings with a survey of actual recreation users (i.e., visitors to wilderness areas in Wyoming) that reported that their tranquility and solitude were negatively impacted by aircraft overflights (Tarrant, Haas, & Manfredo, 1995), and a more comprehensive view of potential noise impacts emerges.

Although the potential for restoration disruption to occur because of noise is ever-present in recreation settings, uncontrollable noise can also lead to visitors remembering higher rates of negative components within the environment (Willner & Neiva, 1986). Female volunteers under an uncontrollable noise condition remembered higher rates of negative trait words. Willner and Neiva’s (1986) findings may seem somewhat benign in light of all of the other impacts discussed; however, demonstrating that noise can make us emphasize the negative leads one to consider the applied impacts on subsequent

visitation, the perception of the setting, and natural valuation (i.e., the value that is placed on the environment or specific factors within the environment). Large recreation areas may be able to overcome this issue due to the saliency of their product; however, museums and other smaller recreation settings may not provide the resources to overcome this as quickly.

Considering the literature in recreation settings and some of the common characteristics these settings share with museums (e.g., restoration; Hoge, 2003; Kaplan et al., 1993), it is quite surprising there is so little research that directly analyzes soundscapes in museums. There are plenty of sources that lay out the framework of “the visitor experience” (Falk & Dierking, 2000; Henry, 2000; Loomis, 1987). However, these sources rarely mention noise alongside other potential stressors. Authors cite lighting levels, crowding, and temperature as important factors in the museum environment, but noise is rarely mentioned (Falk & Dierking, 2000). This dearth of soundscape research in museums is made more noticeable when one considers the museum as an educational setting, and then finds the volumes of research published on the impact of noise on learning. Perhaps those who research the visitor experience leave noise abatement and the impact of unwanted sound to exhibit designers, building engineers, and operation managers. Yet, this does not seem to be the case, either. In several of the more popular museum planning texts, there is little mention of the museum soundscape beyond a simple one-statement acknowledgement (e.g., Cassar, 1995; George & Leo, 2004; Lord & Lord, 1999).

Highlighting this obvious lack of direct and systematic evaluation is not to suggest that there are no adequate museum environment models. There are, in fact,

several models that consider the concepts of restoration, satisfaction, ambient environment, visitor affect, pleasure, perceived quality, and expectations (Jeong & Lee, 2006; Packer, 2008). Others directly mention the impact that cognitive and emotional factors have on visitors (de Rojas & Camarero, 2008). Even though these models do provide a somewhat adequate combination of visitor factors, the closest that any of these get to mentioning noise (or sound) directly is when Jeong and Lee (2006) combined a single factor of “noise” with 13 other ambient factors in a path analysis. However, no experimental manipulation of sound occurred and the sound item was absorbed into 13 other factors during their analysis (see Jeong & Lee, 2006).

The Current Project

The current project investigates the impact of soundscapes in a museum environment and whether these sounds contribute to a stressful or restorative experience. Under scrutiny is whether sound type and sound level impact visitor variables, such as exhibit satisfaction, perceived knowledge gain, dwell time (i.e., time spent in a predetermined space), and engagement with specific exhibit elements. By combining findings from the Irrelevant Sound Effect, environmental stressor research, individual differences literature, restorative environment research, and recreation research, a comprehensive approach to the impact of sounds in a museum was taken.

The current project assessed the impact of sound on visitor outcomes in two different museum spaces. Sounds were randomly piped into both an art exhibit and an interactive natural history exhibit within the museum. The sounds included a human voices soundtrack, natural sounds (i.e., birdsong), and a classical instrumental music soundtrack and were played at a low or high decibel level; a control condition had no

soundtrack played. Dependent measures included visitors' ratings of the exhibit (i.e., satisfaction and restoration), perceived knowledge gain, dwell time, and engagement within exhibit. Several personality traits were measured and deployed as covariates to determine whether certain personality constructs interacted with the independent variables (piped-in sounds) to account for more of the variance in the dependent measures. Dwell time and exhibit engagement were recorded using unobtrusive observation. The two settings in the current investigation (i.e., art and an interactive natural history exhibit) allowed the researcher to test how visitors reacted to the type of noise being played and how different visitor expectations, inherent in each exhibit, influenced these reactions. Generally speaking, art exhibits are associated with quietness and low extraneous noises. If extraneous sounds are heard, visitors often expect sounds that are congruent with the context (e.g., classical music in art exhibits). For interactive nature exhibits, especially those geared towards families, human voices may be more expected. Therefore, in the current investigation, an expectancy situation was set up between the visitor and the exhibit that may ultimately have influenced how visitors scored on different outcome measures depending on how congruent the sounds were with expectations.

Hypotheses

Predictions for Sounds Played in the Art Exhibit

H1: Visitors exposed to a human voices soundtrack should show significantly higher rates of negative visitor outcomes and significantly lower dwell times when compared to visitors exposed to a classical soundtrack or a natural sounds soundtrack.

H2: Overall, visitors exposed to a classical music soundtrack at a lower decibel level should show the highest rates of positive outcomes and highest dwell times.

Predictions for Sounds Played in the Interactive Natural History Exhibit

H3: Visitors exposed to a human voices soundtrack should show significantly higher rates of negative visitor outcomes and significantly lower dwell times when compared to visitors exposed to a classical music soundtrack *or* natural soundtrack.

H4: Overall, visitors hearing the natural sounds soundtrack should show the highest rates of positive outcomes and highest dwell times.

Hypotheses Independent of Exhibit

H5: In both exhibits, visitors exposed to the human voices soundtrack at a higher decibel level should demonstrate the highest rates of negative visitor outcomes and lowest dwell time when compared to their lower decibel level counterparts in other sound conditions.

H6: In both exhibits, visitors in the control (i.e., no sound played) condition should show higher positive outcomes and dwell times when compared to the human voices soundtrack and lower rates of positive outcomes and lower dwell times when compared to visitors exposed to a natural sounds soundtrack or classical music soundtrack.

H7: Visitors with an external LOC, introverted tendencies, and more sensitivity to noise should see high rates of negative visitor outcomes in all conditions, with the highest rates seen in human voice soundtrack conditions. This trend should be seen for both exhibit spaces.

H8: Visitors with an internal LOC, extraverted personality and low noise sensitivity should see lower rates of negative visitor outcomes in all conditions, with the lowest rates occurring in the natural sounds and classical music soundtrack conditions. This trend should be seen for both exhibit spaces.

There were no set predictions for the relationship between the classical music soundtrack and natural sounds soundtrack. The literature suggests both types of sounds may lead to positive outcomes. It is not clear which sound may be more beneficial to the visitor. Although a natural sounds soundtrack could make the environment feel restorative and immersive, a classical music soundtrack may be what visitors expect to hear (or are used to hearing) in exhibit spaces, ultimately leading to better outcomes. In addition, there was no hypothesized influence for the Motivation for Sensory Pleasure and Need for Cognition personality constructs. Although both of these constructs show promise for use within the museum settings, there was not enough available empirical evidence to predict the strength or directionality of the relationships.

CHAPTER 2

METHOD

Research Space and Pilot Study

The Wildlife Experience (TWE) is located in Parker, Colorado, and is a cross between a natural history museum and an art museum, with a wildlife conservation focus. The institution has an annual visitation of nearly 200,000 and, due to its age, location, and recent 25,000 sq.ft. expansion, a large increase in first-time visitors is occurring (visitation has grown 80% since the beginning of 2008, 24% in 2009 alone).

The researcher utilized two exhibit spaces within TWE for the current studies. ‘*Some Like it Hot, Cold, Wet, Dry*’ is a permanent art exhibit and ‘*CritterCam*’ is a temporary natural history exhibit (both exhibit spaces are approximately 5000 sq.ft.). Both galleries that house these exhibits contain a sound system that is operated through a central control panel. The system in each gallery can be set to run independently or in conjunction. Each system allows for basic sound level adjustment via wall mounted volume controls located within each exhibit.

‘*Some Like it Hot Cold, Wet, Dry*’ highlights animal adaptations and habitats grouped into four different climate types. Paintings (33 total), taxidermy (12 total), and sculptures (11 total) mix to form four distinct (and physically separated) climate quadrants (i.e., hot, cold, wet, dry). All quadrants contain larger interpretive panels (12 total), smaller item labels and interactive stations (4 total), providing diverse activities

(including recognition, matching, and previous knowledge tasks). The unique components of this exhibit that make it a natural “next-step” in regards to moving soundscape research into museum settings, is the fact that it is designed to provide visitors with the opportunity to see animals (taxidermy specimens) in their natural habitats, alongside artistic representations of these animals. This natural representation is not markedly different from some of the opportunities outdoor recreation or a park visitor center provides.

The borders defining this exhibit are made of 12-foot high partition-styled walls, colored to correspond to each climate. These partition walls leave an additional 4ft of space between the top of the partition and ceiling. Behind these temporary walls exist an emergency exit, classroom space, and storage (all out of the view of the visitor). The exhibit design allows for observation and tracking of individual visitors. Typical visitors are adults who talk little or quietly with each other or who explain the exhibit to children.

‘*CritterCam*’ is an interactive exhibit designed for families. Through the 10 interactive “pods” within the exhibit, the content is designed to educate visitors about the hidden life of mammals through interactive visual displays. Although there are no live animals, the content is scientifically accurate and educationally relevant to a wide age range. The exhibit is self-enclosed with a clear entrance and exit. Due to the design of the exhibit (which lacks a clear line of sight for approximately 30% of the exhibit), direct observation is difficult. Visitors to the Natural History Exhibit (i.e., ‘*CritterCam*’) have a much different expectation than visitors to the Art Exhibit. The Wildlife Experience purposefully designed their fine art galleries to be completely separate from the more interactive, child-friendly, natural history exhibits. Although 83% of all visitors travel

through the non-art exhibit spaces within the museum, there are different models of behavior exhibited by visitors depending on their location in the museum. Typical visitors to the Natural History Exhibit are adults with children, with both exclaiming excitement and talking loud enough to be heard over other family groups nearby. By design, the Natural History Exhibit lends itself to higher levels of visitor activation, play, and social engagement. In the moderately sized space, there are higher levels of noise and more tolerance of unruly behavior. For example, for the same visitor behavior (e.g., loud children), staff at TWE receive proportionally more complaints from the art exhibits than the interactive exhibit spaces. It is with these differences in visitor tolerance and expectations that a different impact of the same noise may occur.

Due to the complex nature of sound and its impact on humans and the overall length of the planned intercept survey, the researcher conducted a pilot project to ensure that the intercept survey would receive an appropriate completion rate and that sounds being tested were appropriate to average museum visitors and exhibit professionals. Since the strength of the current project is in its applied approach, it was of the utmost importance that the soundscapes created remained relevant to museum and other cultural environments. Prior to the main study, the researcher played a pre-selected series of soundtracks for visitors passing through the aforementioned Art Exhibit and another natural history exhibit called “*Amazing Butterflies*.” *Amazing Butterflies* was a temporary exhibit installed *prior* to *CritterCam* that had many of the same elements seen in the *CritterCam* test environment. For example, *Amazing Butterflies* was built in the same physical space, contained similar interactives, and similar general education outcomes. In addition, *Amazing Butterflies* and *CritterCam* were built for identical

demographics and used identical exhibit build teams. This pilot testing allowed the researcher to determine the sound and decibel level that best fit within each exhibit environment.

The Pilot was qualitative in nature. A total of 28 visitors were intercepted leaving both the Art Exhibit and Amazing Butterflies Exhibit (52 visitors, total). Upon exiting the exhibits, visitors were asked two questions: (1) whether they noticed the sound, and (2) whether they found the sounds obtrusive to their visit. Visitors were also given a Pre-Pilot intercept survey (see *Materials* section below for further details), along with several personality scales. Since the pilot was aimed at getting an approximation of baseline decibel levels and the best sounds to use, decibel level was not altered throughout the Pilot. For the Natural Sound, three tracks were played (with four visitors intercepted per track; 12 visitors, total) from albums within the *Wild Soundscape Series* (see *Soundtrack* section below for further description of final selection). For the classical music soundtrack, three tracks were chosen from TWE's music library (with four visitors intercepted per track; 12 visitors, total). For the human voices, a single soundtrack was played with four visitors intercepted.

The comments received demonstrated little variability in visitors' perception of the sound and visitors' opinion of the obtrusiveness of the sound. Comments tended to be generic and not immediately offering clear direction. However, informal follow-up conversations with several visitors did allow the researcher to narrow down the selection of tracks, as several visitors went back into the exhibit upon being asked the questions above.

After the best-fitting tracks were determined based on visitor feedback, professional raters (i.e., art curator/manager and exhibit designers) within the museum decided which sounds “matched” the exhibit. Professionals listened to the tracks within a TWE office and then within the two exhibit spaces. The investigator ultimately chose the sound that fit well for *both* visitors and TWE professionals. A brief test was also conducted after *CritterCam* was installed.

Results from the Pilot Study suggested that sound levels needed to be slightly adjusted for each exhibit space. Overall, piped-in sound was played louder for ‘*CritterCam*’ (referred to as the “Natural History Exhibit” throughout the remainder of the paper) versus ‘*Some Like it Hot, Cold, Wet, Dry*’ (referred to as the “Art Exhibit” throughout the remainder of the paper). In addition, there were slight adjustments made to each individual soundtrack. This was needed as sounds that originated from different media (e.g., compact disk versus free-source internet sites) tended to play back at different volumes and therefore, needed to be calibrated against in-exhibit decibel readings once they were chosen to be included in the study. A-weighted decibel (dB(A)) levels were the sole variable used for calibration.

In addition to receiving useful sound information, the Pilot Study also allowed for a pre-testing of the intercept survey. This proved useful for the survey layout and for specific questions in the survey. For example, items relating to political and government themes were causing too much attrition, and needed to be removed from the Locus of Control scale (see *Materials* section, below). Finally, the Pilot Study allowed for investigators to become more familiar with the sound equipment and to choose the best

placement for the equipment (see *Materials* section below for sound and equipment details).

Participants

In the Art Exhibit, 430 visitors were successfully selected and tracked. Each of the 7 soundtrack conditions (see below) contained at least 60 visitors. The average age of these visitors was 42 ($SD = 14.5$), and 57 percent of visitors were female. Visitors tended to be in groups that contained between 3 and 4 people ($M = 3.44$). The response rate for intercepted visitors was 87%, with 376 visitors at least starting the survey. However, by the time visitors reached the first set of self-report outcome items, attrition rates were at 39%, with 168 visitors opting not to continue past basic demographic items. Previous demographic testing within this exhibit confirms that the current sample is representative of samples typically seen.

For the Natural History Exhibit, 433 visitors were selected and tracked. Each of the 7 soundtrack conditions contained at least 60 visitors. The average age of these visitors was 38 ($SD = 11.27$), and 75 percent of visitors were female. Visitors tended to be in groups that contained between 3 and 4 people ($M = 3.76$). The response rate for intercepted visitors was 81%, with 350 visitors at least starting the survey. Attrition rates were markedly higher for Natural History Exhibit with 202 visitors (47%) opting not to continue. In addition, the Natural History Exhibit visitors tended to skip more questions (when compared to Art Exhibit visitors) on their way to “completing” the survey. The difference between the two exhibits was most likely due to the Natural History Exhibit visitors having less time to spend due to younger children. This difference may also reflect the types of visitors that go an art exhibit versus a natural history exhibit.

Although response rates were discouraging, previous demographic testing within the temporary natural history exhibit space confirms that the current sample is somewhat representative of samples typically seen in this space.

Design

The 7 conditions in each exhibit represented a between-subjects design that examined the impact (e.g., on dwell time, satisfaction, and perceived knowledge gain) of types and decibel levels of sounds to which visitors were exposed. The sound conditions included were human voices, sounds of nature, and instrumental classical music. In Condition 1, the researcher played human voice soundtracks. The sound in this condition was meant to mimic noise filtering into the semi-open exhibit from other museum areas. For Condition 2 a natural soundtrack designed to fit with the content of the exhibit space (as determined by the Pilot Study), was played throughout the exhibit. Condition 3 contained instrumental music of the type commonly heard in art museums and other formal settings. This type of music most often fits into the category of “classical.” To test the impact that different sound levels had, Conditions 4, 5, and 6 played the same sounds as in Conditions 1, 2, and 3, but at a noticeably (i.e., 5 dB(A)) higher level that is still believable (see *Materials* below for more sound details). The investigator played all sounds over the exhibit’s sound system. Condition 7 did not contain any piped-in sounds; this condition worked as a control condition, although monitoring of ambient museum conditions occurred to ensure the condition operated as a true control.

Sound Analysis Equipment

Specialized sound recording equipment (hardware and software), on loan from the Natural Sounds Program (Fort Collins, CO), was used for the current investigation. The

Natural Sounds Program is housed within the National Park Service (NPS) and regularly uses this equipment for field studies within parks and other settings.

To collect data appropriately, several pieces of equipment had to be used in tandem. To collect the technical specifications of the soundscape (e.g., decibel level and frequency), the researcher used a Larson Davis 831. An Edirol R-09 was used to collect related audio MP3 files. The Larson Davis and Edirol both keep running files for later download and are required to be connected in tandem for proper analysis. The main reason for the interdependency of this equipment was that they both received their data from a single specialized microphone. For both exhibits, the microphone was installed at approximately 4 feet from the ground using a standard tripod. The microphone was then angled 45 degrees toward the exhibit space.

To analyze the audio data, a special software program developed by the NPS was used. The '*Acoustic Monitoring Toolbox*' allowed the researcher to convert raw audio data (i.e., binary data) to meaningful metrics and plots. This software was used for all audio-related analysis.

Soundtracks

As briefly discussed, three types of sounds were used for the current investigation. Each sound type was originally chosen for its relevance within the frameworks previously discussed (e.g., natural sounds and restoration) and the environment in which the sound was played. For all soundtracks, a smoothing algorithm was applied to the tracks in order to remove excessively high and low frequencies (and dB levels) within the track.

Human voices soundtrack. The human voices soundtrack was developed using free-source audio files from ‘*The Freesound Project*’ (see www.freesound.org). Freesound.org is a website dedicated to the sharing of sounds uploaded by Freesound members around the globe. Sounds are searchable by headings given to the sounds when various users upload files to the site. For the Human Voice soundtrack, sounds from different public (e.g., quiet city thoroughfares, museums) and recreational (e.g., parks) locations were downloaded from the Freesound website. Ultimately, three soundtracks were chosen for their simplicity (i.e., few voices per sound), and clarity (i.e., little background distortion). Once the sounds were chosen, the researcher used ‘*Audacity*’ computer software (free audio editing software; see www.audacity.com) to make the sounds more appropriate for use within the current investigation. Specifically, the researcher combined the three different soundtracks into a single audio file (or track) within the software and then removed (or minimized) excessive voices where the track became too loud (voices were also added in areas where the track became too quite). Due to the originality of this soundtrack, the smoothing algorithm was especially helpful in removing high and low frequencies. The final creation was a single audio file layered with human voices, which did, in fact, sound like ambient visitor voices within the museum environment.

Based off of the decibel level used in the Pilot Study, the researcher determined that for this soundtrack within the Art Exhibit an average A-weighted decibel level of 49 was appropriate for the low conditions, with high conditions ending up at an average of 54dB(A). For the Natural History Exhibit, low conditions ended up at an average of 60dB(A) and high was determined to be 65dB(A).

Natural soundtrack. The natural soundtrack was created from the ‘*Carolina Woods*’ album, from the *Wild Soundscape Series* (developed and distributed by the *Wild Sanctuary*; Glenn Ellen, California). The *Wild Soundscape* series was developed solely from acousticians’ recordings from remote natural areas of the globe. The museum has access to the complete series and determined that the soundscape created by *Carolina Woods* fit well with both the Art Exhibit and Natural History Exhibit. The track primarily included various birdsong sounds with intermittent breeze and other natural background music. Decibel levels were chosen based off the Pilot Study findings. Within the Art Exhibit, an average level of 50dB(A) was used for the low conditions. For the high level conditions, the soundtrack was played at an average level of 55dB(A). For the Natural History Exhibit decibel levels of 59dB(A) and 64dB(A) were chosen for the low and high conditions.

Classical music soundtrack. The classical music soundtrack was developed from the album ‘*Museum Cafés and Arts*,’ (developed by *Menus and Music Productions*; Emeryville, California). Using the *Audacity* software, the researcher first identified tracks that contained very little variation in tempo (i.e., not too fast or slow) and “mood” within the music. After the researcher identified the tracks that shared some common traits, those tracks were combined onto a single audio file. Next, the researcher applied an algorithm to the track that smoothed the frequencies and decibel levels that were noticeably too high or too low. This allowed the single track to keep its original sound while controlling for the *extreme* variations that are often found in classical music (note that to preserve the recorded sound, some natural variations were left on the track). To make the spaces between songs less abrupt, all tracks on the single file were faded in at

the beginning and faded out at the end. Spaces between tracks lasted no more than 3 seconds. Baseline levels in the Pilot Study helped determine that within the Art Exhibit, low conditions should be played at an average level of 48dB(A) and high conditions should be played at an average of 53dB(A). In the Natural History Exhibit, low conditions were played back at an average level of 61dB(A) with the high conditions being played at an average of 66dB(A).

Materials

Tracking sheet. A short Visitor Tracking Sheet (see Appendix A) allowed the investigator to record basic visitor behavior within the exhibit. It is on this sheet that the investigator recorded dwell time, whether the visitor entered the exhibit through the correct entrance, the quantity of other visitors in the exhibit, time of day, the composition of the group (e.g., number of children in the group), and other relevant variables. Specifically, the dependent observational measures analyzed from the Tracking Sheet included dwell time and engagement, the latter operationally defined as the number of kiosks/interactives engaged (see Appendix A),

Intercept survey. Based off of feedback from the Pilot Study, the researcher created a final Intercept Survey (see Appendix B for Pre-pilot Intercept and Appendix C for Final Intercept), which was administered as the visitor was leaving the exhibit. The Intercept Survey included selected demographics, noise impact, and items from the personality measures described below. To limit redundancy and time needed to complete, and to acknowledge visitor feedback, the researcher removed some items from the original personality scales mentioned as noted below. Survey scales were also standardized where appropriate.

The first component of the Intercept Survey was a one-page Demographic Sheet to assess visitors' basic demographics (e.g., age, previous TWE visits), recreation experience (e.g., visits to parks), as well as previous experience with other cultural attractions. The second component was a Noise Impact Survey to assess visitors' perceived exhibit-relevant knowledge gain, visitors' perception of the space, exhibit satisfaction, and level of distraction the visitor experienced in the exhibit.

The specific self-report measures analyzed from this portion of the survey were knowledge gain, satisfaction, and restoration. The researcher did have the option of reviewing these outcome measures in single-item form or as being comprised of multiple items. Common psychometric procedures suggest using indicators that are more than one item. However, the researcher was interested in being able to demonstrate that in an applied study with museum visitors, single items can still be valuable. The use of a single-item indicator not only drastically shortens intercept surveys (leading to less participant attrition in applied settings), but also fits with what is used in many technical reports within the fields of visitor and recreation studies (making the current project more accessible to practitioners).

Although the researcher did choose to use single-item indicators, a factor-analysis was conducted on items related to knowledge gain and satisfaction. Specifically, a Principal Component Analysis using Direct Oblimin rotation was used. Eigenvalues over 1.0 were extracted and items with an Absolute Value of less than .60 were suppressed. The forthcoming analysis was then re-run using the multiple-item indicators. The results from this single- versus multiple-item indicator comparison showed no difference in significant relationships and only slight changes in the overall effect size of the reported

relationships. This suggests that the additional items simply replicated the single-item construct that was already being measured. That is, a similar amount of variance was accounted for by the single-item indicator when compared to the multiple-item indicators. The researcher took this as evidence to support the use of single-item indicators throughout the analysis. Items relating to restoration offered a special case to this single-versus multiple-item comparison. Therefore, restoration is reported as a single item initially (in support of applied research settings and following Mace et al.'s, 1999 framework), then factor analyzed in a following section as other restoration items were determined to be highly related to a specific theoretical model in the literature.

Finally, the third component of the Intercept Survey measured individual differences in the form of five different personality measures based on five well-known scales that were shortened for this study:

Extraversion-Introversion (Gosling, Rentfrow, & Swann, 2003; see Appendix D). To measure participants' tendencies to be outgoing and social, the researcher used the extraversion subscale taken from the Ten-Item Personality Inventory (TIPI; Gosling et al., 2003). This survey utilizes a 7-point Likert scale and requires participants to rate how much a single statement ("I see myself as extraverted, enthusiastic") applies to them (1="Disagree Strongly" through 7="Agree Strongly"). Higher scores indicate that the individual is more extraverted. Lower scores indicate that the individual falls more towards the introverted end of this continuum. As previously cited (Slepcevic & Jakovljevic, 2001), intro-extraversion influences the impact of noise on human factors. Since internal reliability cannot be determined from a single-item scale, correlations with other similar measures and test-retest reliability are used to determine the strength of the

scale. Gosling et al. (2003) found that the single-item extraversion subscale correlates highly with the extraversion subscales on other well-known Big Five measures (e.g, a correlation of .87 with the Big-Five Inventory (BFI) extraversion subscale) and has a moderate test-retest reliability ($\alpha = .77$); in the current investigation scales were only administered once per participant, precluding a test-retest reliability calculation for the sample.

Noise Sensitivity-Shortened Version (Kishikawa et al., 2006; Appendix E). The researcher measured noise sensitivity using a shortened version of Weinstein's Noise Sensitivity Scale (Weinstein, 1978). This scale measures sensitivity to noise using a series of applied noise scenarios wherein participants have to indicate their level of agreement using a 1 "agree strongly" through 5 "disagree strongly" scale. To determine noise sensitivity, the researcher used summed ratings to create a noise sensitivity score. The higher the score, the more sensitive the individual is to noise. Noise sensitivity is one of the most widely cited personality factors in noise-human influence research. Although the shortened version of the Noise Sensitivity Scale does not have a reported reliability (Kishikawa et al., 2006), the original Noise Sensitivity Scale (Weinstein, 1978) has been shown to have high reliability ($\alpha = .84$; Dornic & Ekehammar, 1990). Prior to using this shortened version in the current investigation, factor loadings and variance accounted for within these loadings were examined using previous data collected by CSU's Soundscape Lab. In addition, the point of inflexion on the Scree Plot confirmed the selection of items. The Noise-Sensitivity Scale (shortened version) proved to have moderate reliability ($\alpha = .77$) in the current investigation.

Locus of Control (Rotter, 1966; see Appendix F). To measure the degree to which a given participant believes control of his or her daily life events lie within themselves or with other people or factors, the researcher administered a scale assessing locus of control (LOC). For the LOC survey, visitors are required to indicate which of a pair of statements better reflects their beliefs. An internal and external LOC statement appears in each statement pair. Although the original LOC Scale contains 26 statement pairs in all (Mirels, 1970; Rotter, 1966), the current investigation used a shortened version containing 6 statement pairs. In lieu of finding a validated shortened version of Rotter's LOC Scale, the researcher created a new version that is appropriate to the time constraints of the visitors. To create a shortened LOC scale, the researcher removed all items containing average factor loadings below .30. These loadings were taken from an investigation that evaluated the multidimensionality of Rotter's original LOC scale (see Mirels, 1970). In addition, the researcher had to remove items 2 and 7 based on results from the Pilot Study. Visitors tended to stop answering intercept question after reading these items. The researcher felt that the new 6-item scale was a good balance between predictive power, length of scale, and time to complete the scale. A LOC score is measured by summing the number of external and internal statements agreed with. If the ratio of external statements agreed with is higher, then that particular individual operates within an external LOC framework. Participants who have an internal LOC should show higher agreement on the internal statements. Research has shown that LOC is a relevant personality measure in soundscape research (Starnes & Loeb, 2001). Rotter's original scale has sufficient reliability ($\alpha = .77$; Tong & Wang, 2006). In the current investigation

the LOC scale proved to be less reliable with a borderline internal reliability score (i.e., $\alpha = .65$).

Motivation for Sensory Pleasure (Eisenberger, et al., 2010; see Appendix G).

Motivation for Sensory Pleasure (MSP) is a 15-item scale designed to assess the degree to which an individual desires to seek out sensory-rich experiences. Participants indicate their agreement on a series of statements ranging from 1 “strongly disagree” through 7 “strongly agree.” A sum of all items is used as a final score, with a higher score indicating higher MSP. To limit the time visitors spent completing the survey, the current study used a shortened version of MSP. Factor loadings and updated reliabilities were taken from a recent study that utilized these scales (Benfield et al., 2010a). The reanalysis of the shortened scale proved it to have good reliability ($\alpha = .83$). In the current investigation, the shortened scale proved to have good reliability once more ($\alpha = .86$).

Need for Cognition (Cacioppo & Petty, 1982; see Appendix H). Need for

Cognition (NC) is an 18-item scale designed to assess one’s desire for effortful thinking and information seeking (Cacioppo et al., 1996). The scale presents a series of statements for which individuals indicate their agreement ranging from 1 “disagree strongly” through 7 “agree strongly.” A sum of all items is used as a final score, with a higher score indicating higher NC. To limit the time visitors spend completing the survey, the current study used a shortened version of NC. Factor loadings and updated reliabilities were taken from a recent study that utilized these scales (Benfield et al., 2010a). The reanalysis of the shortened scale proved it to have good reliability ($\alpha = .82$). For the current investigation, a moderate reliability for NC was obtained ($\alpha = .70$).

Procedure

All data for the Art Exhibit were collected first, followed by all data for the Natural History Exhibit. The investigator randomly assigned sounds to different days of the week (including weekends). All attempts were made to balance the randomization to reflect visitation trends and visitor demographics (e.g., the museum tends to see younger visitors on the weekend and early weekday mornings). All audio files were copied to a compact disc and were put on the “loop” function while data collection occurred. With the loop function engaged, each file took close to 60 minutes to repeat.

For data collection, the primary researcher collected a majority of the data, while trained research assistants were used sparingly (e.g., days in which the researcher was not available). Assistants were required to take a 60-minute training session followed by real-time data collection practice (e.g., practice approaching visitors and filing data). For data collection, the researcher randomly targeted visitors entering the exhibit. Once visitor selection occurred, the researcher unobtrusively tracked the selected visitor throughout the exhibit space, using the Visitor Tracking Sheet. Due to the higher visitation rates in the Natural History Exhibit, the investigator targeted every seventh adult visitor entering that exhibit. Tracking in the Natural History Exhibit was not completed to the same degree as in the Art Exhibit due to line-of-sight limitations in the exhibit.

Next, as the visitor reached the end of the exhibit, the investigator intercepted the visitor to administer the Intercept Survey. Once visitors completed the Intercept Survey, they were debriefed.

CHAPTER 3

RESULTS

All analyses were conducted using IBM's Statistical Package for the Social Sciences (SPSS) GradPack (i.e., the package marketed specifically for students) version 16.0. Models tested for both exhibits included a set of dependent (or outcome) variables measured from the Tracking Sheet *and* the Intercept Survey. Specifically, the dependent variables from the Tracking Sheet included dwell time and engagement (see Appendix A), with knowledge gain and satisfaction taken from the Final Intercept Survey (see Appendix C, items k and j, respectively)¹. Restoration scores were also analyzed from the Final Intercept (see Appendix C, item s; with follow-up analysis conducted on items b, e, h, l, n, q, and s). Following Mace et al.'s (1999) framework, ratings of restoration were achieved by asking visitors to rate restoration on a single item. Finally, the current analysis contained a test for the interaction of covariates, including personality measures of Motivation for Sensory Pleasure (MSP), Need for Cognition (NC), Locus of Control (LOC), Intra/extraversion, and Noise Sensitivity. The independent variable of interest was the type of sound delivered (labeled "Sound Condition"). See Appendix I for all means and standard deviations for dependent variables for both the Art Exhibit and Natural History Exhibit.

¹ As reported later, noisiness ratings from the Intercept Survey were also analyzed.

Art Exhibit

To test the proposed relationships, the researcher first conducted a Multivariate Analysis of Covariance (MANCOVA), with observed dwell time and engagement, as well as ratings of knowledge gain, satisfaction, and restoration, entered as dependent variables, and Sound Condition as the sole independent variable. To test the main and interactive effects of the personality constructs, NC, MSP, LOC, Intra/extraversion, and Noise Sensitivity were entered as covariates. For the custom component of the MANCOVA model, the main effects of Sound Condition and the personality constructs were entered first, followed by the interaction terms of Sound Condition x personality constructs. In addition to the above analysis, Observed Power scores were requested in the analysis. Power scores were requested post-hoc due to the smaller sample sizes acquired for of the personality constructs. For the analyses throughout this manuscript, Observed Power for significant effects was required to exceed .80. In general, this standard allows researchers and practitioners to be fairly confident in their interpretation of the findings and implications for the field

In partial support of the proposed hypotheses, the main effect of Sound Condition was significant, $F(15, 130) = 4.21, p = .00, \eta^2 = .30$. Follow-up univariate analyses of variance (ANOVA) with Tukey post-hoc comparisons were run. Results indicated that sound significantly influenced both *observational* and *self-report* measures. That is, type of sound significantly influenced visitor dwell time and engagement (i.e., observational factors), in addition to perceived knowledge gain, satisfaction, and restoration (i.e., self-report measures).

Sound significantly impacted visitors' dwell time, $F(6, 422) = 4.65, p = .00, \eta^2 = .06$ (see Figure 1 and Table 1). Tukey post-hoc comparisons indicated dwell times for both the Human Voices High and Human Voices Low conditions were significantly lower compared to both the Natural High and Natural Low conditions, supporting Hypotheses 1 and 5.

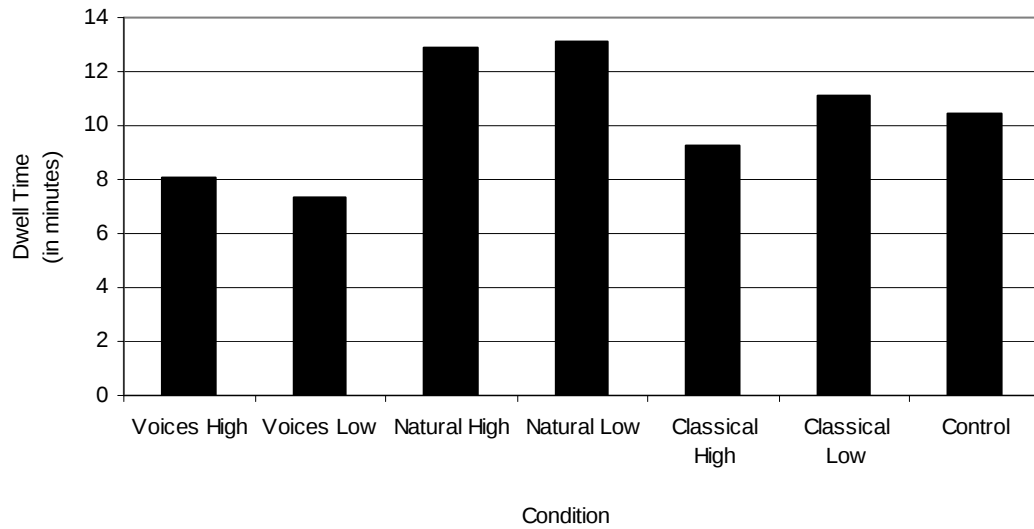


Figure 1. Average dwell time by sound condition within the art exhibit.

Table 1. Significant Tukey post-hoc Comparisons for Sound Condition by Dwell Time in the Art Exhibit

Comparisons (high means minus low means)	Mean Dwell Time Difference (minutes)	Std. Error	95% CI	
			Lower Bound	Upper Bound
Voices High vs. Natural High	-4.48*	1.48	-9.13	-.27
Voices High vs. Natural Low	-5.05*	1.49	-9.33	-.42
Voices Low vs. Natural High	-5.23*	1.47	-9.58	-1.13
Voices Low vs. Natural Low	-5.53*	1.48	-10.17	-1.29

* $p < .05$

Sound also significantly impacted visitor engagement with interactive elements within the exhibit (i.e., number of kiosks visited), $F(6,278) = 5.88, p = .00, \eta^2 = .12$. See

Figure 2 for all engagement means graphed by Sound Condition, and Table 2 for significant post-hoc comparisons. Hypotheses 1 and 5 were only partially supported for the engagement-related data. Tukey post-hoc comparisons indicated that visitors' engagement within the Human Voices High and Human Voices Low conditions was significantly lower when compared to visitors in the Natural High condition. In addition, visitors' engagement in the Natural High condition was significantly higher than visitors' engagement in the Natural Low and Classical High conditions. Finally, comparisons also indicated that visitors within the Classical Low and Control conditions were significantly more engaged than visitors in the Human Voices Low condition.

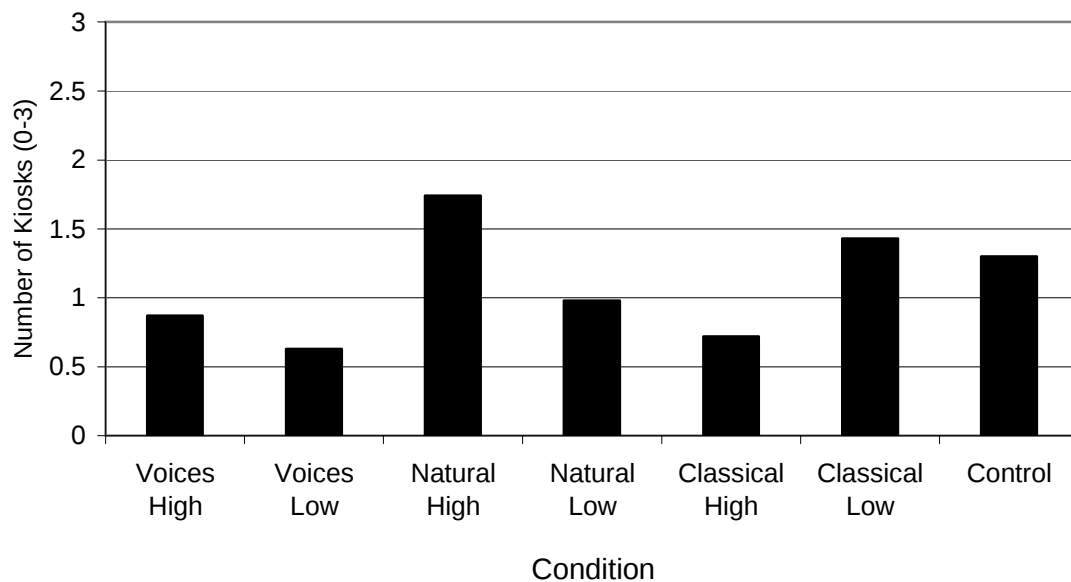


Figure 2. *Average kiosk engagement by sound condition for the art exhibit.*

Table 2. Significant *Tukey Post-hoc Comparisons for Sound Condition by Engagement in the Art Exhibit*

Comparisons (low means minus high means)	Engagement Differences (mean)	Std. Error	95% CI	
			Lower Bound	Upper Bound
Voices High vs. Natural High	-.87*	.26	-1.63	-.10
Voices Low vs. Natural High	-1.10*	.25	-1.83	-.37
Voices Low vs. Classical Low	-.79*	.24	-1.50	-.09
Voices Low vs. Control	-.66*	.18	-1.19	-.13
Natural Low vs. Natural High	-.75*	.25	-1.49	-.02
Classical High vs. Natural High	-1.01*	.25	-1.77	-.26

* $p < .05$

Self-reported measures were impacted, as well. Sounds significantly impacted self-reported gain in knowledge, $F(6, 256) = 4.52$, $p = .00$, $\eta^2 = .09$. See Figure 3 for all knowledge gain means graphed by Sound Condition. Supporting Hypotheses 1 and 5, Tukey post-hoc analysis (Table 3) suggested that visitors in the Natural High, Classical High, and Control conditions reported significantly higher perceived knowledge gain when compared to their Human Voices High counterparts.

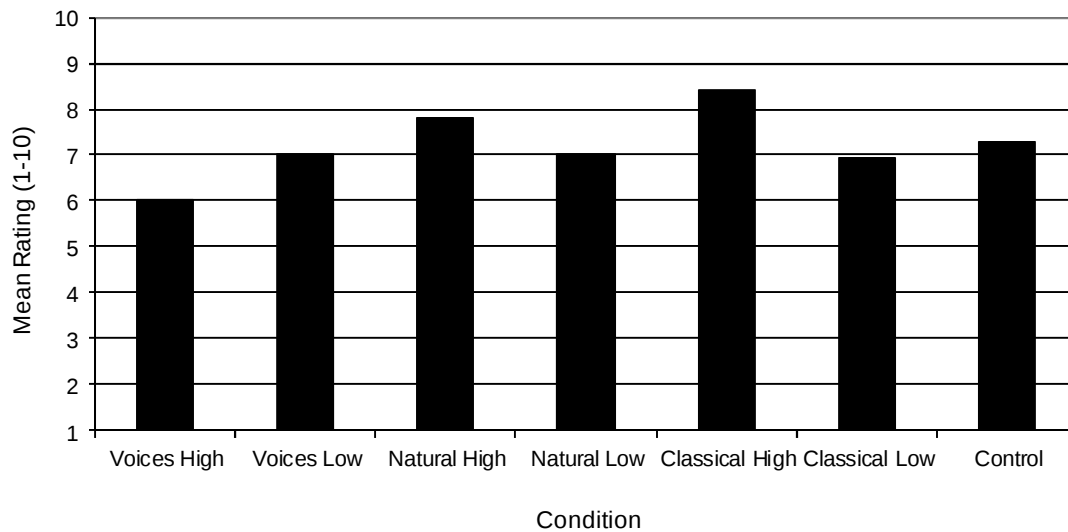


Figure 3. *Average perceived knowledge gain by sound condition in the art exhibit.*

Table 3. *Significant Tukey Post-hoc Comparisons for Sound Condition by Knowledge Gain in the Art Exhibit*

Comparisons (low means minus high means)	Mean Dwell Time Difference (minutes)	Std. Error	95% CI	
			Lower Bound	Upper Bound
Voices High vs. Natural High	-1.75*	.52	-3.29	-.22
Voices High vs. Classical High	-2.36*	.57	-4.05	-.67
Voices High vs. Control	-1.24*	.43	-2.66	-.11

* $p < .05$

Visitor satisfaction with the exhibit was another outcome that is important in the applied literature. Analysis indicated that satisfaction levels significantly varied based on sound delivered, $F(6, 217) = 3.82$, $p = .01$, $\eta^2 = .07$. See Figure 4 for all satisfaction means graphed by Sound Condition, and Table 4 for significant post-hoc comparisons. In partial support of Hypotheses 1 and 5 specifically, Tukey post-hoc comparisons indicated that visitors in the Natural High condition reported higher satisfaction with the exhibit than those in the Human Voices High condition. No other significant variations occurred among the different sounds in regards to satisfaction scores.

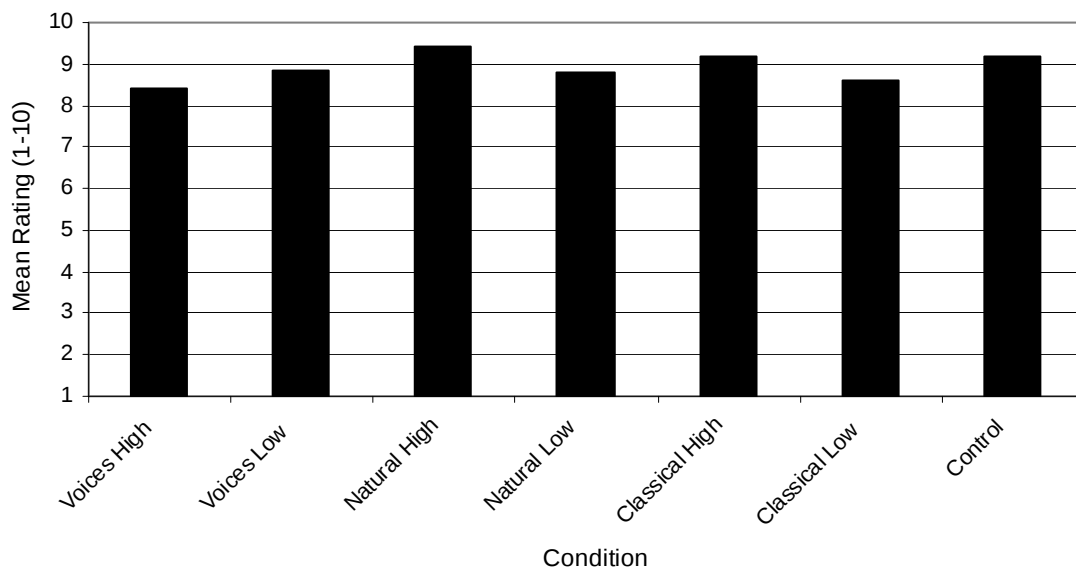


Figure 4. *Average self-report satisfaction scores by sound condition in the art exhibit.*

Table 4. *Significant Tukey Post-hoc Comparisons for Sound Condition by Self-report Satisfaction Scores in the Art Exhibit*

Comparisons (low means minus high means)	Mean Dwell Time Difference (minutes)	Std. Error	95% CI	
			Lower Bound	Upper Bound
Voices High vs. Natural High	-.99*	.31	-1.90	-.08

* $p < .05$

Analysis of restoration ratings indicated that restoration scores varied by Sound Condition, $F(6, 203) = 3.45, p = .00., \eta^2 = .11$ (see Figure 5 and Table 5). In support of Hypotheses 1 and 5, Tukey post-hoc comparisons indicated that visitors in both the Natural High and Classical High conditions rated the Art Exhibit significantly higher in restoration compared to those in the Human Voices High condition.

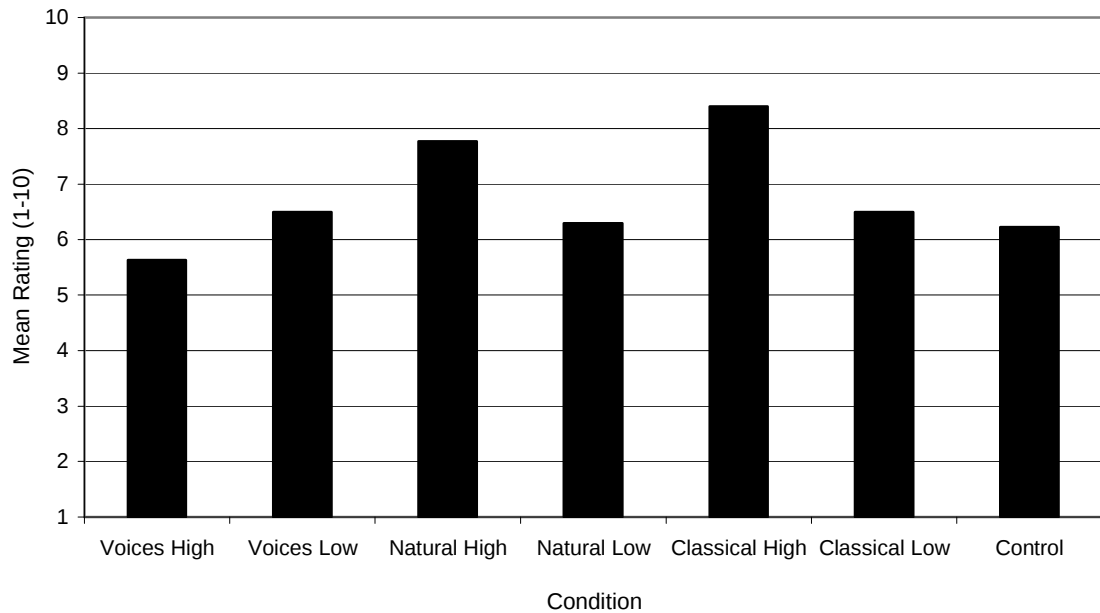


Figure 5. *Average restoration ratings by sound condition in the art exhibit.*

Table 5. *Significant Tukey Post-hoc Comparisons for Sound Condition by Restoration by in the Art Exhibit*

Comparisons (low means – high means)	Restoration Differences (mean)	Std. Error	95% CI	
			Lower Bound	Upper Bound
Voices High vs. Natural High	-2.14*	.67	-4.14	-.14
Voices High vs. Classical High	-2.77*	.73	-4.94	-.59

*p < .05

No support was found for Hypothesis 2. Based off common conjuncture, and from speaking with museum colleagues, the researcher proposed that the highest rates of positive outcomes would appear for visitors exposed to the classical music soundtrack. This was not the case. Classical soundtracks led to favorable outcomes; however, the natural soundtracks led to better outcomes. In addition, no support was found for Hypotheses 7 and 8 within the Art Exhibit data. Personality traits did not impact visitor behavior under these particular circumstances within the Art Exhibit setting. Some of the data limitations that may have accounted for these individual difference findings are discussed later.

Natural History CritterCam Exhibit

A similar process was used to examine the impact sound had on visitor outcomes within the Natural History Exhibit. To test the proposed model, the researcher first conducted a multivariate analysis of covariance (MANCOVA). Observed dwell time and engagement, as well as ratings of perceived knowledge gain, satisfaction, and restoration, were entered as dependent variables, with Sound Condition being the sole independent variable. To test the main and interactive effects of the personality constructs, NC, MSP, LOC, Intra/extraversion, and Noise Sensitivity were entered as covariates. For the custom component of the MANCOVA model, the main effects of Sound Condition and the

personality constructs were entered first, followed by the interaction terms of Condition x personality constructs.

The main effect of sound was significant, $F(20, 146) = 2.87, p = .00., \eta^2 = .23$. No other main effect or interaction terms reached the .05 significance level. Univariate analyses of variance were conducted, with Tukey pos-hoc comparisons. Sound Condition significantly influenced visitor dwell time, $F(6, 422) = 11.48, p = .00., \eta^2 = .13$ and perceived knowledge gain, $F(6, 132) = 2.29, p = .04., \eta^2 = .03$. Figure 6 and Table 6 show dwell time means and significant post-hoc comparisons by Sound Condition. Tukey post-hoc comparisons showed partial support for Hypothesis 6 in that visitors in the Control condition remained in the exhibit significantly longer when compared to both High and Low Human Voices conditions.

Surprisingly (i.e., not anticipated in the hypotheses), visitors in the Control condition also remained in the exhibit significantly longer when compared to both of the Natural conditions and the Classical High condition. In addition, visitors in the Classical Low condition remained in the exhibit significantly longer than visitors in the High and Low Human Voices conditions (supporting Hypothesis 3). Running counter to the hypotheses, Classical Low condition visitors also remained significantly longer than visitors in the Natural Low condition or the Classical High condition. The longer dwell time seen in the Control condition is examined more thoroughly in the next section.

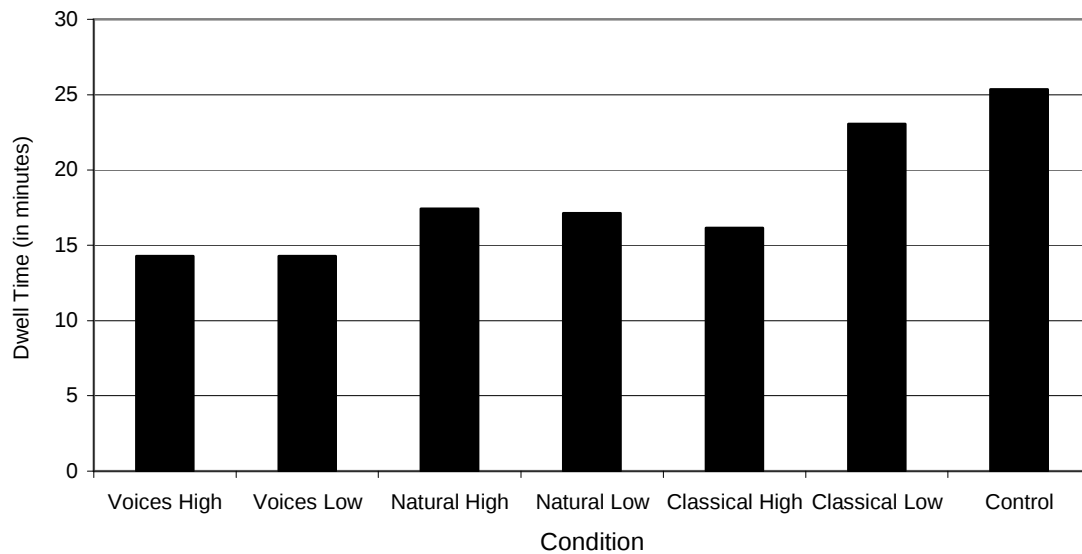


Figure 6. Average dwell time by sound condition in the natural history exhibit.

Table 6. Significant Tukey Post-hoc Comparisons for Dwell Time by Sound Condition in the Natural History Exhibit

Comparisons (low means minus high means)	Mean Dwell Time Differences (minutes)	Std. Error	95% CI	
			Lower Bound	Upper Bound
Voices High vs. Classical Low	-8.79*	1.80	-13.54	-3.12
Voices Low vs. Classical Low	-8.78*	1.79	-13.66	-3.30
Natural Low vs. Classical Low	-5.94*	1.79	-11.12	-.33
Classical High vs. Classical Low	-6.91*	1.78	-12.02	-1.27
Voices High vs. Control	-11.07*	1.79	-16.27	-5.48
Voices Low vs. Control	-11.08*	1.80	-16.32	-5.42
Natural High vs. Control	-7.61*	1.80	-13.13	-2.33
Natural Low vs. Control	-8.23*	1.78	-13.45	-3.09
Classical High vs. Control	-9.20*	1.78	-14.35	-4.02

*p < .05

Figure 7 and Table 7 show visitor perceived knowledge gain means and significant post-hoc comparisons by Sound Condition. Upon reviewing the relationship between Sound Condition and perceived knowledge gain, Tukey post-hoc comparisons indicated that the sole significant relationship fell between the Human Voices High and Human Voices Low conditions, with those in the Human Voices Low condition reporting

significantly higher rates of knowledge gain, in partial support of Hypothesis 5. The results in Figure 7 did not support other hypotheses.

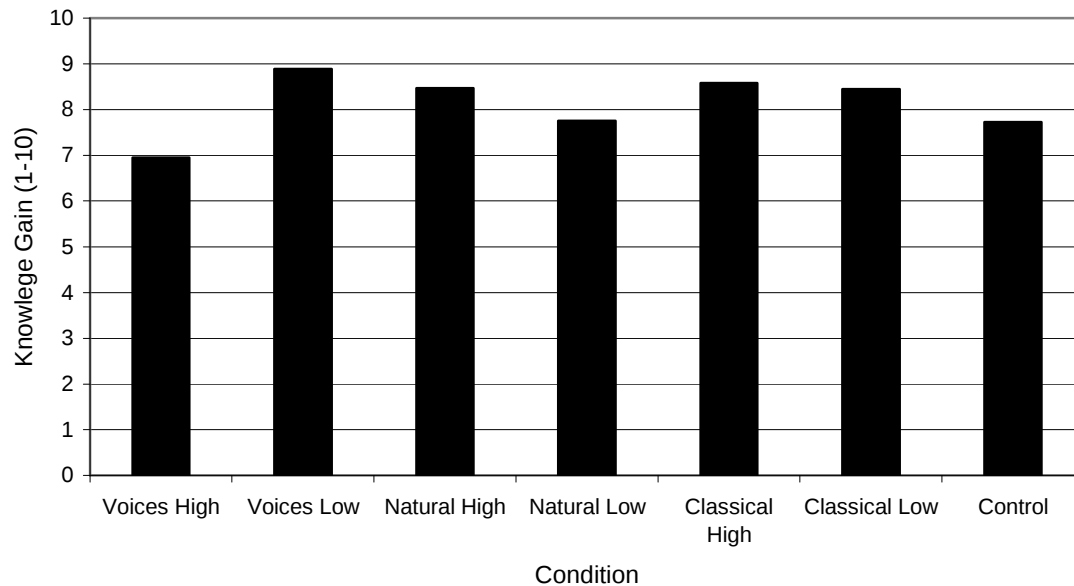


Figure 7. Average knowledge gain by sound condition in the natural history exhibit.

Table 7. Significant Tukey Post-hoc Comparisons for Sound Condition by Perceived Knowledge Gain in the Natural History Exhibit

Comparisons (low means minus high means)	Knowledge Gain (mean)	Std. Error	95% CI	
			Lower Bound	Upper Bound
Voices High vs. Voices Low	-1.94*	.63	-3.84	-.06

*p < .05

No support was found for Hypothesis 4 in either of the above relationships. The researcher suspected that visitors to the Natural History Exhibit would find the Natural Sounds more appealing. However, out of the two “congruent” soundtracks (i.e., Classical and Natural), the Classical conditions saw slightly better visitor outcomes when compared to the Natural conditions (with the Control condition leading to the best outcomes, overall). In addition, no support was found for Hypotheses 7 and 8 within the

Natural History Exhibit data. Although the personality traits do not seem to impact visitor behavior under these particular circumstances, there were other significant self-report ratings (e.g., noisiness ratings; see next section).

Perception of Noisiness in the Two Exhibits

Upon reviewing the recordings from each exhibit, it became clear that the physical noise environment present in each setting was different. In the Natural History exhibit for example, the environment was such that the noise from visitors frequently exceeded the experimental sound delivery. Since there was some “masking” of the sound conditions that occurred, the researcher sought *first* to examine the relationship between visitors’ perceptions of noisiness (see Appendix C item b for specifics) in the various conditions (and the impact of these perceptions on dwell time) *before* dissecting the recorded sounds (see following section).

For Art Exhibit noisiness scores, a one-way ANOVA was conducted with Noisiness as the dependent variable and Sound Condition as the independent variable. Although the analysis was significant $F(6, 215) = 2.46, p = .02., \eta^2 = .03$, Tukey post-hoc comparisons demonstrated there was only one significant difference (Human Voices High rated significantly noisier than Classical Low). Although there was limited significance in this analysis, Figure 8 suggested a pattern of what the researcher expected, with less congruent and louder sounds being rated as noisy and more congruent and sounds played at a lower level being rated as less noisy.

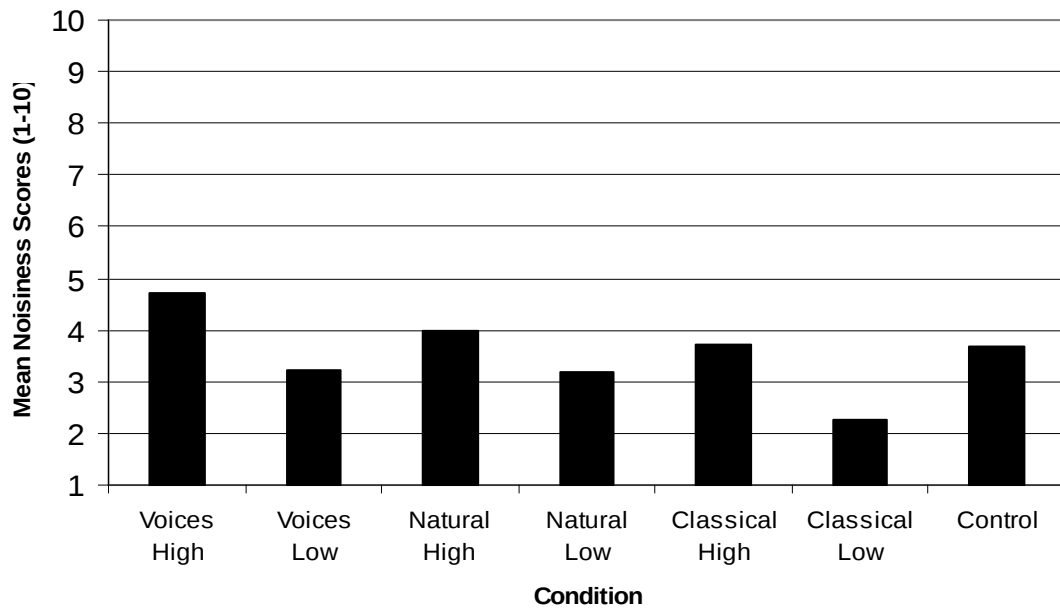


Figure 8. *Sound condition by mean noisiness ratings in the art exhibit.*

To further examine the information in the noisiness ratings, a one-way ANOVA was conducted with Noisiness as the dependent variable and Sound Condition as the independent variable for the Natural History exhibit data. See Figure 9 for means and Table 8 for significant post-hoc comparisons. Results showed that ratings of exhibit noisiness varied significantly by the type of sound visitors were exposed to, $F(6, 132) = 4.96$, $p = .00$, $\eta^2 = .18$. As with the significant relationship between dwell time and Sound Condition previously discussed, visitors in the Control condition had better visitor outcomes (i.e., lower noisiness scores) when compared to several other Sound conditions. Visitors in the Control condition rated the noisiness of the exhibit significantly lower when compared to both Human Voice conditions, as well as to the Natural High and Classical Low conditions. In addition, visitors in the Natural Low condition rated noisiness significantly lower than visitors in the Human Voices High condition. This partially supports Hypothesis 3.

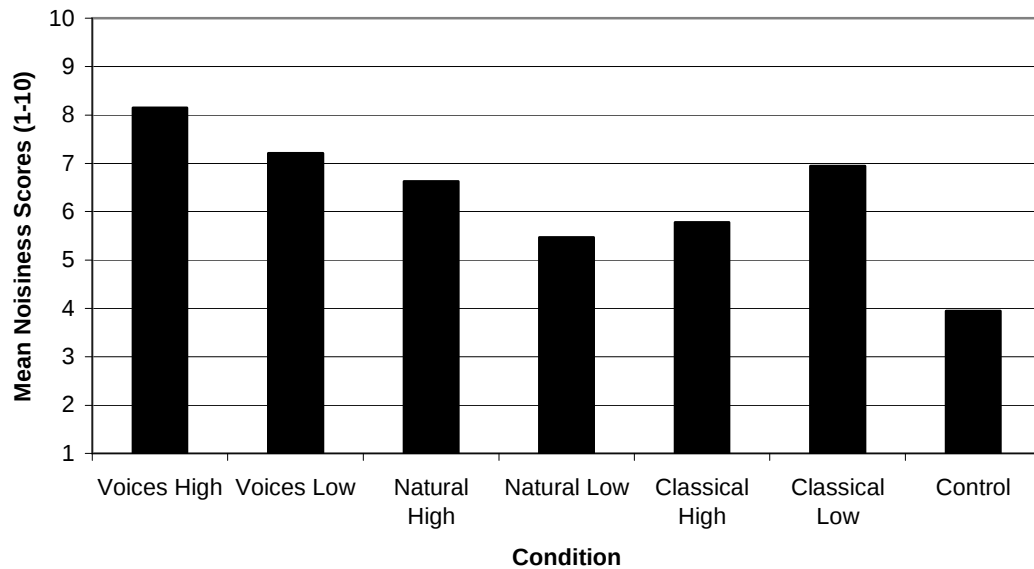


Figure 9. Sound condition by mean noisiness ratings in the natural history exhibit.

Table 8. Significant *Tukey Post-hoc Comparisons for Sound Condition by Noisiness Scores in the Natural History Exhibit*

Comparisons (high means minus low means)	Noisiness Difference (Mean)	Std. Error	95% CI	
			Lower Bound	Upper Bound
Voices High vs. Natural Low	2.69*	.88	.03	5.32
Voices High vs. Control	4.21*	.87	1.58	6.81
Voices Low vs. Control	3.26*	.87	.64	5.87
Natural High vs. Control	2.68*	.87	.06	5.29
Classical Low vs. Control	3.00*	.86	.41	5.57

*p < .05

As a next step in determining how the relationship between noisiness ratings and sound conditions impacted dwell time, an ANCOVA model was run. This model was run to determine whether the relationship between Sound condition and dwell time was influenced once ratings of noisiness scores were statistically controlled (i.e., added as a covariate). The ANCOVA model included dwell time as the dependent variable and Sound condition as the independent variable; noisiness ratings were entered as a

covariate. Results indicated that the significant relationship between Sound condition and dwell time remained when ratings of noisiness were included as a covariate, $F(6, 131) = 14.51, p = .00., \eta^2 = .19$.

General Analysis of Recording and Potential Masking

The above analyses revealed numerous differences between the two exhibits on the impact of Sound Condition on outcomes. The physical components of sounds within the exhibit environment were reviewed to see if they might explain the differences in the outcomes. Analyses of the sound recordings indicated a clear difference between the two exhibit environments in terms of the physical soundscape (see Table 9). In regards to dB(A) specifically, the main difference was not only within the dB(A) of the actual sound delivery (e.g., higher delivery for sounds in the Natural History Exhibit, per the design), but also in the dB(A) of the environment itself (i.e., hard to control ambient crowd noises in the Natural History Exhibit).

Upon analyzing the day-to-day recordings within the Art Exhibit, the ambient sound levels (i.e., no soundtracks added) were relatively quiet overall during normal visitation, $M = 47.85\text{dB(A)}$, and remained near this level fairly consistently, $SD = 3.70\text{dB(A)}$. This lower noise level is partially attributed to the low amount of visitor traffic (an average of 5.30 visitors during observation/intercept, including those being tracked), proportionally more adult visitors to the Art Gallery, and the cultural norm of quietness within fine art settings. By design, the average dB(A) level of the Sound conditions was designed to find the balance between Sound Condition saliency and visitor crowd noise. The mean and standard deviation scores of day-to-day dB(A) levels

Table 9. *Averages and Standard Deviations for A-weighted Decibel Levels of Both Test and Design Level Sounds in Both Exhibits**

Art Exhibit	Control (No Soundtrack)	Voices High	Voices Low	Natural High	Natural Low	Classical High	Classical Low
Testing Level(M)	47.85	57.01	52.52	56.24	53.71	57.63	53.69
SD	5.29	4.25	3.68	3.88	4.35	4.58	3.80
Design Level(M)	48	54	49	55	50	53	48
Natural History Exhibit	Control (No Soundtrack)	Voices High	Voices Low	Natural High	Natural Low	Classical High	Classical Low
Testing Level(M)	63.90	68.15	67.79	69.17	70.03	69.66	67.52
SD	5.45	4.16	4.41	3.84	4.23	4	4.30
Design Level(M)	64	65	60	66	61	64	59

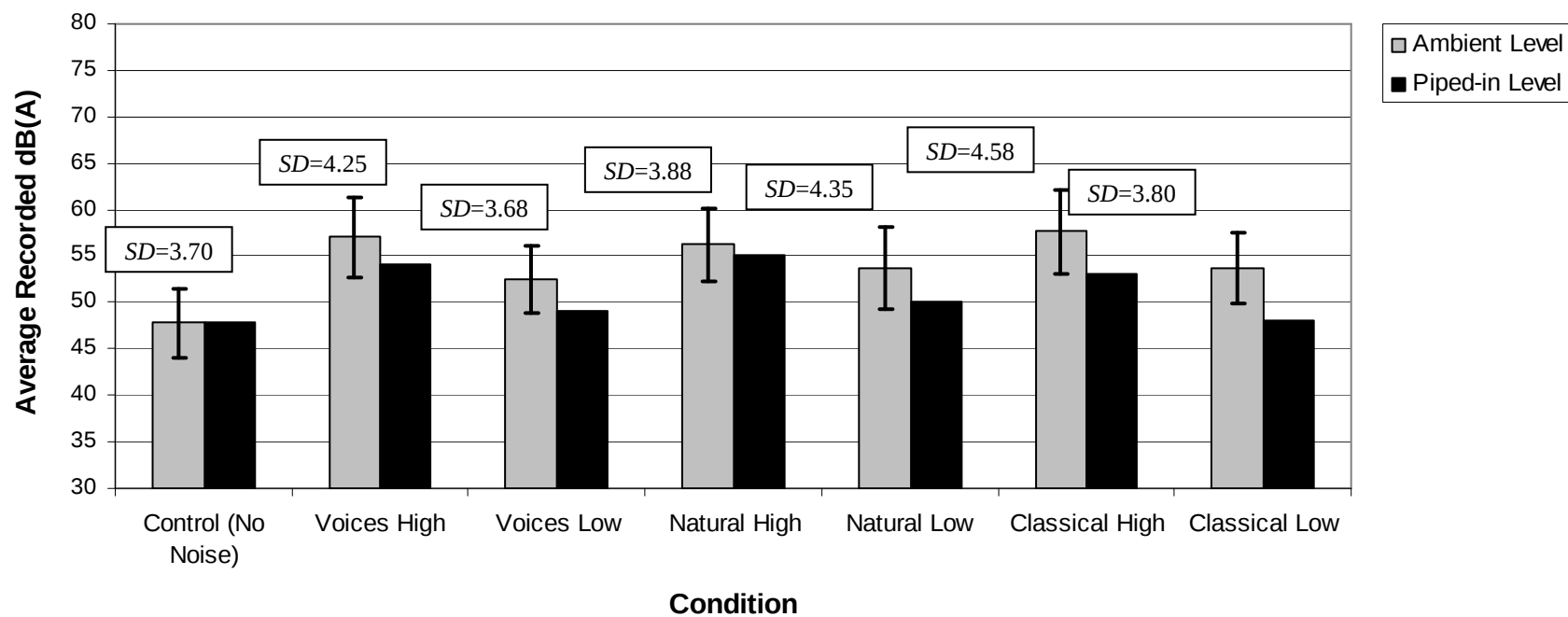
Note. For Control, delivery level is same as recorded mean.

*“Design Level” is the dB(A) in which the researcher delivered the piped-in sound only. This is a level with extraneous sounds minimized (i.e., no crowd noise). “Testing Level” is the average level of the piped-in sound during data collection (i.e., other ambient noise present)

indicate that all soundtrack conditions remained fairly audible throughout the study (see Table 9 for mean and variability of dB(A) levels for each condition). This *lack* of audible “masking” is also evident when reviewing the graphed means and standard deviations for decibel levels across all of the Art Exhibit conditions (see Figure 10) and reviewing a representative spectrogram for the Art Exhibit (see Figure 11).

Ambient (non-experimental) noise levels within the Natural History Exhibit were not only much higher than expected, $M = 63.9\text{dB(A)}$, but also showed more variability in relation to the Art Exhibit soundscape, $SD = 5.45\text{dB(A)}$ in the Natural History Exhibit vs. $SD = 3.70\text{dB(A)}$ in the Art Exhibit. Upon analyzing the recordings further, the delivery of the soundtracks in the Natural History Exhibit seemed to be masked more often than in the Art Exhibit as evidenced by the degree to which mean dB(A) levels within the Natural History Exhibit consistently exceeded the delivery dB(A) levels of each soundtrack (see Table 9 and Figure 12).

Although the researcher adjusted to anticipated increases in noise levels during the Pilot Study (and *CritterCam* itself after installation), the masking could not be avoided while keeping the decibel level of piped-in sounds at a believable and unobtrusive level. Audible masking was seen in all 6 soundtrack conditions. The spectrogram in Figure 13 demonstrates that ambient visitor noise masked the delivery of the piped-in soundtrack. Upon comparing Figure 11 to Figure 13 one can see that masking occurred more often in the Natural History Exhibit when compared with the Art Exhibit.



Note. Whiskers represent one standard deviation

Figure 10. Recorded A-weighted decibel ratings for all conditions within the art exhibit.

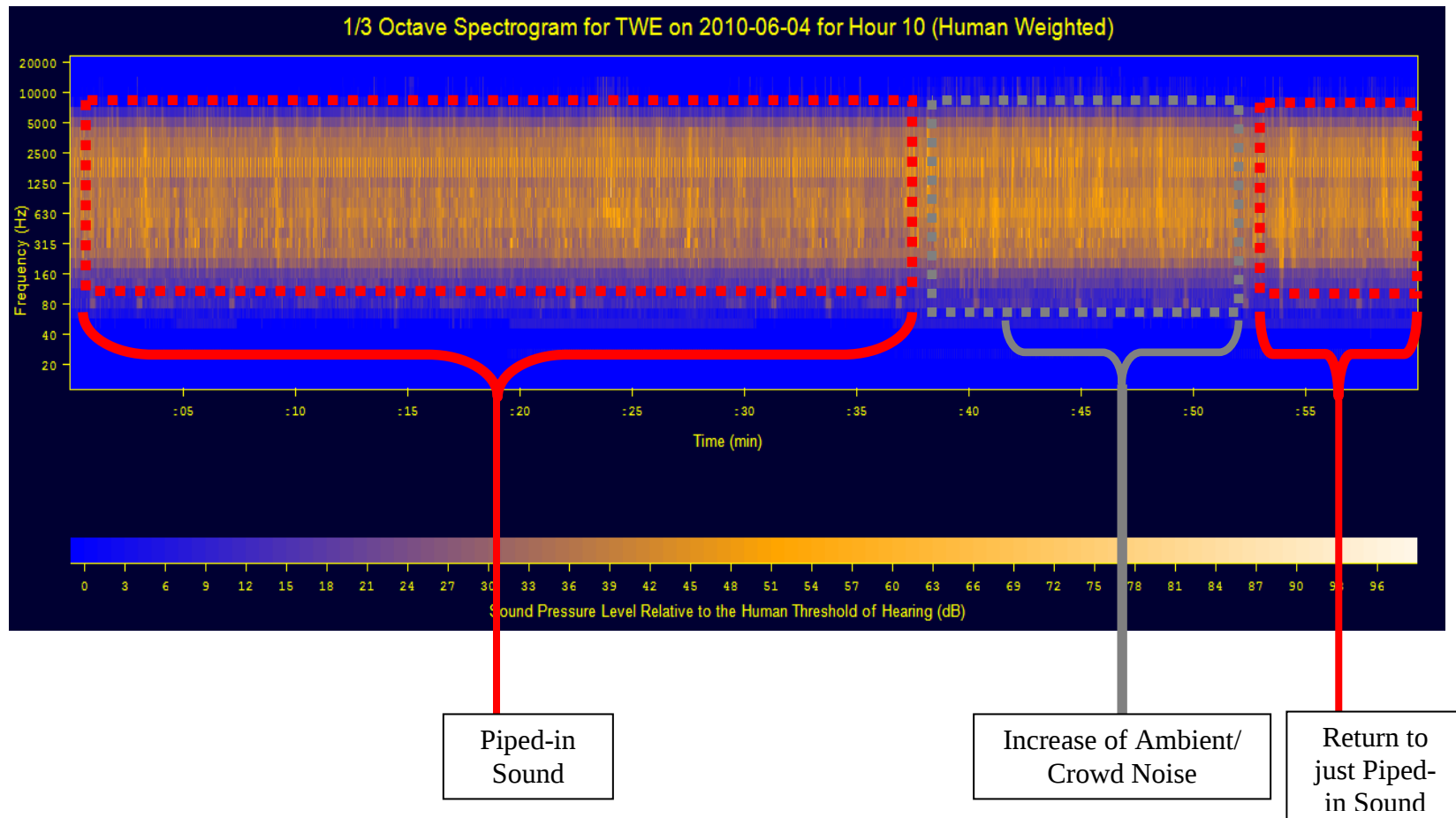
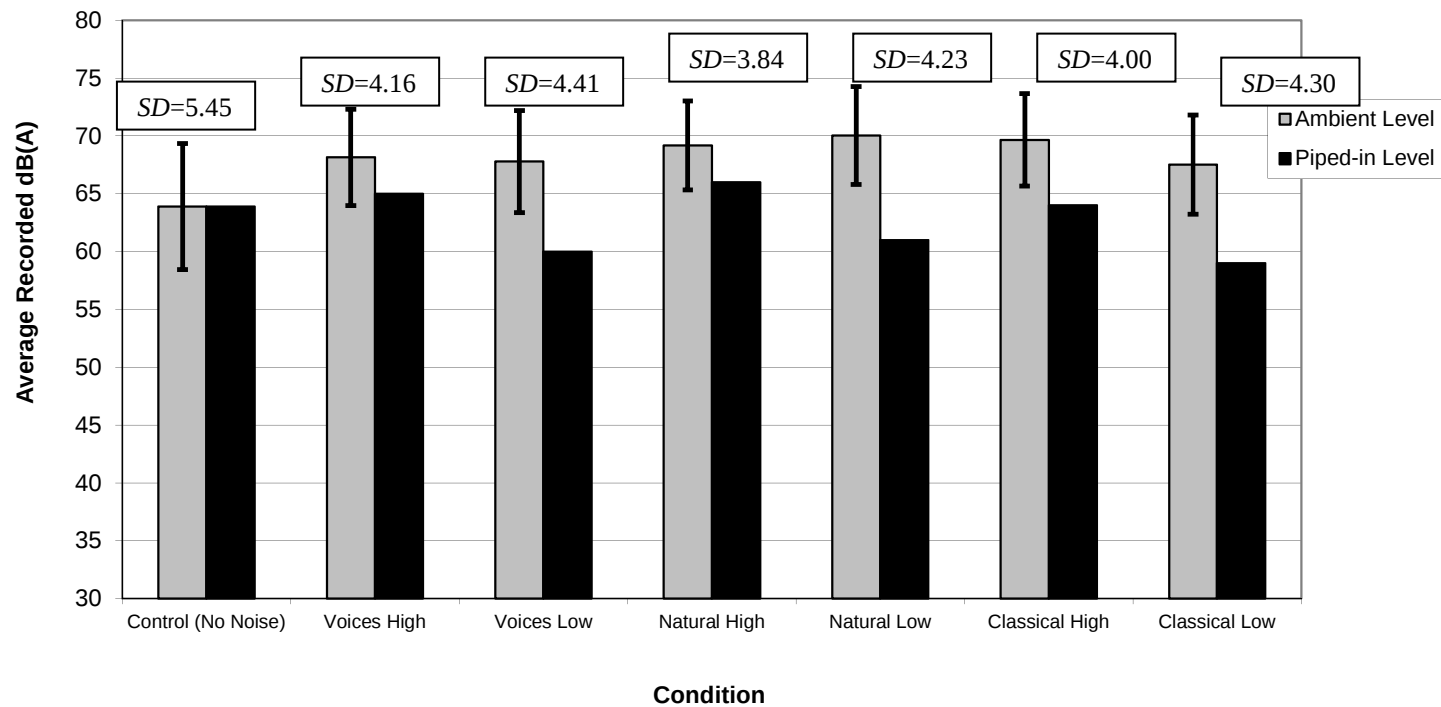


Figure 11. *Lack of masking by crowd noise in relation to piped-in sound in the art exhibit.*



Note: Whiskers represent one standard deviation

Figure 12. Recorded A-weighted decibel ratings for all conditions in the natural history exhibit.

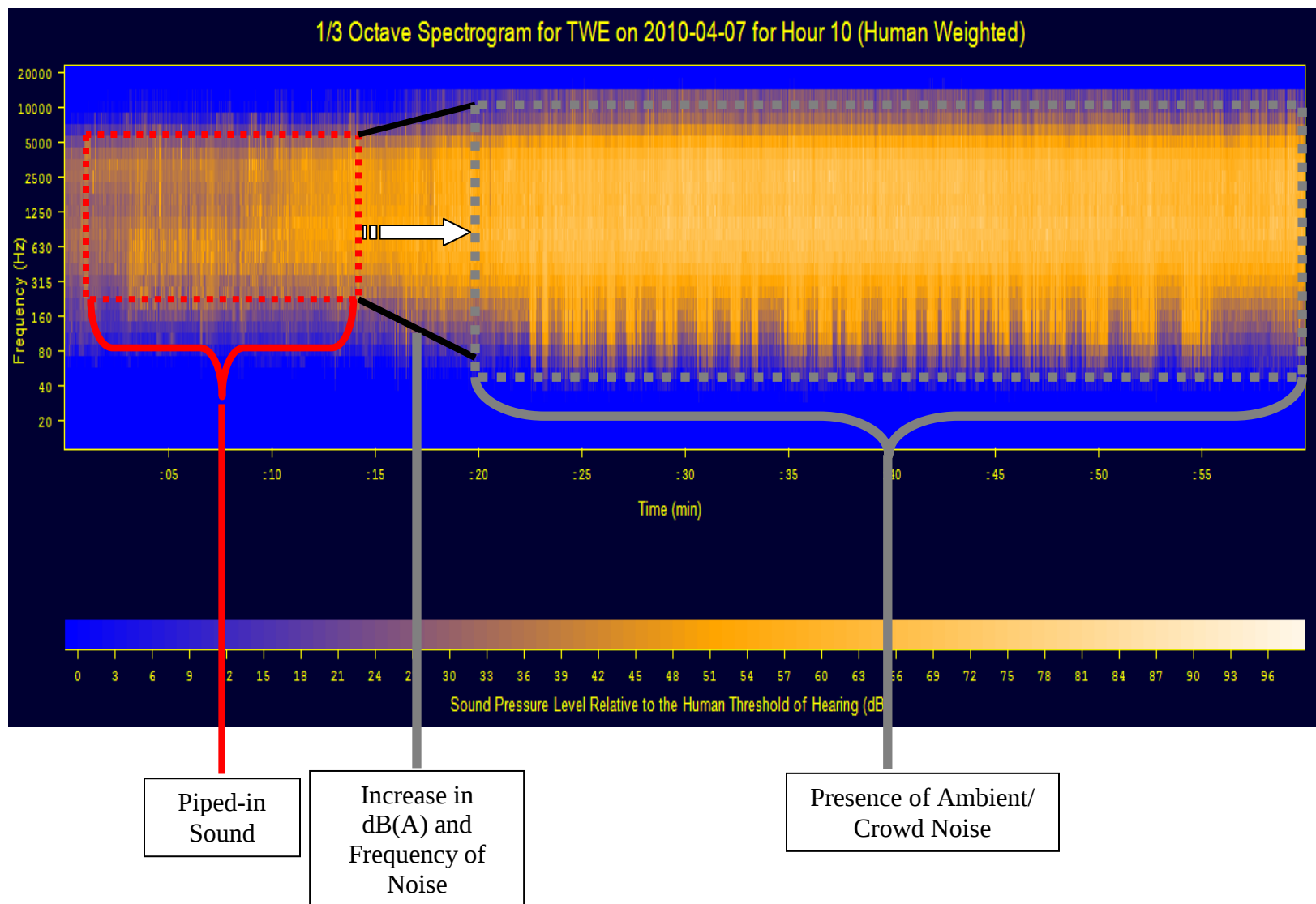


Figure 13. *Piped-in sound being masked by ambient noise in the natural history exhibit.*

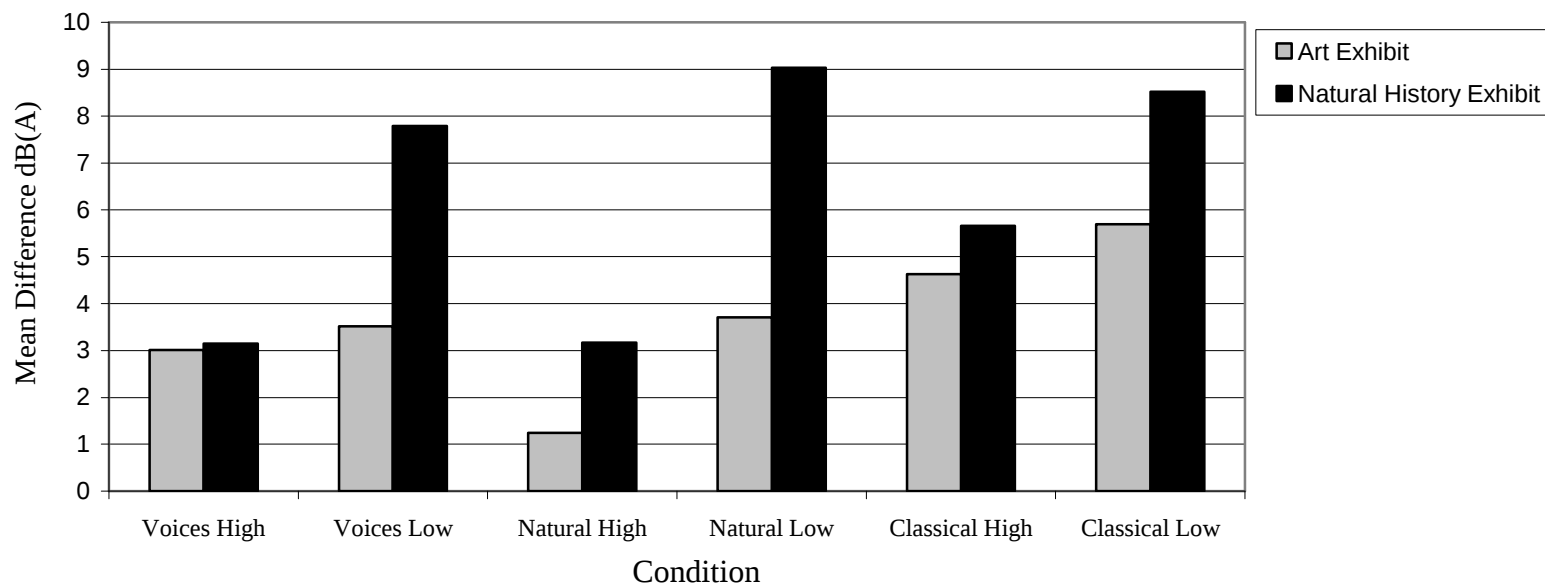


Figure 14. Mean difference A-weighted decibel scores (difference between ambient and piped-in sound within each exhibit) comparison by condition for both the art and natural history exhibit.

Furthermore, upon reviewing mean differences between ambient and piped-in sounds for both the Art Exhibit and Natural History Exhibit (see Figure 14), it is clear that masking of Sound Conditions is a distinct possibility in the Natural History Exhibit. The implications of this masking and other possible effects (e.g., the creation of a cumulative noise environment) are discussed below.

Restorative Experience and Scale Indicators

Although some evidence was found to indicate that Sound Condition influenced the restorative experience for visitors, unfortunately some of the direct indicators (e.g., ratings of feeling restored; see Appendix C, item s) did not perform as strongly as expected. Due to the lack of robust evidence, a Principal Component Analysis (PCA) using Direct Oblimin rotation (the suggested rotation for related items) was run using items from the Final Intercept Survey. Principal Component Analysis was chosen as the researcher was interested in determining which item structure accounted for the most variability overall, versus assuming an underlying factor structure prior to the analysis (a prerequisite for more traditional factor analysis). Since, there was no predicted theoretical factor structure planned at the outset of the current study, this was the most appropriate approach to determining a more predictive item structure. Moving forward, the underlying structure of items would be referred to as “factors,” although traditional factor analysis was not used. The items included in the analysis were ratings of noisiness, naturalness, peacefulness, quietness, and loudness of the exhibit. In addition, visitors’ ratings of whether they felt distracted, irritated, rested, tired, relaxed and/or restored were also included. Eigenvalues over 1.0 were extracted and items with an absolute value of

less than .60 were suppressed (i.e., not included in the output). Analysis was run independently for both the Art Exhibit data and the Natural History Exhibit data.

The Kaiser-Meyer-Olkin (KMO) statistic indicated a compact factor structure with very little diffusion. In both datasets, the KMO was in the “good” range (i.e., between .7 and .8, out of a 0 to 1 score), but slightly higher for the Natural History Exhibit when compared to the Art Exhibit (.79 and .77, respectively). Furthermore, Barlett’s Test of Sphericity was significant in both analyses ($p = .00$, in both datasets), indicating that further interpretation of the factor structure is appropriate. In both analyses, a 3-factor structure emerged. However, after reviewing the inflexion point on the Scree Plot and the content of the items, it was decided that interpreting the data from a 2-factor structure was more appropriate. Within the remaining factors, items loaded independently onto each factor (i.e., no item loaded onto both factors)

In the first factor, labeled “Coherence,” there was a clear emergence of a 4-item scale in which all loadings above .7 were retained. The items that measured *noisiness*, *quietness*, *distractedness*, and *loudness* were retained (see Appendix C, items b, e, h, and L). Upon review, the researcher feels these items most closely relate to the ‘coherence’ component of Kaplan’s restoration framework (Kaplan & Talbot, 1983). Within restoration, the coherence suggests that an individual needs to feel separated from day-to-day experience in order to reach a restorative state. Within the museum environment, it seems that these three items would either act as a *catalyst* to feeling “separated” from the normal day-to-day experience (i.e., perceiving the environment as quiet and non-distracting) or as *interfering* with the feelings of separation from the day-to-day experience (i.e., being distracted reminds one of the “realness” of the environment).

Conceptually taken as a sub-scale of general restoration, these coherence items proved to have good reliability in both the Natural History Exhibit and Art Exhibit ($\alpha = .83$ & $.81$, respectively).

Within the second factor, labeled “Compatible,” another clear scale emerged (i.e., loadings over $.7$ retained) that contained items rating how *rested*, *relaxed*, and *restored* visitors felt (see Appendix C, items n, q, and s). These most closely relate to the ‘compatible’ component of Kaplan’s restoration framework (Kaplan & Talbot, 1983). Kaplan suggests that a given setting should be compatible with the motivations of the individual in order for it to be restorative. Arguably, if museum visitors do not feel rested, they may have a hard time reaching a motivational state. Taken as a sub-scale of restoration, these Compatible items proved to have good reliability in both the Art Exhibit and the Natural History Exhibit ($\alpha = .75$ & $.74$, respectively).

Since the researcher was able to obtain more robust measures of restoration, a further analysis was run on the data to determine if these two new scales impacted visitor outcomes. First, the researcher sought to replicate the part of the initial MANCOVA model. However, instead of a single-item measure of restoration being entered as a dependent variable in the model, the Coherence and Compatible scales were entered. Observed dwell time and engagement, as well as ratings of satisfaction and perceived knowledge gain, were not re-tested in this stage as they were thoroughly tested in the initial analysis. Sound Condition was the sole independent variable. The main and interactive effects of the personality constructs, NC, MSP, LOC, Intra/extraversion, and Noise Sensitivity were entered as covariates. For the custom component of the MANCOVA model, the main effects of Sound Condition and the personality constructs

were entered first, followed by the interaction terms of Condition x personality constructs. The analysis for the Natural History Exhibit indicated that visitors did not significantly differ on ratings of restoration based on the type of sound being delivered.

Results for the Art Exhibit suggested that the type of sound being delivered influenced feelings of restoration, $F(12, 162) = 1.83, p = .04, \eta^2 = .12$. No other interactive or main effects were found. To further determine where the differences lay in the above relationship, an ANOVA with post-hoc comparisons was run. Both restoration scales were entered as dependent variables with Sound Condition as the independent variable. Results suggest that both the Coherence and Compatibility component of restoration were influenced by the type of sound being delivered, $F(6, 205) = 2.33, p = .03, \eta^2 = .06$ and $F(6, 203) = 2.69, p = .01, \eta^2 = .08$, respectively. Upon further review of the post-hoc comparisons for the Coherence component, those in the Classical Low condition reported higher rates of Coherence restoration versus those in the Human Voices High condition, $M(SD) = 8.26(1.68)$ and $6.37(2.06)$, respectively, supporting Hypothesis 1. For the Compatible component, those in the Natural High condition reported higher rates of Compatible restoration compared to those in Human Voices High condition, $M(SD) = 7.82(1.87)$ and $6.14(2.05)$, respectively (supporting Hypothesis 1).

The Coherence and Compatibility restoration scales offer a bit more clarity into the impact the sound had on visitors' restoration within the Art Exhibit (especially when compared to the single restoration item used earlier). Although the single-item outcome of restoration showed a similar pattern of differences, using the newly developed scales offered an opportunity to gain some insight regarding what components of restoration were specifically influenced and by what type of sound. Additionally, taking all three

measures of restoration into consideration, significant restoration differences occurred in 3 of the 4 congruent soundtracks within the Art Exhibit. That is, restoration was higher for Classical High, Classical Low, and Natural High conditions in the Art Exhibit.

As a next step in exploring the new restoration scales, correlations were run to explore other possible restoration relationships. Although there was some correlational evidence to suggest a mediated relationship (e.g., correlations between Compatibility, knowledge gain, and extraversion), the follow-up regression modeling did not point to any further meaningful relationships in regards to restoration. Results are later explained in terms of environmental congruence and within a restoration framework.

Individual Difference Measures, P-E Fit, and Congruence

Although the MANCOVA models reported above did not reveal any significant effects for the individual difference measures (LOC, extraversion, NC, MSP), the fact that these measures have been correlated with outcome measures in previous visitor studies research argues for a closer examination of potential relationships, as the nature of the MANCOVA treatment of the variables could mask some theoretically important relationships. Table 10 shows correlations between the four individual difference measures and the primary outcome measures for each exhibit. In the art exhibit, extraversion was positively correlated with self-reported knowledge gain, satisfaction, and restoration; and need for cognition was positively correlated with knowledge gain, satisfaction, and dwell time. In the natural history exhibit, extraversion was positively correlated with engagement and knowledge gain; and noise sensitivity was negatively correlated with satisfaction and knowledge gain. These correlations are consistent with Hypotheses 7 and 8.

Table 10. *Correlations among Outcome Measures (Dependent Variables) and Individual Difference Measures by Exhibit*

Art Exhibit									
Measure	1	2	3	4	5	6	7	8	9
1. Dwell Time	-	-	-	-	-	-	-	-	-
2. Engagement	.25**	-	-	-	-	-	-	-	-
3. Knowledge gain	.09	.01	-	-	-	-	-	-	-
4. Satisfied	.17**	.07	.55**	-	-	-	-	-	-
5. Restored	-.01	-.12	.34**	.41**	-	-	-	-	-
6. Locus of control	-.02	-.18	.12	.03	.06	-	-	-	-
7. Extraversion	-.06	-.04	.31**	.21**	.19**	.25**	-	-	-
8. Noise Sensitivity	-.03	-.03	.01	-.01	-.04	-.03	-.13	-	-
9. Need for Cognition	.24*	.05	.24*	.27**	.12	-.05	.35**	-.04	-
10. Mot. for Sensory Pleasure	.19	.10	.10	-.01	.11	.07	.34**	-.06	.39**
Natural History Exhibit									
Measure	1	2	3	4	5	6	7	8	9
1. Dwell Time	-	-	-	-	-	-	-	-	-
2. Knowledge gain	.01	-	-	-	-	-	-	-	-
3. Satisfied	.03	.56**	-	-	-	-	-	-	-
4. Restored	-.09	.22*	.23**	-	-	-	-	-	-
5. Locus of control	-.08	-.07	.04	.02	-	-	-	-	-
6. Extraversion	.13	.34**	.27**	.12	-.31*	-	-	-	-
7. Noise Sensitivity	-.04	-.25*	-.22*	-.17	.09	-.10	-	-	-
8. Need for Cognition	.20	.22	.16	.10	-.35**	.23	-.31*	-	-
9. Mot. for Sensory Pleasure	-.01	.19	.24	.07	-.18	.09	-.22	.46**	-

*p< .05

**p<.01

CHAPTER 4

DISCUSSION

At least partial support was found for 6 of the 8 hypotheses. Environmentally congruent sounds had a positive impact on visitor outcomes, including increased feelings of restoration. In several comparisons, visitors exposed to either natural or classical music sounds (both designed with visitors' expectations in mind) saw improvement in outcomes, when compared to their incongruent (human voices conditions) counterparts. Within the Art Exhibit, differences were seen for *both* observational and self-report measures. Although the interactive Natural History Exhibit proved to have a louder (and a more unpredictable) ambient noise environment, significant differences were still found for *both* observational and self-report measures, as well. Findings within each exhibit were patterned differently from each other. Upon reviewing the self-report noisiness scores, recorded decibel levels, and spectrograms for the Natural History Exhibit, there was evidence that the delivered conditions were masked by crowd noise, ultimately changing the dynamic of the sound environment when compared to the Art Exhibit.

In the Art Exhibit, dwell time was improved with the presence of an environmentally congruent sound (i.e., natural sound), when compared to visitors exposed to non-congruent sounds (both high and low volume human voices). Visitors' engagement with interactive displays improved in the presence of a congruent natural sound, as well. Although visitors exposed to higher volume natural sounds saw both the

highest level of engagement the no sound (control) and low volume classical sounds also saw higher engagement compared to visitors exposed to lower-volume human voices. Upon reviewing self-report measures, visitors exposed to high-volume natural sounds reported increased knowledge gain and satisfaction with the exhibit, when compared to those exposed to high-volume human voices. Visitors exposed to high-volume classical music reported more knowledge gain, when compared to their high-level human sound counterparts.

In the Natural History Exhibit, visitor outcomes reflected a different pattern. For example, dwell time differences *were* found. However, visitors not exposed to any experimental sound or to low-volume classical music visited the longest. Low-volume classical music held people longer, when compared against human voices, low-volume natural sounds, and high-volume classical music. Having no sound present actually yielded the highest number of significant differences in dwell time (5 out of 6 possible comparisons), with visitors staying longer, when compared to visitors exposed to human voices (both volumes), natural sounds (both volumes), and low-volume classical music. With regards to self-report measures, visitors exposed to low-volume human voices reported more knowledge gain, but only when compared against their high-volume human voices counterparts.

Unexpected Findings

Several of the findings in the Natural History Exhibit ran contrary to expected outcomes. This is especially true in regards to the prevalence with which the control condition led to higher rates of positive visitor outcomes. Although the novelty of the current investigation tempered the researcher's expectations, the increased dwell times

among visitors not exposed to any sound was surprising. Ultimately, this led the researcher to further investigate the day-to-day sound environment present in the Natural History Exhibit. The researcher first sought to determine how visitors perceived the different sounds through a review of self-reported noisiness scores. Similar to the pattern for dwell time, visitors exposed to no experimental sound reported that the exhibit was less noisy, when compared to visitors exposed to human voices (both high and low volume), high-volume natural sounds, and low-volume classical music.

In regards to noisiness ratings of visitors to the Art Exhibit, mean noisiness scores changed in a more expected fashion, with higher-volume human voices rated as the noisiest and other, more congruent sounds being rated as less noisy. This difference in noisiness score patterns between exhibits was a bit surprising, and led the researcher to further investigate the dynamics at play within the Natural History Exhibit specifically.

The degree to which changes in noisiness scores (by condition) mirrored other visitor outcomes (by condition) in Natural History Exhibit, leads one to question the saliency of the delivered sounds. It is possible that either the delivered sounds did not fit the expectations, and disposition, of those visiting the Natural History Exhibit and/or the delivered sounds created a cumulative sound environment, in which the delivered sound simply added to the perception of *noise* (rather than exhibit-relevant *sound*), within the exhibit.

Related to the former possibility (i.e., certain sounds not fitting dispositional characteristics), the researcher sought to further investigate the individual difference measures (e.g., Motivation for Sensory Pleasure). As previously mentioned, Person-Environment fit (or P-E fit) literature suggests that the less an individual's traits (and

expectations) fit within a given environment, the higher likelihood of negative outcomes (Holland, 1973). These negative outcomes can range from psychological to cognitive to physical.

P-E fit hypotheses were partially supported by correlations at the exhibit level (Table 10), which support the view that visitor outcomes are somewhat influenced by personal characteristics, and that these characteristics impact visitors in the theoretically consistent manner. For example, in the Art Exhibit, measures of extraversion were positively correlated with all of the self-report measures tested (i.e., knowledge gain, satisfaction, and restoration). Extraversion was also positively correlated with knowledge gain and satisfaction in the Natural History Exhibit. In addition, some of the dispositional correlations with outcomes were exhibit dependent. For instance, noise sensitivity was negatively correlated with knowledge gain and satisfaction in the Natural History Exhibit, but did not show any significance in the Art Exhibit. The exhibit-level correlations suggest that the fit between an individual's personal attributes (e.g., being an extrovert or having sensitivity to noise) and the immediate environment warrants careful consideration.

Although this correlational evidence helps to further support the P-E fit literature, the lower frequency of dispositional correlations in the Natural History Exhibit may have been partly due to the degree to which the experimental delivery of sounds was masked by ambient visitor noise, as discussed below. Altogether, the P-E fit findings suggest that research should continue to consider both environmental features *and* the unique contribution of individual traits. Future considerations will allow for a better

understanding of the person-environment balance that exists within many applied settings.

The Occurrence of Physical Noise Masking

Upon reviewing the spectrograms (Figures 11 and 13) and recorded decibel levels for both exhibits (Figures 10 and 12), it is clear that the ambient crowd noise masked the experimental delivery. Not only did the average ambient crowd noise level exceed the average of the piped-in decibel levels (in the Natural History Exhibit), but ambient decibel levels were higher by at least one standard deviation for each condition, when compared against the piped-in sounds (see Figure 13). Although this *did* occur in the Art Exhibit, it was not nearly as often (see Figure 10). In addition, the spectrograms created clearly demonstrate the difference in potential masking, when comparing the two exhibits.

Considering the degree of masking that occurred in the Natural History Exhibit, it is argued that exhibit-relevant sound (i.e., piped-in natural or classical) could not be leveraged as a positive environmental feature. In fact, it is more likely that any delivered sound within the Natural History Exhibit simply blended with the crowd noise, to create a noisier, if not louder, environment overall. This, in turn, led to higher rates of positive outcomes for visitors within the control (no sound) condition, for the Natural History Exhibit, when compared to the Art Exhibit. This is not to say that this masking accounts for all of the differences between visitor outcomes in the two exhibits. As the discussion of the P-E fit correlations suggests, there are, of course, theoretical reasons as to why these differences may have occurred.

Environmental Congruence and Attention Restoration Theory

After reviewing the current findings, it could be argued that certain sounds created an environment that was undesirable to museum visitors. Under certain circumstances, the presence of human sounds led to decreased dwell time and engagement, and lower ratings of satisfaction, perceived knowledge gain, and restoration. These findings dovetail nicely with previous research demonstrating the deleterious effects of noise. For example, Persinger et al. (1999) found that common-source noise can increase fatigue in applied settings. Although fatigue was not directly measured in the current investigation, it is possible that lower dwell time can be at least partially attributed to increased feelings of fatigue among museum visitors. Furthermore, findings reported by Aniansson et al. (1983), in which noise led to higher negative affect, closely relates to the satisfaction differences reported herein. Not only do these findings further incriminate noise as an environmental stressor, but they also extend the noise-as-stressor research into another applied setting in which meaningful activities are occurring.

Using the wealth of literature on noise-stressor research, one eventually uncovers the organizing theories and frameworks within this domain. Matching nicely with the current project's goals and findings, theories related to environmental congruence are highly applicable. In accordance with environmental congruence theory, results suggest that sound designed to match (to be in congruence with) a given context does have a positive impact on behavior and well-being. Interpreted through the congruence lens, visitors to settings in which an environmentally congruent sound was present showed increased dwell time, exhibit engagement, satisfaction, perceived knowledge gain, and restoration. This is especially true for environments in which ambient noise (e.g., noise

from visiting crowds) is not as prevalent. These findings run in conjunction with restoration literature, as well. In fact, upon the follow-up restoration item analysis, the researcher demonstrated that for restoration outcomes specifically, sound-environment congruence ties directly to the *coherence* and *compatibility* factors within Kaplan and Talbot's (1983) restoration framework. Conversely, sounds that are incongruent with the setting (e.g., human voices) interfere with, and lessen the feelings of, restoration and well-being.

The emergence of Kaplan's restoration factors suggests, as expected, that incongruent sounds lead to restoration disruption. Further framing the current findings within Kaplan's *Attention Restoration Theory* (ART; Kaplan & Kaplan, 1989) helps to explain the differences in visitor outcomes that were seen between the two exhibits. In relation to museum visitors, ART suggests that visitors who feel fatigued look for ways to lessen this fatigue. This creates a motivational force within the visitor. Naturally, the disparity between fatigue and restoration drives visitors towards activities and/or settings they find restorative. However, if there are distractive agents that interfere with the processes involved with a particular activity, such as learning about art, negative outcomes will result.

Viewing the current findings through an ART framework helps partially explain why differences in visitor outcome patterns emerged within each exhibit. Within the art exhibit tested (and many art exhibits in general), information about the artwork is often exchanged through interpretative materials alone. Be it through panels, labels, or even exhibit design in general, information is delivered through a single interpretive filter. With most visitor-exhibit exchanges being limited to a single "channel," it becomes easier to

interfere with the restoration-motivation process. In contrast, family-oriented natural history exhibits tend to contain several channels through which visitors can meet their goal of engaging the exhibit in a meaningful and purposeful way. Within many natural history exhibits (and certainly within the one utilized herein), information and engagement is acquired through interpretive material, meaningful interaction with the exhibit, and through social interaction with others. With these increased channels of information/engagement available to the visitor, incongruent sounds may have had less of an opportunity to interfere with visitor outcomes (or at the very least led to a different pattern of visitor outcomes). This viewpoint, in conjunction with the physical difference in the sound environments, may help account for the outcome differences seen between the two exhibits. Future research should account for both the physical and theoretical factors that may influence visitor outcomes and attempt to further this “channel” viewpoint.

Implications for Applied Recreation Research and Museum Studies

The current project not only adds to the congruence and restoration research, but also expands upon recent projects spearheaded by the National Park Service (see Benfield et al. 2010). Of great importance to the NPS Natural Sounds Program is the degree to which research findings relate to the day-to-day situations in which park managers and visitors find themselves. The current investigation takes another step towards identifying the types of human outcomes that applied recreation and park researchers would find useful and informative. Clearly, the outcomes impacted in the current study are those that should be of concern to any manager involved with education, interpretation, restoration, or simply overall environmental satisfaction. Moreover, the current research moves the

recent soundscape and recreation literature out of the lab and into an informal educational setting—a setting that somewhat mirrors the settings in which park visitors and managers find themselves when creating or engaging with interpretive panels or simply entering interpretive centers.

Finally, the relevance of the current research to museum studies is somewhat novel. The fact that the manipulation of sounds had any impact at all suggests that museum soundscapes deserve more than a cursory overview. In fact, the behavior change seen with everyday visitors suggests that soundscapes deserve the same consideration as other physical environmental features (e.g., signage, lighting, label font size). Dwell time, engagement, and satisfaction are of primary importance to museum planners, and yet, considerations of the soundscape continue to be left out of the “museum environment” in the museum planning literature. This is not to say that adding congruent sounds is always the best option. On the contrary, there were certain situations herein in which ambient (no sound) seem to be the best choice. The point is that the museum environment is a dynamic and complex place, and that for certain visitors, in certain exhibits sounds can have a meaningful impact. One hopes that the current research will lead to some lively debate and interesting research within this field.

Limitations and Future Directions

Although the current findings are intriguing and valuable, there are several limitations to the current study. Ironically, these limitations mostly stem from the study’s main strength, its applied approach. The sample size of the study may have limited some of the findings. Although the sample size was adequate to test the main hypotheses of the study, it is the researcher’s opinion that some of the individual difference measures saw

attrition rates that were too high. Since many visitors decided not to fill out the personality scales to completion, the power of the interactive models tested was limited. It is believed that the main reasons for this attrition were twofold. First, in applied studies, visitors are not “recruited” in the traditional sense. That is visitors have very little prior awareness of the study in general, and the structure of the tools within the study, specifically. This is not to say that visitors do not complete surveys in recreation and leisure settings. Within the settings examined, the nature of the psychological scales used was a bit non-traditional, and could possibly be considered “off-topic,” in this particular setting. The researcher did make adjustments to counter some of the issues associated with this surprise (e.g., dropping specific items that might be offensive and warning visitors prior to taking the survey). Although these precautions were taken, several visitors still opted not to complete the entire survey. Future research should attempt to either (a) develop more applied scales that are unique to the environment, or (b) find proxy measures that assess similar constructs in a less abrasive way. Second, visitors have major time constraints. The researcher anticipated this in that some of the original scales were greatly reduced using factor analysis on previous data. However, other measures needed to be left longer for exploratory purposes (e.g., restoration items), but could be reduced in future projects.

Another limitation stemming from an applied sound study is the presence of ambient noise. The researcher conducted an informal pilot study, reviewed previous literature, and met with museum experts to determine the best levels in which to deliver the various sounds. However, the uncontrollability of ambient crowd noise left certain components of the data difficult to analyze and interpret. The researcher did have enough

sound environment data to draw general conclusions about the presence of ambient crowd noise (see spectrograms in previous chapter); however, there were not enough resources to fully review the more technical aspects of the sound data (e.g., reverberation and pitch). In addition, some of the technical data fell outside the scope of the current project. Of course, acousticians would have been much more interested in the structure of the sound data; however, the psychologist involved in the current project tried to focus on sound source differences and psychological testing and measurement. Future interdisciplinary projects could attempt to look at “percent time audible,” frequency of sound, and reverberation of sound with respect to the experimental treatment delivery.

A third limitation involves the timing of exhibit installation and other museum-related activities. On several occasions, data collection was halted, due to short-term exhibit closures, special events, and other museum-related factors that clearly would have influenced data collection. Temporary exhibits, such as the CritterCam Natural History Exhibit, often have short display times of 3 to 6 months. This short timeframe presents many challenges to applied researchers. To combat these challenges, future research should focus on creating an inventory of general findings and common trends that exist across many different exhibit styles (family-friendly natural history exhibit versus more adult-oriented art exhibit), rather than on items unique to specific temporary exhibits. Identifying commonalities would allow for a clearer picture of person-environment interaction within applied settings.

Based on the current findings and theoretical underpinnings, there are many other underexplored areas that would add value and perspective to sound-related research. For example, future research could include examining the impact of sound exposure on

recreation and cultural-sector employees as some may be exposed to certain sounds for upwards of 8 hours per day. One could argue that even congruent sounds would be draining after that length of time. Although it may be in the best interest of the visitor for the museum to add certain sounds, playing adding those sounds might come at the cost of disengaged or stressed staff, such as docents, information booth attendants, and interpretive center employees. Future research should explore sound impact on employee performance and satisfaction.

Conclusion

The current project provides new and important information to those studying the impact of environmental factors on human outcomes. Not only do the results fit nicely into a well-worn theoretical structure (e.g., congruence research in general, and Attention Restoration Theory, more specifically), but the project's novel approach should provide new directions to those invested in any sort of informal learning environment. The findings do have some clear limitations. However, the fact that the researcher was able to demonstrate that incongruent yet realistic sounds influence visitor outcomes, far outweighs the shortcomings that are inherent with an applied research design. Future research should correct for some of these limitations, while continuing to indentify the positive and negative roles that sound and other environmental factors have on human outcomes. Over time, perhaps a stronger theoretical model and more standardized independent and dependent variables can be developed, tested, and made accessible to a wide range of researchers and practitioners

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Appendix A

Visitor Tracking Sheet

Date: ____/____/____

Number of Visitors for Day: _____ Actual # of Visitors in Exhibit: _____

Formal Entry into Exhibit: Yes No

Group #'s: ____Adult Males ____Adult Females ____Children / Total in Group: _____

Time Start:_____ Stop:_____

Correct Rotation through Exhibit: Yes No

Number of interactives engaged (more than 5 seconds): _____

Level of engagement with exhibits: _____(1-LOW through 10-HIGH)

Appendix B

Pre-Pilot Intercept

1. Other than this visit, how many times did you visit The Wildlife Experience in the past 12 months? _____times
2. How much time will you spend at The Wildlife Experience today?
3. ☐ Less than 1 hour ☐ 1-2 hours ☐ 2-3 hours ☐ 3-4 hours ☐ 4-5 hours ☐ 5+ hours
4. Which of the following were reasons for your visit today? (check all that apply)

☐ To see art	☐ To be entertained	☐ To see natural history	☐ To be relaxed
☐ To see a film	☐ Something for children to do	☐ Educational experience	☐ To be refreshed
5. How many times have you been to this particular exhibit in the past? _____ times
6. How many art galleries or art museums have you been to in the last 12 months? _____
7. How many natural history exhibits or interactive exhibits involving animals have you been to in the last 12 months? _____
8. Do you consider yourself someone who is interested in art (an art enthusiast)? ☐ Yes ☐ No
9. Do you consider yourself someone who is interested in natural history? ☐ Yes ☐ No
10. In the past 12 months, how many natural areas have you been to (including parks, hiking, skiing, etc.)? _____.
11. What types of recreational activities do you enjoy (check all that apply)?

☐ Hiking	☐ Skiing/Boarding/Snowshoeing	☐ Camping	☐ Viewing Nature
☐ Bird watching	☐ Biking (road/mountain)	☐ Walking Nature trails	☐ Motorized activities (e.g., atv)
☐ Boating	☐ Climbing/bouldering	☐ Stargazing	☐ Other _____

 - a. In any given year, how often do you participate in these activities? _____ a year
12. How do you rate the admission charge at The Wildlife Experience?

☐ Less than expected	☐ As expected	☐ More than expected
---	--------------------------------------	---
13. Was the visit worth the admission price? ☐ Yes ☐ No
14. After visiting this exhibit, please indicate how much you agree with the following statements. Please use the following scale:

1	2	3	4	5	6	7	8	9	10
Completely									Completely
Disagree									Agree

 - a. I felt immersed in the exhibit _____
 - b. The exhibit was noisy _____
 - c. I felt the gallery environment was natural _____
 - d. I felt the gallery environment was peaceful _____
 - e. I felt the gallery environment was quiet _____
 - f. The exhibit met my expectations _____
 - g. The Museum is worth the price of admission _____
 - h. I felt distracted in the exhibit space _____
 - i. I learned a lot in the exhibit _____

j. I will visit this space again soon_____

Using the same 1 – 10 scale, did the exhibit make you feel:

- k. Irritated? _____
- l. Relaxed? _____
- m. Rested? _____
- n. Confused? _____
- o. Board? _____
- p. Restored? _____
- q. Tired? _____

15. Using a 1 “the worst” through 10 “the best” scale, and your honest opinion, please grade the artwork on the following 4 dimensions:

- a. Beauty_____
- b. Realism_____
- c. Representation of Nature_____
- d. Quality_____

16. *Please answer the following question to the best of your ability:

- a. What was the major theme of the art show?_____.
- b. How many zones were represented in the art show? _____.
- c. Name the zones that were represented in the art show_____.
- d. Describe your favorite piece of artwork in the show (this can be a taxidermy, a painting, or a sculpture you saw): _____.
- e. What type of content was mentioned the most (Circle one):

Diversity of life
Beauty of Nature

Climate Change
Endangered Animals

Animal Adaptations

Animal Survival

Not at all/No

Very/Yes

- | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|----|
| 17. How satisfied are you with the Museum today? | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 18. How satisfied are you with the exhibit today? | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 19. The museum was worth the admission price. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 20. Did the gallery meet expectations? | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 21. Do you feel you left the exhibit with more knowledge? | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 22. Do you feel the exhibit was too loud? | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Please Tell Us a Bit about Yourself and Your Group

What is your gender? ☐ Male ☐ Female
☐ No

Zip Code:_____

Are you a Museum Member? ☐ Yes

How many people (including you) are in your group today?_____

What are the approximate ages of the people in your group (include yourself first)?

_____,_____,_____,_____,_____

What is your profession?

☐ Retired

☐ Service ☐ Managerial

☐ Sales

☐ Technical

☐ Labor

☐ Student

☐ Homemaker

☐ Education

☐ Medical

☐ Legal

☐ Other_____

What is your level of education?

☐ High school

☐ High school graduate

☐ Technical school

☐ Some college

☐ College degree

☐ Graduate school

Do you intend to come back to the Museum anytime soon? ☐ Yes ☐ No

If you were to come back, would you visit this particular exhibit? ☐ Yes ☐ No

Should people donate money to keep this exhibit running? ☐ Yes ☐ No

Appendix C

Final Intercept Survey

1. How much time will you spend at The Wildlife Experience today?
☐ Less than 1 hour ☐ 1-2 hours ☐ 2-3 hours ☐ 3-4 hours ☐ 4-5 hours ☐ 5+ hours
2. How many times have you been to this particular exhibit in the past? _____ times
3. How many art galleries or art museums have you been to in the last 12 months? _____
4. In the past 12 months, how many times did you visit natural areas (parks, forests, trails, etc.)? _____

Please use your honest ratings: After visiting the Art Exhibit, please indicate how much you agree with the following statements.

Please use the following scale:

1	2	3	4	5	6	7	8	9	10
Completely Disagree									Completely Agree

- a. I felt immersed in the exhibit _____
- b. The exhibit was noisy _____
- c. I felt the exhibit environment was natural _____
- d. I felt the exhibit environment was peaceful _____
- e. I felt the exhibit environment was quiet _____
- f. The exhibit met my expectations _____
- g. The Museum is worth the price of admission _____
- h. I felt distracted in the exhibit space _____
- i. I learned a lot in the exhibit _____
- j. I am satisfied with the exhibit today _____
- k. I left the exhibit with more knowledge _____
- l. The exhibit was too loud _____

Using a 1 to 10 scale, where 1 = not at all and 10 = completely, did the Art Exhibit make you feel...

- | | |
|---------------------|--------------------|
| m. Irritated? _____ | q. Relaxed? _____ |
| n. Rested? _____ | r. Confused? _____ |
| o. Bored? _____ | s. Restored? _____ |
| p. Tired? _____ | |

Please answer the following questions using the scale provided. These questions apply to how you see yourself and they have no right or wrong answer.

1	2	3	4	5	6	7
Disagree Strongly			Neither Agree nor Disagree			Agree Strongly

____ 1. I see myself as extraverted, enthusiastic.

____ 2. I am easily awakened by noise.

- ____3. I get used to most noises without much difficulty.
- ____4. I find it hard to relax in a place that's noisy.
- ____5. I am good at concentrating no matter what's going on around me.
- ____6. I get mad at people who make noise that keeps me from falling asleep or getting work done.
- ____7. I am sensitive to noise.

**This information helps the museum create better exhibits – please turn over to complete...
Please continue completing these statements through number 15...**

- ____8. I like to have the responsibility of handling a situation that requires a lot of thinking.
- ____9. Thinking is not my idea of fun.
- ____10. I really enjoy a task that involves coming up with new solutions to problems.
- ____11. Learning new ways to think doesn't excite me very much.
- ____12. Beautiful scenery has always been a significant part of my life.
- ____13. Experiencing nature is central to my life.
- ____14. I have found the sound of rustling leaves to be pleasant.
- ____15. I enjoy long walks.

For EACH pair of statements, pick the one statement you agree with most. There are no right or wrong answers.

1. ____ Becoming a success is a matter of hard work. Luck has little or nothing to do with it.
____ Getting a good job depends mainly on being in the right place at the right time.
2. ____ In my case getting what I want has little or nothing to do with luck.
____ Many times we might just as well decide what to do by flipping a coin.
3. ____ Who gets to be the boss often depends on who was lucky enough to be in the right place first.
____ Getting people to do the right thing depends upon ability, and luck has little or nothing to do with it.
4. ____ As far as world affairs are concerned, most of us are the victims of forces we can neither understand, nor control.
____ By taking an active part in political and social affairs the people can control world events.
5. ____ Most people don't realize the extent to which their lives are controlled by accidental happenings.
____ There really is no such thing as "luck."
6. ____ Many times I feel that I have little influence over the things that happen to me.
____ I do not believe that chance or luck plays an important role in my life.

These questions may seem random, but they have shown to be related to how visitors rate various types of museum spaces

Thank you for your help!!

Appendix D

Ten-Item Personality Inventory (TIPI) Extraversion Sub-scale (Gosling et al., 2003)

1	2	3	4	5	6	7
Disagree			Neither Agree			Agree
Strongly			nor Disagree			Strongly

1. ____ I see myself as extraverted, enthusiastic.

Appendix E

Noise Sensitivity Scale – Shortened Version (Kishikawa et al., 2006)

Please indicate how much you agree with the following statements using the numbers 0 “agree strongly” through 5 “disagree strongly.”

1. I am easily awakened by noise.
2. I get used to most noises without much difficulty.(R)
3. I find it hard to relax in a place that's noisy.
4. I am good at concentrating no matter what's going on around me.(R)
5. I get mad at people who make noise that keeps me from falling asleep or getting work done.
6. I am sensitive to noise.

R = Reversed Scored

Appendix F

Rotter's Locus of Control scale (Rotter, 1966) Shortened based off average factor loadings reported in Mirel's (1970)

In the following statement pairs, indicate which statement you agree with more. There are no right or wrong answers.

1. ____ Becoming a success is a matter of hard work. Luck has little or nothing to do with it.
____ Getting a good job depends mainly on being in the right place at the right time.
- 2*. ____ The average citizen can have an influence in government decisions.
____ This world is run by the few people in power, and there is not much the little guy can do about it.
3. ____ In my case getting what I want has little or nothing to do with luck.
____ Many times we might just as well decide what to do by flipping a coin.
4. ____ Who gets to be the boss often depends on who was lucky enough to be in the right place first.
____ Getting people to do the right thing depends upon ability, and luck has little or nothing to do with it.
5. ____ As far as world affairs are concerned, most of us are the victims of forces we can neither understand, nor control.
____ By taking an active part in political and social affairs the people can control world events.
6. ____ Most people don't realize the extent to which their lives are controlled by accidental happenings.
____ There really is no such thing as "luck."
- 7*. ____ With enough effort we can wipe out political corruption.
____ It is difficult for people to have much control over the things politicians do in office.
8. ____ Many times I feel that I have little influence over the things that happen to me.
____ I do not believe that chance or luck plays an important role in my life.

Note. Items number 2 and 7 were removed after Pilot Study. These two items were leading to increased attrition.

Appendix G

Shortened Motivation for Sensory Pleasure (Eisenberger et al., 2010)

Please indicate your agreement with the following items. Use the scale below:

1	2	3	4	5	6	7
Disagree						Strongly
Strongly						Agree

- _____ 1. Beautiful scenery has always been a significant part of my life.
- _____ 2. Experiencing nature is central to my life.
- _____ 3. I have found the sound of rustling leaves to be pleasant.
- _____ 4. I enjoy long walks.

Appendix H

Shortened Need for Cognition (Cacioppo & Petty, 1982)

Please indicate your agreement with the following items. Use the scale below:

1	2	3	4	5	6	7
Disagree						Agree
Strongly						Strongly

_____ 1. I like to have the responsibility of handling a situation that requires a lot of thinking.

_____ 1. Thinking is not my idea of fun. (R)

_____ 2. I really enjoy a task that involves coming up with new solutions to problems.

_____ 3. Learning new ways to think doesn't excite me very much.(R)

R = reversed scored

Appendix I

Means and Standard Deviations for Outcome Measures (Dependent Variables) by Exhibits

Art Exhibit	Control	Human High	Human Low	Natural High	Natural Low	Classical High	Classical Low
Dwell Time (<i>M</i>)	10.41	8.07	7.32	12.55	13.12	9.29	11.08
<i>SD</i>	6.55	5.13	5.41	11.18	7.58	7.10	8.31
Engagement (<i>M</i>)	1.30	0.87	0.63	1.74	0.98	0.72	1.43
<i>SD</i>	1.12	0.92	0.86	0.65	0.83	0.88	0.92
Knowledge Gain (<i>M</i>)	7.28	6.04	7.00	7.79	7.00	8.40	6.94
<i>SD</i>	1.61	2.77	1.96	1.38	2.07	1.65	2.15
Satisfaction (<i>M</i>)	9.19	8.42	8.86	9.40	8.81	9.20	8.61
<i>SD</i>	1.11	1.69	0.94	0.912	1.25	1.01	1.34
Restoration (single item) (<i>M</i>)	6.22	5.63	6.50	7.77	6.29	8.40	6.50
<i>SD</i>	2.87	2.43	2.21	2.33	2.65	1.47	2.19
Natural History Exhibit	Control	Human High	Human Low	Natural High	Natural Low	Classical High	Classical Low
Dwell Time (<i>M</i>)	25.35	14.27	14.26	17.42	17.12	16.15	23.06
<i>SD</i>	13.05	7.80	5.56	10.80	8.20	9.48	12.76
Knowledge Gain (<i>M</i>)	7.73	6.95	8.89	8.47	7.76	8.58	8.45
<i>SD</i>	1.88	2.97	1.52	2.11	1.41	1.64	1.70
Satisfaction (<i>M</i>)	8.05	8.5	9.16	8.47	8.38	8.16	8.45
<i>SD</i>	1.93	2.28	1.11	2.09	1.43	1.67	1.46
Restoration (single item) (<i>M</i>)	3.75	6.13	6.31	4.25	4.41	4.71	5.45
<i>SD</i>	2.71	2.50	3.47	3.47	3.06	2.93	2.78
Noisiness (<i>M</i>)	3.95	8.16	7.21	6.63	5.47	5.78	6.95
<i>SD</i>	2.59	2.81	2.22	3.18	3.15	2.93	2.48