Effects of Contingent and Non-Contingent Audio on Performance and Quality of Experience in a Role-Playing Video Game

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Abstract

The aim of this study was to explore the influence of different levels of sound on players’ video game performance and quality of experience. Twenty-three male participants with previous Role-Playing Game experience played *The Legend of Zelda: Twilight Princess* (Nintendo, 2006) on the Wii console for five 45-min sessions. Employing a within-subjects design, we exposed gamers to four levels of video game audio: *Full Sound* (screen and Wiimote), *Partial-Sound* (Wiimote only), *No Sound*, and *Non-Contingent Music* (unrelated background music played on a boombox). Measures included multiple performance scores. Questionnaire ratings included enjoyment, self-appraisal of performance, telepresence, and flow. Surprisingly, no significant differences were found for the sound conditions for most performance and quality of experience measures. However, significant results were found for the number of ‘continues,’ which are a game feature players use when they run out of ‘life.’ Further, when some performance measures were recalculated to include only scores earned before the first continue was used, significant results were found for the positive effect of sound on performance. Unexpectedly, highest scores for most performance measures were yielded in the non-contingent music condition. Findings of general interest to video game research were also discussed.
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Effects of Contingent and Non-Contingent Audio on Video Game Performance and Quality of Experience in a Role-Playing Video Game

Despite the interactive possibilities offered by video game audio, such as its use as an aural guide to navigate virtual environments, few studies have explored its role empirically in the experience of the player (Hébert, Béland, Dionne-Fournelle, Crête, & Lupien, 2005; Tafalla, 2007; Zehnder & Lipscomb, 2006). The player can now take an active role with video game sound by interacting within the virtual environment to influence the music and sound effects experienced. Interactions with sound can range from deciphering cues in the musical score to infer information about the surrounding environment (e.g., Eternal Darkness: Sanity’s Requiem, Nintendo, 2002) to listening to sound effects, such as foot steps, which situate the player within the virtual environment (e.g., Okami, Capcom, 2006). Sound cues can also accompany the completion of tasks to signify success on the part of the player (e.g., The Legend of Zelda: Ocarina of Time, Nintendo, 1998). In addition, sound can be used to communicate aspects of the narrative, enhance immersion, and convey emotion (Zehnder & Lipscomb). Just as the visual environment of video games is filled with complexity, video game audio contains a great deal of intricacies, which can enrich the experience of the player.

To gain a more complex understanding of video game sound’s functions in the playing experience of gamers, the present study will explore the current literature on video games and audio. However, despite the importance of audio, one of the key factors in the gaming experience lies on the console and game that are played. Thus, the introduction to this study will briefly review relevant video game innovations that have influenced the video game industry. Following this, the study will delve into research regarding two important areas of the gaming experience: performance and immersion.
Immersion will also be examined at a comprehensive level by investigating the many other factors that contribute to a sense of immersion. Finally, the author will apply Cohen’s (1999) list of the functions of music in multimedia to *The Legend of Zelda* video game series to demonstrate the functional links between sound and an enhanced gaming experience. The method, results, and discussion of the significance and implications of the findings of the present study will then be discussed in the remainder of the paper.

**Wii and “The Legend of Zelda”**

The Nintendo Wii console was first released in 2006, and has since won several awards and become extremely popular across the world. The console’s unique appeal has drawn a number of unconventional players to start playing video games. In addition to its popularity, the system has also been heralded for its innovative approach to playing games and game design. The system employs a Wii remote, which responds to motion-control movements and can be pointed directly at the screen to interact with games. The Wii console’s use of a simplified interface has capitalized on a market saturated with sophisticated, but specialized, consoles. In turn, it has allowed many players to access games previously too difficult to play.

A unique feature of the Wii console’s interface is that its controller relies on kinetic gestural movements for input. Moving the controller a certain way will influence the avatar on the screen to repeat that similar motion. With the Wii, when one uses their sword, such as in *The Legend of Zelda: Twilight Princess* (Nintendo, 2006), one moves the Wii remote as if it were a sword. This is in direct opposition to previous gaming consoles, which relied exclusively on button input. The Wii remote also features a small speaker, which can emit a number of different sounds. The speaker can also be used to emit sounds that are linked to the kinetic gestures of the player, heightening the
immersive aspect of the motion. Another important feature of the Nintendo Wii console is that it hosts one of the latest installments of one of the most influential game series of all time, *The Legend of Zelda*.

*The Legend of Zelda* series debuted in 1986, and introduced a revolutionary gaming experience. The game featured non-linear explorative play focusing on puzzles and problem-solving rather than a strict point-based system. The player could move throughout the environment any way one wished and could accumulate items as one saw fit. The game’s creator, Shigeru Miyamoto, wanted to create an experience, in which players tried to “complete” the game rather than aim to get the highest possible score (Vestal, O’Neill, & Shoemaker, 2008). By doing this, the game gave future games a template to develop non-linear gaming experiences. Although the original *The Legend of Zelda* game does not resemble modern Role-Playing Games, it is credited as one of the original inspirations for the creation of the genre (Long, 2000). The series itself is usually classified as an “Adventure” game, because of its exploratory nature and by its blending of elements from multiple genres.

Another defining characteristic of the series is its pervasive use of music throughout the games and especially the inclusion of music into its game play, for example as audio cues for the player. Although all of the series’ games have incorporated music, one of the later games in the series, *The Legend of Zelda: Ocarina of Time* (Nintendo, 1998), featured a musical instrument as the key item for solving puzzles and game play, and was the first non-music game to significantly incorporate music-making into its structure (McDonald, 2008). In addition to its use of sound effects and music to convey meaning to the player, the game also used musical concepts as a tool for solving puzzles. Characters in the game would possess specific themes, and players would need to recognize when certain characters’ musical themes were
necessary to interact with the virtual environment. This is very similar to the concept of leitmotiv, which will be discussed later. Entire areas of the virtual world also came to have individual themes, and certain characters belonging to those areas would possess themes similar in nature to the environment. In multiple cases, some of these themes have become iconic and been used in multiple games (e.g., “Saria’s Song”). In one puzzle, for instance, players had to navigate a forest maze by following the melody played by a character hidden at the end of the maze. The melody not only formally belonged to the character, but was also the bass line of the overarching music for the forest area. By using music in a both cinematic and interactive fashion, Ocarina of Time broke ground for non-music games, and also cemented the importance of music in the series.

Performance

Regardless of genre, video games have incorporated performance or competition to encourage players to continue playing. Even The Legend of Zelda series, which distanced itself from a strictly points-based performance, incorporates performance into its game play. Just as points and grades can be used to evaluate performance, sound can be used as an indicator of excelling or failing in a game. With The Legend of Zelda series, whenever a key item, task, or puzzle is completed, it is accompanied by a trademark melody to distinguish it from the completion of any ordinary task. Recognizing musical themes mentioned earlier (e.g., Saria’s Song) are often crucial to moving forward in the game as well. In the case of sound effects, slight adjustments to the sound of a sword attack occur depending on whether the attack is doing damage or not, which allows the player to adapt appropriately. Just as performance can be indicated with a grand melody, it can also be indicated with subtler sound effects. However, the limited
literature examining how internal factors of a video game, such as sound, affect overall video game performance have revealed mixed results.

For instance, a study by Wolfson and Case (2000) examined the effects of visual and loudness of the video game audio in the game, *Brick*, on performance, arousal, and excitement. Performance was measured through an in-game score. Wolfson and Case found that while color had a significant effect on performance and arousal, loudness of sound had a minimal effect on both. Wolfson and Case speculated that their lack of findings for sound resulted from using sound that was too predictable. Regardless of the music’s repetiveness, the loudness of sound may not necessarily have the strongest effect on performance. As evidenced by later research (Tafalla, 2007), the presence of sound seems to have a greater impact.

Wolfson and Case’s (2000) findings stand in contrast to the findings of Tafalla’s (2007) research on video game sound and performance. Tafalla examined the effects of contingent sound on male and female video game performance, perception of a game’s level of violence, and arousal. He reported that when playing the game *DOOM* with the soundtrack, males’ performance scores nearly doubled than when playing without the soundtrack. However, no significant difference for performance was found for women. Tafalla also found that only males experienced a significant increase in arousal, as measured by increased heart rate. Although Tafalla interpreted the differences observed between males and females as relating to males having a greater affinity for violent content in video games, he did not present data on players’ level of general experience with video games, which could have accounted for a portion of the difference as well. The contrasting results suggest that the presence of sound is more important to performance than loudness.
The discrepancy in findings between Wolfson and Case (2000) and Tafalla (2007) suggest that the different methods employed by the researchers may have played a role in their findings as well. Tafalla used a more complex game, *DOOM*, which is a First-Person Shooter game. In a First-Person Shooter game, the player takes on the role of an avatar and often has an area to explore and a number of enemies to defeat that can require different strategies, which bears similarities to Role-Playing and Adventure games. In comparison, Wolfson and Case’s *Brick* game, was far simpler, as it involved hitting a ball with a paddle continuously. Sound may be more important in a complex game than it is for a simplistic game, as a complex game creates a more immersive and demanding environment for the player. Thus, having louder sound may not matter as much as having sound that conveys information about the environment, as sound in *DOOM* would. It appears that future research would benefit from considering the complexity of the game and its use of sound when investigating its facilitation or enhancement of performance.

Another divergence between the two studies is that Tafalla (2007) employed sound that was directly linked to the content of the game, as opposed to Wolfson and Case’s (2000) selection of sound that was not associated with the content of the game. Wolfson and Case noted that the music used was “upbeat” and “jazzy,” which may not necessarily have been contingent with the content or tone of the game (p. 187). Different findings yielded by the two studies suggest that synchronization between sound and game play may play a role in performing better, but as Tafalla did not employ a non-contingent sound manipulation, further research is needed to understand whether non-contingent sound facilitates performance.

*Immersion*
In addition to creating a challenging environment that inspires a player’s best performance, video game designers also seek to create an immersive environment, which absorbs the player into all aspects of the virtual world. Sound itself acts as an immersive conduit to involve the player, just as a captivating storyline or unique game play feature might. Sound effects and music intertwine to communicate information about all levels of the gaming world, from the sound of wind blowing in a field to a rapturous theme symbolizing a budding romance. When an important character is dying in *The Legend of Zelda: Twilight Princess* (Nintendo, 2006), the music changes to match the desperation and gravity of the situation in which the player finds themselves. Another notable game is *Spore* (Electronic Arts, 2008), in which the goal of the player is to evolve a single-celled organism into the dominant species in the universe. With every evolutionary path the player chooses for their organism, the music changes to reflect the choices of the player and embody their created species. For example, when a species evolves to become more aggressive, the music of the game becomes more aggressive to symbolize the change in the reality of the species. With its flexible nature and communicative properties, sound can operate as one of the central means of immersion.

The concept of immersion itself is divided into two categories: perceptual and psychological (Kim & Biocca, 1997; Zehnder & Lipscomb, 2006). *Perceptual immersion* involves feeling one’s sensory system is submerged within a virtual environment as opposed to the physical environment surrounding the player. *Psychological immersion* relates to the extent that one feels connected to the elements of the virtual environment. Players may find that the presence of sound can contribute to feeling both kinds of immersion in addition to other components of immersion, which, in turn, may contribute to enhancing performance and enriching gameplay. These other components of immersion, such as (tele)presence and flow, correspond to specific elements of an
effects of video game audio immersive experience and will be discussed with associated research. unfortunately, certain aspects of immersion, such as identification with the avatar and emotion, have a limited body of applicable research and will not be reviewed. although other areas of research possess applicable studies, the role of audio in immersion and other aspects linked to it have yet to be investigated thoroughly in the context of video game play, and a majority of research has not yet focused on the potential influence of sound on immersion.

(Tele)presence. another component of immersion is “telepresence” or “presence,” which lee (2004) explicated using existing research regarding the concept. lee identified three working definitions of presence: telepresence, virtual presence, and mediated presence. however, lee asserted that the separate definitions of “presence” were arbitrary and that “presence” should be used as presence is not influenced by properties of technology and the term can be applied to future technologies. lee defined presence as “a psychological state in which virtual objects are experienced as actual objects in either sensory or nonsensory ways” (p. 37). lee’s definition involves three levels of presence: physical, social, and self. physical presence refers to one being in a state in which objects perceived in a virtual environment are experienced as actual objects. social presence refers to one being in a state in which social beings within a virtual environment are experienced as actual social beings. self presence refers to one being in a state in which the virtual self is experienced as the actual self.

despite lee’s (2004) assertion of “telepresence” as an extraneous definition of “presence,” it will still be used by this study as it describes the feeling of being present in an area created by technology. in addition, lombard and jones (2007) noted that “telepresence” and “presence” were relatively interchangeable terms, and that the concept of the word is more important than the word itself. as both terms are used in
the literature, the term “(tele)presence” will by used in the present paper. In the context of video games, a high level of (tele)presence while playing *Twilight Princess* (Nintendo, 2006) may result in the player experiencing environments, objects, characters, and even the avatar as actual entities as opposed to artificial constructs. A greater feeling of presence may enable the player to perceive threats to their avatar and react appropriately within the virtual environment.

Västfjäll (2003) investigated the effect of spatialized sound on presence and induction of emotions in individuals. Forty-five participants were randomly exposed to a music clip associated with negative emotions in one of three conditions: mono, stereo, or six speakers. Västfjäll stated that participants exposed to the negative music clip in the stereo and six speakers conditions reported negative changes in emotional states in post-test questionnaires compared to pre-test questionnaires. The stereo and six speakers conditions also elicited higher ratings of presence than the mono condition. These findings suggest that higher levels of spatialized sound can influence feelings of presence and induce changes in mood, which signifies a link between sounds playing a role in the individual’s feeling of presence and emotion. Further investigation into the relationship between sound and (tele)presence is of immediate interest to gain a more detailed understanding of (tele)presence as it applies to video games specifically.

*Flow.* A vital component of immersion is flow, a concept first developed by Csikszentmihalyi (1975) to describe the autotelic experience. Autotelic means having a purpose in itself rather an external source. Csikszentmihalyi found that individuals who devoted considerable amounts of time to certain hobbies or work (e.g., chess, rock climbing, surgery) gained intrinsic rewards from participating in the activities, regardless of whether extrinsic rewards were present or not. The intrinsic rewards of these activities come from the experience of being completely involved in an activity to
the point that actions are performed without conscious thought and intervention on part of the individual. The term “flow” was used to describe this experience, and Csikszentmihalyi noted that games are activities encouraging flow states. Csikszentmihalyi’s original concept of “flow” applying to games could then be extended to include modern video games as a possible medium to experience “flow.”

Although Shin (2006) and Skadberg and Kimmel (2004) did not investigate the experience of flow in the context of video games, their results may be applied to future video game research. Shin found that an individual’s perception of their own skill and the challenge of stimuli influenced his or her level of flow. Shin also noted that motivation for a task was key in strengthening a flow state. Skadberg and Kimmel (2004) reported that increased levels of attractiveness and interactivity were associated with a stronger flow experience with participants’ browsing of websites. They also noted that experience of flow had a positive impact on an individual’s learning. That particular finding signifies the value of understanding what factors affect flow.

When compared to research on competition (e.g., Worchel, Shebilske, Jordan, & Prislin, 1997), the findings of Shin (2006) and Skadberg and Kimmel (2004) show potential for the design of future video game studies. Worchel et al. examined the effects of competition on individuals’ performance at a computer task. By reminding participants of the monetary rewards for placing into the top three of all participants, participants’ performance significantly increased. However, Worchel et al. noted that this effect was greatest for the highest-aptitude players. In conjunction with research on flow, these findings suggest that employing a competitive tournament structure can enhance players’ performance. In turn, challenging and motivating stimuli have been found to strengthen a flow state. Perhaps by employing a tournament structure within research, a motivating situation can be created to strengthen the flow state experienced
in a video game. Similarly, using video games that appeal to players could bolster possible flow states. These findings provide a possible framework for video game research to investigate phenomena. In addition, the particular findings for flow have not focused on sound as a potential influence on flow, effectively providing another specific avenue of research relatively untouched.

*Time distortion.* Time distortion is a facet of immersion that involves losing track of time or being unconscious of the passage of time (Hancock & Weaver, 2005; Shin, 2006; Skadberg & Kimmel, 2004). Hancock and Weaver noted that individuals who experienced time distortion might experience an objective time of 10 s, but report experiencing 8 s of time, signifying that the individual has perceived each second to be longer than they are in reality. Thus, when an individual is doing a particularly absorbing activity, such as playing a video game, they may find time suddenly alters its perceived speed. In the context of accumulation models (Hancock & Weaver), time distortion occurs when a large portion of one’s attention is spent on interpreting a novel or complex stimulus at a rate larger than one uses for standard stimuli. Diverted attention towards a novel or complex stimulus reduces attention to actual time’s duration, and results in the individual perceiving time to move slower than in actuality.

Whereas Hancock and Weaver focused on time distortion in extraordinary circumstances, others (Skadberg & Kimmel, 2004; Wood, Griffiths, & Parke, 2007) have respectively investigated time distortion as a part of “flow” or found instances of experienced time distortion with video games. Although “flow” was of primary interest to Skadberg and Kimmel, the two authors noted that time distortion can be used as a measurement for assessing an individuals’ level of flow. They posited that further measurements of flow included enjoyment of the activity and (tele)presence. As opposed to Skadberg and Kimmel’s inclusion of time distortion as a component of
“flow,” Wood et al. investigated time distortion specifically with gamers. An online survey of self-proclaimed “gamers” was conducted and 99% of participants reported experiencing time loss during play and 33% reported that time loss experiences happen all the time. Participants were also asked to identify structural characteristics of games associated with time loss, and 38.9% of participants reported that games with “complex and immersive” characteristics were related to experiencing time loss. These findings suggest that time distortion not only contributes to other aspects of immersion, but is a common phenomenon experienced with video game players. However, little empirical research has been conducted to explore the depth of the relationship between this particular characteristic of immersion and characteristics, such as audio, and video games.

Control and effectance. Control and effectance are two concepts that relate to how one interacts with a sense of self-efficacy in a video game (Klimmt, Hartmann, & Frey, 2007). The term “control” describes the feeling of fully understanding the dynamics of a situation and being able to impact the situation to accomplish a desired goal. “Effectance” describes whether a participant has the ability to act as a causal agent in a situation and actually impact the situation at hand.

Although there was no focus on video game audio specifically, research on control and effectance in video games has shown that players tend to enjoy having an influence on control and effectance while playing (Klimmt, Hartmann, & Frey, 2007). Researchers used three versions of the game Brick to evaluate the importance of control and effectance on enjoyment of a game. The game was similar to the game used by Wolfson and Case (2000). The game consisted of a controllable racket that moves horizontally at the bottom of the screen and bounces a ball up at several layers of bricks. In the three versions used by the researchers, the standard version featured no
modifications, whereas one version had reduced effectance and the other version had reduced control. The version with reduced effectance was modified so that there was a 33% chance that input to move the racket from the player would be ignored, reducing the player’s ability to interact with the virtual environment. The reduced control version of the game utilized a faster ball than the standard version, making it harder for players to maintain control over the ball.

Five hundred participants played in a first practice session with the standard level of the game and then were randomly assigned into playing one of the conditions in a second session (Klimmt et al., 2007). After each session, participants completed a questionnaire measuring perceived effectance, control, and enjoyment of gameplay. Results showed that the reduced effectance condition had a significant effect and negatively affected player’s enjoyment of gameplay. The reduced control condition did not influence significant differences in levels of enjoyment, leading the researchers to infer that a reduced level of control increases the challenge of the activity, which can elicit more enjoyment. This finding supports Csikszentmihalyi’s (1975) view that challenges are central to maintaining the flow state as an absence of difficulty generates boredom. Klimmt et al. suggested that future research should address issues of interactivity using more advanced video game technology. This suggestion affirms an inference made earlier that perhaps using modern video games might be more relevant and provide for an interesting trove of exploration. Just as future research begins to incorporate modern games into their design, it would be of great interest to understand whether the aspects of modern video games, such as video game audio, can influence control and effectance.

In designing research on video games, it is essential to acknowledge and investigate the complex gaming experience. In addition to how little is known about
sound’s role in video games, how sound affects the player’s performance, and feelings of immersion is still relatively unexplored. The components of immersion are also salient as they contribute to creating a sense of immersion. Future research should focus not only on these components and how they fuse to form the gaming experience, but also on how video game audio may facilitate that fusion and create a dynamic gaming experience. Because few studies have examined whether a relationship is present between audio and specific facets of game play, the author will adapt Cohen’s (1999) list of the functions of music in multimedia to video games. By doing this, the author hopes more may be understood about the potential relationships between video game audio and music, and future researchers can begin to investigate accordingly.

The Functions of Music in Video Games

Drawing from film music literature, Cohen (1999) compiled a list of the functions of music in multimedia. Cohen’s list comprised eight major functions of music in multimedia contexts, but still noted that music may have additional effects contingent on characteristics of the new medium. The interactive nature of video games adds another dimension not found in films, possibly shifting how music may particularly interact with the player. An example of the variety of sounds can be seen in Table 1, which contains a catalog of sounds found in five levels of Twilight Princess (Nintendo, 2006). These sounds, including music, represent the broad amount of audio used to both immerse and alert the player in only five levels of the game. Because of both the medium’s interactive nature and its diverse use of sound, it is pertinent then to apply these functions to video games. To do this, the author will use examples found in The Legend of Zelda series to illustrate the multiple functions of music in multimedia as posited by Cohen.
## Table 1

### Catalog of Video Game Audio in Five Levels of Twilight Princess (Nintendo, 2006)

<table>
<thead>
<tr>
<th>Level</th>
<th>Audio Generated by or Associated with Avatar*</th>
<th>Audio Generated by or Associated with Non-Playable Characters*</th>
<th>Audio Generated by the or associated with the Environment/Ambient Sounds*</th>
<th>Music (Diegetic and Non-Diegetic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Gerudo Desert</td>
<td>Voice, Footsteps, Rolling, Transformation, Breathing, Digging, Barking, Growling, Biting, Jumping, Z-Targeting, Item selection, Sword slashes, Shield blocks, Fairy movements, Hookshot, Lantern flames, Shooting arrows, Iron boot footsteps, Boomerang, Slingshot firing, Fishing rod, Bomb fuse and explosion, Hawkeye focusing, Bottle uncorking, Heart collection, Rupee collection</td>
<td>Midna’s voice, Enemy movements, sounds, and attacks: Moldorm, Bulbin, Peahat, Bullbo, Poe, Skultula, King Bulbin, Stalkin, Poison Mite</td>
<td>Wind Blowing, Moving Sand/Sand Traps, Fire, Item/Area of Interest Chimes, Barricade/Tower crashes, Doors Opening, Locks, Box smashes, Skull smashes, Jar smashes, Chains, Restart Sounds</td>
<td>Gerudo Desert Theme, Dangerous Area Theme, Combat Theme, Cavern Theme, Twilight Battle Theme, King Bulbin Battle Theme, Burning Building Theme, Arbiter’s Grounds, Item/Chest Appearance Theme, Open Treasure Chest Theme, Catch Item Fanfare, Catch Small Item Fanfare, Success Theme, Heart Low Beeps, Game Over Music</td>
</tr>
<tr>
<td>1: Forest Temple</td>
<td>Voice, Footsteps, Rolling, Breathing, Climbing, Z-Targeting, Item selection, Sword slashes, Shield Blocks, Fairy movements, Lantern flames, Boomerang, Slingshot firing, Fishing rod, Bomb fuse and explosion, Bottle uncorking, Heart collection, Rupee collection</td>
<td>Midna’s voice, Monkey squeaks and claps, Ooccoo movement and voice, Enemy movements, sounds, and attacks: Keese, Bokoblin, Walltula, Skultula, Deka Baba, Big Baba, Baba Serpent, Deku Like, Bombling, Tile Worm, Ook</td>
<td>Flowing water, Wind blowing, Fire, Webbing stretches, Item/Area of Interest Chimes, Doors Opening, Locks, Box smashes, Skull smashes, Jar smashes, Seed smashes, Bridge smashes, Bridge twisting, Chains, Restart Sounds</td>
<td>Forest Temple Theme, Dangerous Area Theme, Combat Theme, Ooccoo theme, Ook Strikes Theme, Ook the Monkey King Theme, Item/Chest Appearance Theme, Open Treasure Chest Theme, Catch Item Fanfare, Catch Small Item Fanfare, Success Theme, Heart Low Beeps, Game Over Music</td>
</tr>
<tr>
<td>2: Eldin Province Under Twilight</td>
<td>Footsteps, Rolling, Breathing, Digging, Barking, Growling, Biting, Jumping, Z-Targeting, Item selection, Fairy movements, Heart collection, Rupee collection</td>
<td>Midna’s voice, Enemy movements, sounds, and attacks: Twilit Bulbin, Twilit Insect, Twilit Kargarok, Twilit Keese, Twilit Vermin, Twilit Vermin</td>
<td>Wind blowing, Flowing water, Fire, Explosions, Volcano Explosions, Falling rocks, Windows smashing, Furniture falling, Crate shifting, Twilit Pillars falling, Box smashes, Skull</td>
<td>Twilight Theme, Twilight Battle Theme, Barnes Panics Theme, Colín Hopes for Link Theme, Burning Building Theme, Resurging of Kakariko Village Theme, Kakariko Village Theme, Open Treasure Theme</td>
</tr>
</tbody>
</table>
### Effects of Video Game Audio

<table>
<thead>
<tr>
<th></th>
<th>Messengers</th>
<th>Chest Theme, Catch Item Fanfare, Catch Small Item Fanfare, Success Theme, Heart Low Beeps, Game Over Music</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3: Goron Mines</strong></td>
<td>Voice, Footsteps, Rolling, Transformation, Breathing, Z-Targeting, Item selection, Sword slashes, Shield blocks, Fairy movements, Lantern flames, Iron boot footsteps, Magnet boot footsteps, Boomerang, Slingshot firing, Fishing rod, Bomb fuse and explosion, Bottle uncorking, Heart collection, Rupee collection</td>
<td>Midna’s voice, Oocco movement and voice, Enemy movements, sounds and attacks: Fire Toadpoli, Torch Slug, Bulbin, Dodongo, Fire Keese, Teklite, Beamos, Water Toadpoli, Dangoro</td>
</tr>
<tr>
<td><strong>4: Sacred Grove</strong></td>
<td>Voice, Footsteps, Rolling, Climbing, Transformation, Breathing, Digging, Barking, Growling, Biting, Z-Targeting, Item selection, Sword slashes, Shield blocks, Fairy movements, Hookshot, Lantern flames, Shooting arrows, Iron boot footsteps, Boomerang, Slingshot firing, Fishing rod, Bomb fuse and explosion, Hawkeye focusing, Bottle uncorking, Ball and Chain spinning and attacks, Spinner spinning, Heart collection, Rupee collection</td>
<td>Midna’s voice, Trill’s voice, Golden Cucco movements and clucks, Ooccoo movements and voice, Enemy movements, sounds, and attacks: Puppet, Poe, Skull Kid, Skull Kid’s horn playing, Twilit Messengers, Keese, Young Gohma, Lizalfos, Armos</td>
</tr>
</tbody>
</table>

*Sounds will often change slightly depending on the context of the situation and action. Avatar specific sounds will be constant if the actions are performed alone in the same situation, but if an action is used on a Non-Playable Character (NPCs) or Environmental factor, then the sound will change accordingly (e.g., a sword slash will clang on a metal pipe as opposed to a chopping sound on a tree trunk). For instance, sounds will change if an attack is effective against a particular enemy or not, providing additional cues to the player.

**On these two levels, the player has the opportunity to interact underwater, which will distort Avatar, NPC, and Environmental sound.

Cohen (1999) proposes that one of the primary functions of music in multimedia involved masking extraneous sounds from the real physical environment. In the case of
video games, this would not only account for physiological sounds or environmental sounds, but sounds created by the act of playing a game, such as pressing buttons. Gaver (1993) suggests that individuals identify and listen to sounds consistent with their aims and their environment; distracting sounds from the physical environment may hinder a player’s immersion and from fully attending to cues present in the game. In addition, music can be used to enhance the aesthetic beauty of a game. *Twilight Princess* (Nintendo, 2006) complements the beauty of a spring with romantic music, and the unsettling nature of twilight with eerie, haunting music. Other games influenced by *The Legend of Zelda* series also employ this particular function to enhance gameplay (e.g., *Okami*, Capcom, 2006). Music can also create a sense of continuity between constantly changing camera angles during play. Cohen noted that music can heighten arousal and also focus attention on the elements of the visual space.

Music can also draw attention to certain aspects of the visual display through structural or associationist congruence between elements of the visual display and temporal or semantic components of the music (Bolivar, Cohen, & Fentress, 1994; Boltz, Schulkind, & Kantra, 1991; Cohen, 1999; Marshall & Cohen, 1988). Structural or associationist congruence refers to how elements of the music (e.g., temporal speed or structural qualities, such as patterns) can draw the viewer’s attention to certain elements on the screen. As a result of this, the elements on the screen and the elements of the music become linked and are considered ‘congruent’ with one another. For example, music with a faster tempo may draw the viewers’ attention to a fast-moving object on the screen rather than a static object. Marshall and Cohen illustrated this concept by exposing participants to a film featuring three geometric shapes with different musical soundtracks. They found that attention was drawn to a small triangle when music was temporally congruent with the small triangle’s movement. When
music was not temporally congruent with the small triangle, attention reverted to a large triangle. In addition to research on temporal congruence, Bolivar et al. reported that audio played a role in participant’s perceptions of social exchanges between wolves. Congruence between the mood of scenes and music resulted in higher rates of perceiving those moods from participants as opposed to scenes in which music was not congruent with the mood of the scene. Greater semantic congruence between audio and visual channels resulted in clearer perception of scenes and interactions.

Structural and temporal congruence is also present in video games, and can enhance the interactivity of games. In The Legend of Zelda: Twilight Princess (Nintendo, 2006), temporal congruence is present during a particular boss battle, in which the temporal elements of the music shift to match the changing size and speed of the boss. Associationist congruence is present when the player moves closer to an enemy. With the entrance of an enemy in the space around a character, the music shifts to become more sinister. As the music takes on a different semantic quality, the viewer will pay attention to elements of the visual space that correspond with the new music. Once the congruent elements are found, the player can then understand and respond to the intended message of the change in music. In video games, congruence between audio and visual stimuli aids players in interpreting and reacting appropriately to the virtual environment.

Another function of music in multimedia is that it can influence the interpretation of a narrative and convey meaning as well (Bullerjahn & Güldenring, 1994; Cohen, 1999). The entrance music used for enemies in Twilight Princess (Nintendo, 2006) represents not only music’s shift to stay congruent with the environment, but also signifies to the player that the environment has changed and become more dangerous. Changes in music for previously visited locations can signify developments in the
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game’s narrative, and players must decipher what these shifts imply about the new environment. In a forest once accompanied by friendly music, but now accompanied by dark eerie music, the player must infer from this change that the forest is not like it was before and previous strategies must be adapted to interact with the different surroundings. The “Song of Healing” in The Legend of Zelda: Majora’s Mask (Nintendo, 2000) is music employed by the player to further the narrative of the story and heal computer-controlled characters wracked by sadness. Employing music that is congruent with the mood of the narrative can compensate for graphic and visual limitations of emotion in video games.

Music aids in the memorization and recall of events, characters, and elements of the narrative (Boltz et al., 1991; Cohen, 1999). This can occur through the technique of leitmotiv, which was mentioned earlier. Leitmotiv is a piece of music played in conjunction with an element, such as a character, and comes to symbolize that element, even when that element may not be present on the screen. In Ocarina of Time (Nintendo, 1998), important characters introduced in the main character’s childhood are given their own individual themes and their themes are incorporated into soundtracks used for levels associated with them (e.g., “Zelda’s Lullaby,” “Epona’s Song,” and “Saria’s Song”). “Zelda’s Lullaby” is an integral song to memorize, as it symbolizes one of the main characters in the game and can be used to access restricted areas within the game (Kondo, 1998). “Saria’s Song” is associated with a childhood friend, and when the player must find their friend in a forest labyrinth, the theme is played when players are taking the correct path. This type of puzzle is repeated in a later game, Twilight Princess (Nintendo, 2006), even when the character is not included in the game. Not only does it signify to the player who is familiar with the series the importance of the music to the puzzle, but contains a degree of nostalgia that can enrich the experience. By recognizing
musical themes and associated elements, players can recall and implement effective strategies to interact with the environment and increase performance.

With this typology, Cohen (1999) created an effective framework to extrapolate the functions of music in multimedia to new mediums. However, new research is crucial for exploring the complexities of how individuals interact with not only music, but sound effects, which add another dimension to how one interacts with sound in a game. In order to fill the gap, recent research will be reviewed to examine exactly what progress has been made in the field of video game music and what directions future research should take.

Recent Research

The research previously introduced over the course of this study may not have always directly addressed the question of “How does sound affect video game performance and immersion,” but still provides a foundation for future research focuses and design. For instance, Hébert et al. (2005) analyzed the effects of techno music on cortisol levels in video game play. They hypothesized that exposure to music while playing would create a more stressful playing experience, and induce a greater amount of cortisol secretion compared to the group playing in silence. Fifty-two male participants played Quake III Arena (Activision, 1999) for two 10-min sessions. Saliva samples were taken following the first practice session, immediately after the testing session, and twice more at 15-min post-game intervals. The researchers observed a significant effect between the music group and an increased level of cortisol at the 15-min post-game interval compared to the no music group. Hébert et al.’s findings are also similar to Tafalla’s (2007) findings that playing video games induced significantly higher levels of arousal in both male and females. These findings illustrate music’s facilitation of arousal in video games (Cohen, 1999).
Hébert et al.’s (2005) method is also comparable to current video game research (Tafalla, 2007; Wolfson & Case, 2000; Zehnder & Lipscomb, 2006) in the field of video game research. All four studies examined sound’s effect on the gaming experience, ranging from the physiological to in-game performance. However, all studies examined the gaming experience with one kind of sound or no sound, rather than investigating to see if multiple levels of sound or other sounds, such as non-contingent sound, would have an effect. In addition, the two studies (Hébert et al.; Tafalla) that reported significant results employed games with content that may have been more closely linked to the content of the sound used. Whereas Tafalla employed completely contingent sound and Hébert et al. used fast-paced techno music, Wolfson and Case used upbeat jazz music that may have had little to do with the basic game they employed. This suggests that contingent or related audio may be best for inducing stronger performances and arousal, implying that the sound does not exist as a simple backdrop and plays a role. The differences among the three studies suggest that future research should examine what role different levels of audio or non-contingent audio can play in the gaming experience.

Just as the previous studies suggest that contingent audio may be central to gameplay, a recent study reviewed different video games genres and how they tended to incorporate components of sound (Zehnder & Lipscomb, 2006). Games (N = 159) from all genres were coded for options they offered to players to control elements of sound, ranging from volume controls for sound effects and music to whether music could be arranged in a playlist. Significant differences were found between genres, as Racing/Driving and Simulation genres were more likely to allow players to control sound effects and music than Action/Adventure and Role-Playing Game (RPGs) genres. The lack of control over music and absence of popular music in RPGs and
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Action/Adventure games suggests that the built-in music for those games is more central to the gameplay than it is in other genres. This finding stands in contrast to previous research that has investigated sound (Hébert et al., 2005; Tafalla, 2007; Wolfson and Case, 2000), which employed different games and found different results in regards to sound. The significant results reported from studies employing First-Person Shooters (Hébert et al.; Tafalla) suggests that genres comparable to the Action/Adventure or RPG genres may have sound that is more important to an enjoyable or successful gaming experience for the player. As inferred from the results of Zehnder and Lipscomb, different results for sound may arise from employing games that incorporate sound differently.

In addition to these findings, gamers also noted that absorption and empathy with characters was more possible in Role-Playing Games (RPGs) and The Legend of Zelda series (Wood et al., 2007). RPGs are notable for emphasizing character development, employing a main “quest” for players, and using fantasy environments. The structural characteristics of RPGs (e.g., specifically designed sound, complex puzzles, narratives), in concordance with players’ perceptions of these games, signify that these games are designed to create an immersive and challenging experience for players. Thus, employing a game, such as Twilight Princess (Nintendo, 2006), may present a more demanding gaming experience to the player than Brick would, as it is a casual game not requiring greater problem-solving skills. Sound may also facilitate the more difficult aspects of the gaming experience. How sound facilitates task completion in four of the levels used in the study is presented in Table 2. As it can be seen, sound plays a role in task completion and strengthening the gaming experience, such as with audio cues associated with enemies that cannot be seen. Taking Zehnder and Lipscomb’s (2006) results on the RPG genre’s propensity for important music into...
account, it appears that RPGs could be employed by future research investigating sound.

<table>
<thead>
<tr>
<th>Table 2</th>
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<tbody>
<tr>
<td><strong>Role of Audio in Completion of Tasks</strong></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Levels and Tasks</th>
<th>Description of Sound/Facilitation of Task Completion</th>
<th>Source of Sound</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forest Temple:</strong> Cluster 1: Task 1:</td>
<td>Monkey claps/squeaks near correct path</td>
<td>Television</td>
</tr>
<tr>
<td></td>
<td>Enemies’ movements make sounds alerting players to presence</td>
<td>Television</td>
</tr>
<tr>
<td></td>
<td>Non-Diegetic Music changes with the presence of an enemy and when player enters battle</td>
<td>Television</td>
</tr>
<tr>
<td><strong>Cluster 1:</strong> Task 2:</td>
<td>Successful attacks on enemies sound different than unsuccessful ones</td>
<td>Television</td>
</tr>
<tr>
<td></td>
<td>Midna giggles near altar to alert player to in-game hint</td>
<td>Remote</td>
</tr>
<tr>
<td></td>
<td>Monkey claps/squeaks near correct path</td>
<td>Television</td>
</tr>
<tr>
<td></td>
<td>Monkey squeaks in fear near enemies</td>
<td>Television</td>
</tr>
<tr>
<td><strong>Cluster 2:</strong> Task 1:</td>
<td>Monkey claps/squeaks near correct path</td>
<td>Television</td>
</tr>
<tr>
<td></td>
<td>Captured monkey squeaks to alert player to their location</td>
<td>Television</td>
</tr>
<tr>
<td></td>
<td>Enemies’ movements make sounds alerting players to presence</td>
<td>Television</td>
</tr>
<tr>
<td></td>
<td>Non-Diegetic Music changes with the presence of an enemy and when player enters battle</td>
<td>Television</td>
</tr>
<tr>
<td><strong>Cluster 1:</strong> Task 2:</td>
<td>Monkeys clap/squeak near correct path</td>
<td>Television</td>
</tr>
<tr>
<td><strong>Cluster 3:</strong> Task 1:</td>
<td>Sound of bomb’s fuse increases in speed when bomb is close to exploding</td>
<td>Television</td>
</tr>
<tr>
<td></td>
<td>Captured monkey squeaks to alert player to their location</td>
<td>Television</td>
</tr>
<tr>
<td></td>
<td>Items of interest chime when player nears them</td>
<td>Television</td>
</tr>
<tr>
<td><strong>Cluster 4:</strong> Task 2:</td>
<td>Captured monkey squeaks to alert player to their location</td>
<td>Television</td>
</tr>
<tr>
<td></td>
<td>Enemies’ movements make sounds alerting players to presence</td>
<td>Television</td>
</tr>
<tr>
<td><strong>Cluster 1:</strong> Task 1:</td>
<td>Monkeys clap/squeak near correct path</td>
<td>Television</td>
</tr>
<tr>
<td><strong>Cluster 1:</strong> Task 2:</td>
<td>Ook’s weapon makes sound when it is headed towards player</td>
<td>Television</td>
</tr>
<tr>
<td></td>
<td>Ook’s weapon makes sound when it allows smaller enemies to attack player</td>
<td>Television</td>
</tr>
<tr>
<td></td>
<td>Music changes to “Heroes’ Theme” when Ook is in vulnerable state</td>
<td>Television</td>
</tr>
<tr>
<td><strong>Eldin Province:</strong> Cluster 1: Task 1:</td>
<td>Enemies’ movements make sounds alerting players to presence</td>
<td>Television</td>
</tr>
<tr>
<td></td>
<td>Non-Diegetic Music changes with the presence of an enemy and when player enters battle</td>
<td>Television</td>
</tr>
</tbody>
</table>
### Task 2

#### Cluster 2:

**Task 1:**
- If player leaves one Twilit Messenger alive, then the Messenger shrieks, bringing others back to life
- Midna giggles near areas of interest, allowing them to access important areas

**Task 2:**
- Enemies’ movements make sounds alerting players to presence, despite being invisible
- Midna giggles near areas of interest, allowing them to access important areas
- When house is on fire, Non-Diegetic music turns frantic, suggesting danger by staying in the house

#### Cluster 3:

**Task 1:**
- Enemies’ movements make sounds alerting players to presence, despite being invisible

**Task 2:**
- Midna giggles near areas of interest, allowing them to access important areas
- Non-Diegetic Music changes with the presence of an enemy and when player enters battle
- If player leaves one Twilit Messenger alive, then the Messenger shrieks, bringing others back to life
- Enemies’ movements make sounds alerting players to presence, despite being invisible
- When house is on fire, Non-Diegetic music turns frantic, suggesting danger by staying in the house

#### Cluster 4:

**Task 1:**
- Sound of horse grows louder as horse draws near

**Task 2:**
- As horse’s strength returns, sound accompanies visual cues

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### Goron Mines

#### Cluster 1:

**Task 1:**
- Lava pillars make sound as they rise, allowing players to dodge/time attempts to jump
- Switches have timers that increase in speed as switch is about to turn back on

**Task 2:**
- Lava pillars make sound as they rise, allowing players to dodge/time attempts to jump
- Successful attacks on enemies sound different than unsuccessful ones
- Stone slab makes sound as it moves, allowing players to see if they have time to get past it
- Sound of Iron Boot footsteps change when on magnetic surfaces, helping player recognize they are successfully attached

**Task 2:**
- Sound of Iron Boot footsteps change when on magnetic surfaces, helping player recognize they are successfully attached
- Sound of crane’s movement alerts player to its approach

**Task 1:**
- Switches have timers that increase in speed as door is about to close
- Before Beamos attack, they make a sound, allowing player to dodge
- Sound of Iron Boot footsteps change when on magnetic surfaces, helping player recognize they are successfully attached
<table>
<thead>
<tr>
<th>Cluster 4: Task 2:</th>
<th>Sound of Iron Boot footsteps change when on magnetic surfaces, helping player recognize they are successfully attached</th>
<th>Television</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster 4: Task 1:</td>
<td>Successful attacks on enemies sound different than unsuccessful ones</td>
<td>Television</td>
</tr>
<tr>
<td>Cluster 4: Task 2:</td>
<td>Sound of Iron Boot footsteps change when on magnetic surfaces, helping player recognize they are successfully attached</td>
<td>Television</td>
</tr>
</tbody>
</table>

| Sacred Grove: Cluster 1: Task 2: | Z-Targeting makes “lock sound” onto appropriate part of bridge | Television |
| Sacred Grove: Cluster 2: Task 1: | Skull Kid plays melody from a horn, and this melody can be heard in the rooms the Skull Kid is in | Television |
| Sacred Grove: Cluster 2: Task 2: | Skull Kid plays melody from a horn, and this melody can be heard in the rooms the Skull Kid is in | Television |
| Sacred Grove: Cluster 3: Task 1: | Skull Kid plays melody from a horn, and this melody can be heard in the rooms the Skull Kid is in | Television |
| Sacred Grove: Cluster 3: Task 2: | Skull Kid’s horn blares when he summons enemies to attack you | Television |
| Sacred Grove: Cluster 4: Task 1: | Skull Kid’s horn blares when he summons enemies to attack you | Television |
| Sacred Grove: Cluster 4: Task 2: | Enemies’ movements and attacks make sounds alerting players to presence | Television |

| Sacred Grove: Cluster 1: Task 2: | Skull Kid plays melody from a horn, and this melody can be heard in the rooms the Skull Kid is in | Television |
| Sacred Grove: Cluster 2: Task 1: | Skull Kid’s horn blares when he summons enemies to attack you | Television |
| Sacred Grove: Cluster 2: Task 2: | Skull Kid’s horn blares when he summons enemies to attack you | Television |
| Sacred Grove: Cluster 3: Task 1: | Skull Kid’s horn blares when he summons enemies to attack you | Television |
| Sacred Grove: Cluster 3: Task 2: | Enemies’ movements and attacks make sounds alerting players to presence | Television |
| Sacred Grove: Cluster 4: Task 1: | Enemies’ movements make sounds alerting players to presence | Television |
| Sacred Grove: Cluster 4: Task 2: | Non-Diegetic Music changes with the presence of an enemy and when player enters battle | Television |
| Sacred Grove: Cluster 4: Task 2: | If player leaves one Twilit Messenger alive, then the Messenger shrieks, bringing others back to life | Television |
| Sacred Grove: Cluster 4: Task 2: | Successful attacks on enemies sound different than unsuccessful ones | Television |
| Sacred Grove: Cluster 4: Task 1: | Enemies’ movements make sounds alerting players to presence | Television |
Zehnder and Lipscomb (2006) continued their research by investigating the role of music specifically in the perception of a game and its elements. Unlike other research (Hébert et al., 2005; Tafalla, 2007; Wolfson and Case, 2000), there was no focus on performance. The researchers randomly assigned 76 students (63 university students and 13 high school students) to one of three conditions: with music, without music, and music-only. Participants played through three segments from The Lord of the Rings: The Two Towers (Electronic Arts, 2002), and following each segment researchers conducted a questionnaire with 21 continuous scale measures and a response form related to perception of the aural/visual components of the segment played. Results showed that participants’ responses to scale measures differed depending on whether music was present or not. However, Zehnder and Lipscomb did not discuss these findings, leaving many questions regarding the depth of the relationship between sound and video games unanswered.

Even if not directly focused on video game audio, literature exists that is of interest to understanding what sound might facilitate or enhance in video games. For performance, mixed results (Tafalla, 2007; Wolfson and Case, 2000) amplify the need for greater research into how sound impacts in-game performance. In the case of quality of experience, a more disparate array of literature warrants more research that can present a more coherent image of video game audio’s relationship with the player’s experience. However, Västfjäll’s (2003) findings signify the importance of sound in facilitating the feeling of presence or inducing changes in mood. Flow, which can be measured with time distortion (Skadberg & Kimmel, 2004), also plays a role in both how well one learns in a virtual space (Shin, 2006). How sound may affect either flow or time distortion is still unknown, and how sound functions with the interactive component of
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video games must be explored, as flow can be enhanced by interactivity (Skadberg & Kimmel). In addition, how sound affects control and effectance is unexplored, but warrants investigation considering how crucial the feeling of acting as a causal agent are to any game’s success. Ultimately, all characteristics of a game, both its competitive and immersive aspects, relate to a game’s success both in the hands of the player, and understanding how audio influences will lead to stronger game design.

The Present Study: Aims and Hypotheses

The aim of the present study was to investigate the effects of video game audio on players’ performance and quality of experience in the virtual environment created by the game. Despite the little research directly investigating the impact of audio on video game performance and quality of experience (Hébert et al., 2005; Tafalla, 2007), there is literature on the functions of music and sound in multimedia that can be applied to video game research (Bolivar et al., 1994; Boltz et al., 1991; Cohen, 1999; Csikszentmihalyi, 1975). In addition, there is also research examining components of immersion in relation to video games, but do not focus on video game audio as a possible factor (Klimmt et al., 2007). From these findings, the researchers hypothesize that players’ level of interaction with audio plays a role in facilitating both players’ performance and quality of experience. The levels of audio interactivity tested in the study are normal playing conditions or Full Sound (sound from both the television and Wii remote), Partial-Sound (sound from only the Wii remote), No Sound, and Non-Contingent Music (unrelated background music played on a nearby boombox). The authors hypothesize that: (1) higher interaction with audio will result in participants’ better performance; (2) higher interaction with audio will result in a better and more immersive playing experience, measured through multiple items including: enjoyment, (tele)presence, and flow; (3) higher interaction with audio will result in increased
frequency of reported time distortions; and (4) higher control over and ability to affect audio will result in greater enjoyment of play. In addition, we were also interested in exploring relationships between different variables relevant to the gaming experience, notably enjoyment, (tele)presence, and flow. We had no specific hypotheses for these examinations, because few (if any) previous studies have examined the relationship between the specific variables we included in our study.

Method

Participants

A total of 23 males participated in the study. Twelve were Kalamazoo College undergraduate students (mean age = 20.13 years, SD = 1.47) and 10 were Brigham Young University undergraduate students (mean age = 23.73 years, SD = 1.57). One participant was a high school senior (age = 18). Participants were recruited through e-mails and advertisements. Only 20 participants were included in the final sample as three participants from Brigham Young University were dropped because they failed to complete at least one cluster of tasks in a play session. All other participants completed at least one cluster for every play session. The dropped participants were replaced with two participants from Kalamazoo College and one high school senior.

Participants were required to have experience with Role-Playing Games (e.g., The Legend of Zelda series) and some experience with the Wii console. We requested that participants have experience with RPGs and the Wii console to minimize the amount of time needed for players to adjust to the new gaming experience. Participants were excluded if they had played The Legend of Zelda: Twilight Princess for either the Wii or Gamecube consoles. No participants played Twilight Princess before participating in the study.
Prequestionnaire: Video Game Experience. A pre-questionnaire revealed that more than half of the participants (N = 13) spent two to 10 hours playing video games on a weekly basis. The participants did not play RPGs as often though, and several (N = 14) reported playing RPGs for less than four hours a week. However, the 20 participants were familiar with The Legend of Zelda series, and played an average 3.63 of the 14 available games at the time of the study. The participants’ level of experience with The Legend of Zelda series ranged from three participants who played zero games to one participant who played 11 games. All participants were unfamiliar with The Legend of Zelda: Twilight Princess though. Participants also had limited experience with the Wii as a majority of participants (N = 13) noted that they spent less than two hrs weekly playing the Wii console. There were no significant differences on measures across location, so we did not include location as a variable.

Stimuli and Apparatus

Stimuli for this study were selected from levels within The Legend of Zelda: Twilight Princess video game for the Wii console. The five episodes selected were: “Gerudo Desert,” “Forest Temple,” “Elidn Province under Twilight,” “Goron Mines,” and “Sacred Grove/Temple of Time.” “Gerudo Desert” was used as a practice session to assist participants in acclimating to the game. All other sessions were played in experimental conditions in the order listed above. The character participants played as for all sessions was Link, the series’ human protagonist. In “Elidn Province under Twilight,” “Sacred Grove/Temple of Time,” and “Gerudo Desert,” players could play as a wolf. See Figure 1 for examples of scenes found in episodes 1 through 4. See Table 3 for detailed descriptions of episodes and examples of overall objectives given to participants. Sessions were played on a Nintendo Wii Entertainment System connected to an INSIGNIA NS-LCD19 LCD Television.
Figure 1
Scenes from Video Game Episodes Used in the Study

<table>
<thead>
<tr>
<th>Episode</th>
<th>Description</th>
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<tbody>
<tr>
<td>Episode 0:</td>
<td><em>Gerudo Desert</em> features the game’s protagonist and playable character, Link, exploring a large desert, bandit camp, and abandoned prison. The only objectives given to players were to learn how to play the game. As players move through the level, they are attacked by sandworms, bandits and skeleton soldiers. Used as the practice level.</td>
</tr>
<tr>
<td>Episode 1:</td>
<td><em>Forest Temple</em> features Link exploring the first dungeon of the game, which is a temple in the forest. The main objectives given to players were to save all the monkeys and defeat Ook the Bad Baboon. Eight monkeys are imprisoned and scattered throughout the temple and after rescuing monkeys, the monkeys begin to assist players in accessing new areas and finding secrets.</td>
</tr>
<tr>
<td>Episode 2:</td>
<td><em>Eldin Province under Twilight</em> features Link, in wolf form, exploring a mountain village trapped in twilight. Twilight causes the village to appear dark and transforms local creatures into enemies. The main objectives for players were to remove the influence of twilight by locating invisible twilit insects and defeating them. Special instructions were given to participants on how to perform a long-range jump that could not be practiced in earlier sessions.</td>
</tr>
</tbody>
</table>
**Episode 3:** *Goron Mines* features Link exploring a forge inside an active volcano. The main objectives for players were to locate key shards carried by Goron elders and defeat Dangoro the Goron, a large guard that protects one of the treasures in the level. There are multiple traps throughout the level, which can be deactivated temporarily. While deactivated, a non-diegetic timer sounds to inform the player of how long is left before the trap reactivates.

**Episode 4:** *Sacred Grove/Temple of Time* features Link exploring a hidden forest and temple. The main objectives for players were to locate the skull kid and find the Temple of Time. In order to find the skull kid, the player must look for light emitted from the skull kid’s lantern and the music coming from a flute the skull kid plays. The music the skull kid plays is an excerpt from the non-diegetic music playing during the level. Defeating the skull kid allows the player to find the temple.

Musical stimuli for the non-contingent sound condition were taken from within *Twilight Princess*. As mentioned earlier in the introduction, *The Legend of Zelda* series is known for its rich musical scores, and its use of recurring themes similar to operatic models. However, the music selected for the non-contingent sound condition was intended to not stand out or distract the player. The excerpts used were: “Ordon Village,” “Ordon Ranch,” “Lake Hylia,” “Hyrule Castle Town,” “Tobias and Geremias,” and “S.T.A.R. Game Room” (Minegishi, Ohta, & Kondo, 2006). The musical pieces were short digital compositions, and were orchestral in nature. There were no sound effects present in the music excerpts used. The pieces selected did not match the content of the episodes. The musical pieces were arranged on a 60-min compact disc (see Appendix H for arrangement). The compact disc was played on a SONY CFD-G55 CD-radio cassette recorder next to the television.

**Scoring**

*Performance.* Performance was one of the two central focuses of our scoring system. To measure performance, the researchers constructed a scoring guideline for each experimental episode, based on the tasks of each episode (See Appendix F). These
Effects of Video Game Audio

scoring guides were used to measure participants’ progress during sessions while they played. Criteria emphasized in every scoring guideline were players’ completion of “challenge clusters,” time management, and number of hits on the player that incurred damage. “Challenge clusters” refer to in-game overarching goals and the minor tasks they encompass. Completion of minor tasks are necessary to accomplish those overarching goals, and these minor tasks can be structured in a way that allows for certain sections, or “clusters,” of a specific challenge to be completed. For instance, in “Forest Temple,” a larger challenge would be saving all the monkeys, whereas a minor task within that challenge cluster would be defeating an enemy guarding a key that allows the player to complete a portion of the larger goal. Point scores were assigned for challenge clusters and minor tasks, and completion of clusters or tasks would award a player points.

In addition to scoring based on the completion of “challenge clusters,” players also received points for how quickly they completed “challenge clusters” (referred to as “time points” in this study). The number of times players fell or were damaged by enemies, obstacles, traps, or environmental dangers resulted in points being subtracted from a set number of points allotted for “hits.” Whenever a player lost all available life force in the game, and was forced to use a “continue,” a point penalty was instituted. The severity of a penalty was related to the amount of health available to the player in the episode. For instance, if a player died in an episode with a larger amount of health available, the penalty would be greater than if they died in an episode with a smaller amount of health available. Participants were not given any of the scoring criteria for performance.

**Questionnaire.** The other focus of our study was to measure player’s quality of gaming experience. A questionnaire was administered following all sessions played in
Effects of Video Game Audio

The 30-item questionnaire consisted of continuous scales measuring participants' experience of (tele)presence, focused attention, time distortion, and flow, which were adapted from measures used in previous studies (as shown in Table 4). In addition, the researchers created scales measuring control and effectance, and identification with avatar and emotion. During the final session of play, a form was administered to participants to rank sessions based on perceived length of time according to experimental condition.

Table 4

<table>
<thead>
<tr>
<th>Component of immersion</th>
<th>Items</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Tele)presence:</td>
<td>When the game ended, I felt like I came back to the “real world” after a journey.</td>
<td>Kim &amp; Biocca, 1997 (Barfield &amp; Weghorst, 1993; Slater, Usoh, &amp; Steed, 1994); Nicovich, et al. 2005</td>
</tr>
<tr>
<td></td>
<td>The television came to me and created a new world for me, and that world suddenly disappeared when the game ended.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>While playing, I felt I was in the world the game created.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>While playing, I never forgot that I was in the middle of an experiment.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>While playing, my body was in the room, but my mind was inside the world created by the game.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>While playing, the world created by the game was more real or present for me compared to the “real world.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The world created by the game seemed to me only “something I saw” rather than “somewhere I visited.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>While playing, my mind was in the room, not in the world created by the game.</td>
<td></td>
</tr>
<tr>
<td>Focused attention:</td>
<td>While playing the game, I was not distracted.</td>
<td>Shin, 2006; (Hani, 1995; Novak et al., 1998)</td>
</tr>
<tr>
<td></td>
<td>When interrupted by the research assistant, I felt annoyed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>While playing the game, I couldn’t seem to concentrate.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>While playing the game, I was unaware of what was going on around me.</td>
<td></td>
</tr>
</tbody>
</table>
Time Distortion:
- I was unconscious of the passing of time while playing the game.
- It felt like time flew while I was playing the game.

Flow:
- I was totally involved in what I was doing.
- I seemed to be cut off from the “real world” that was physically around me.
- I was really quite oblivious to my surroundings after I got going.
- I felt less aware of myself and my problems.

Identification with avatar and emotion:
- My character’s personality is a lot like my own.
- I felt many of the emotions that my character might have been feeling.
- While playing, I felt emotionally involved in the events happening in the virtual world around my character.

Control and effectance:
- It was easy to control the actions and movements of my character.
- After doing something or going somewhere, I often did not know where it was the right thing to do.
- Many events happened often without warning and caught me by surprise.
- While playing, I felt a strong sense of mission or clear goals in mind.
- While playing, I felt unsure about what to do or somewhat lost.

Shin, 2006; Skadberg and Kimmel, 2004
Chen et al., 2000 (Csikszentmihalyi, 1975)
The present authors

Procedure

The procedure employed a within-subjects design. Each participant attended five one-hour individual sessions. All sessions were run in a small laboratory equipped with a television, a small boombox, and a couch.

Practice/Orientation Session. The first of the five sessions was a practice meeting that allowed the participants to familiarize themselves with the game play, controls, and laboratory setting. Participants played for 45 minutes with both audio from the television and the Wii remote (i.e., in normal playing conditions). During this practice meeting they were informed that continued involvement across the four experimental sessions would enter them into a tournament. The winner would receive The Legend of
Zelda: Twilight Princess game for the Wii and 50 dollars cash. A tournament structure was used as an incentive to encourage participants to complete all sessions and play as well as they would in a real-world setting. Participants also completed a pre-questionnaire to assess their previous video game experience. They then signed an agreement stating that they would not play Twilight Princess or consult Twilight Princess strategy guides outside of their sessions. After the practice meeting, the participants returned to the lab for four sessions on four consecutive days.

Experimental Sessions. The four sessions following the practice meeting were played in experimental conditions. The four conditions participants played in were: (1) Full Sound, (2) Partial-Sound, (3) No Sound, and (4) Non-Contingent Music. The Full Sound condition featured Twilight Princess with audio from both the television and the Wii remote (i.e., normal playing conditions). The Partial-Sound condition involved playing the video game with no audio from the television, but audio from the Wii remote. The No Sound condition had no audio at all. The Non-Contingent Music condition featured the video game with a pre-recorded soundtrack of music taken from other levels within the game, but no corresponding audio to the actions of the player. The sound conditions participants played in were randomized across the four sessions. However, the order of the video game episodes played during the experimental sessions stayed consistent due to the graduated scheme of the episodes. Each episode contained certain demands and intrinsic rules (e.g., items interact with sections of the environment in a certain way) that players would need to learn to progress in subsequent episodes.

Before every experimental session, participants were reminded of the tournament and instructed to do their best. Participants were also told:
During these 4 sessions, you may sometimes be playing under special conditions, which might be a little different from normal. If you notice anything different today, don’t stop - just keep playing.

These instructions were to keep players focused on their objectives rather than experimental manipulations. Researchers also collected the participants’ time-keeping devices so they would not be able to keep track of time while playing.

Participants played for 45 minutes per session. Researchers sat behind participants while they played so they could observe participants’ game play without distracting them. If players lost all their health, they were instructed to use a “continue” and keep on playing. Players were also given a hint if they spent longer than 22.5 minutes on a task. The only other interaction the researchers had with the participants was to ask the players how long they felt they had been playing. This question was asked twice during the session to determine whether participants experienced time distortion. After participants completed 45 minutes of play in each session, researchers administered the questionnaire.

After participants completed their session and were leaving, researchers made seemingly candid remarks such as, “By the way - based on what I saw today, I think you’re somewhere towards the top so far.” The bogus feedback was used as an equalizer to make sure participants would be encouraged to do well.

This procedure was repeated until all four experimental sessions were completed. After finishing the final session in the study, participants completed the session rankings form. This final form asked participants to rank their four sessions on perceived length. Before participants left the final session, they were individually debriefed.
Results

Effects of Sound Manipulation

A one-way repeated measures analysis of variance [ANOVA] was run for each performance measure, with sound condition as the within-subjects factor. Surprisingly, no significant effects were found for sound condition on total performance points, time points, cluster points, or hit points. The performance scores were run as raw scores and also converted into ordinal data, and neither analysis yielded significant results for these performance measures.

The only significant finding for sound condition was for the number of “continues” used during play, $F(3, 57) = 3.34, p < .026$. As a continue allows a gamer to keep playing when one would otherwise have run out of power and would have had to quit the game, this is an important finding, which will be addressed in the discussion. As shown in Table 5, most continues were requested in the No Sound condition ($M = 2.6, SD = 2.21, range = 0 to 7$), followed by Partial-Sound ($M = 2.1, SD = 1.41, range = 0 to 5$), and then Full Sound condition ($M = 1.45, SD = 1.67, range = 0 to 5$). Surprisingly, participants used the least number of continues in the Non-Contingent Music condition ($M =1.0, SD = 1.52, range = 0 to 6$).

<table>
<thead>
<tr>
<th>Sound Condition</th>
<th>Total Score</th>
<th>Time Points</th>
<th>Cluster Points</th>
<th>Hit Points</th>
<th>Number of Continues Used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
</tbody>
</table>

Table 5

Effects of Sound Condition on Performance Measures
Recalculated Data. Because the number of continues varied with sound condition, we computed the number of clusters completed and the amount of time played that the participants would have earned without continues. Doing this allows us to see how participants might have performed if we stopped them before using their first continue. The recalculated number of clusters were calculated by counting all clusters (full and partial) a participant finished until a continue was first used. When an individual had multiple continues in the cluster they used their first continue, we assigned a partial cluster completion for that cluster. This way, participants would not be credited with full completion of clusters before using a continue, but still receive credit for the progress made. The recalculated playing time was determined by the length of time participants played before using their first continue. This method tended to overestimate individuals’ actual playtimes as the times used were when participants completed the cluster, not when the continues occurred. Actual playing times may have been shorter for certain participants, and if there were no time limit on sessions, certain participants’ times may be even longer as they did not use a single continue. Similar to the method used with the number of clusters completed, if multiple continues occurred...
during the cluster, then the time taken to complete the cluster was divided by the number of continues used. By doing this, we were better able to approximate the amount of time participants played before using a continue.

One-way repeated measures ANOVAs were run for the number of clusters completed and the amount of time played (using the recalculated measures, as described above). Sound condition was used as the within-subjects factor. Significant effects were found for both the number of clusters completed, $F(3, 57) = 3.17, p < .05$, and the amount of time played, $F(3, 57) = 3.7, p < .05$. Continuing with our surprising findings, participants did best overall in the Non-Contingent Music condition, as they completed an average of 2.6 clusters (SD = .33) and played an average of 33.3 minutes (SD = 3.42 minutes) before using a continue. For clusters completed, participants did next best in the Full Sound condition (M = 2.05, SD = .32), then in the Partial-Sound condition (M = 1.64, SD = .24), and finally in the No Sound condition (M = 1.36, SD = .29). Results were similar for time spent playing, as participants played second longest in the Full Sound condition (M = 30.3 minutes, SD = 3.63). However, participants did play for slightly longer in the No Sound condition (M = 20.53 minutes, SD = 3.835) than they did in the Partial-Sound condition (M = 19.405 minutes, SD = 2.66). These findings suggest that having greater interaction with sound did have a significant effect on the number of tasks players completed and the amount of time they were able to play without running out of ‘life,’ once players’ use of continues were applied to their performance. The results also continue to illustrate our surprising finding of Non-Contingent Music facilitating participants’ best performance.

*Trends.* In addition to these significant findings for the recalculated performance data, it should be noted that there were some interesting trends for earlier performance scores collected. The lowest mean score for performance across all four sessions was for
the No Sound condition (M = 196.45, SD = 85.27). This trend was in the predicted direction. Interestingly, the highest mean performance scores were earned in the Non-Contingent Music condition (M = 248.14, SD = 87.72). The Contingent Full Sound (M = 227.43, SD = 90.93) and Contingent Partial-Sound (M = 232.67, SD = 84.5) conditions yielded very similar performance scores in between the No Sound and Non-Contingent Music scores. These trends are rather interesting in that sound did seem to have an effect, albeit not significant.

Also, when all participants were ranked on the basis of the grand total scores for all four sessions and divided into Top-scoring, Moderate-scoring, and Low-scoring groups (each consisting of approximately one-third of the sample), some interesting trends were observed. First, as shown in Table 6, the lowest performance scores for each of the three groups were again earned in the No Sound condition. In other words, regardless of their level of proficiency, participants tended to earn their lowest scores when playing in silence.

<table>
<thead>
<tr>
<th>Sound Condition</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Top</td>
<td>Moderate</td>
</tr>
<tr>
<td>Full Sound</td>
<td>316.99</td>
<td>198.07</td>
</tr>
<tr>
<td>Partial-Sound</td>
<td>283.05</td>
<td>243.95</td>
</tr>
<tr>
<td>No Sound</td>
<td>253.26</td>
<td>173.18</td>
</tr>
<tr>
<td>Non-Contingent Music</td>
<td>309.8</td>
<td>263.1</td>
</tr>
<tr>
<td>Total Score</td>
<td>290.78</td>
<td>219.58</td>
</tr>
</tbody>
</table>
The data in Table 6 also hint at possible individual differences among the participants. Playing with Contingent Full Sound yielded very different performances for the three groups: Whereas the Top-scoring group performed best in the Contingent Full Sound condition, participants in the Low-scoring and Moderate-scoring groups both earned their second lowest mean performance scores when playing with Contingent Full Sound. Also, the range of mean performance scores for the lowest and highest scores across the four sound conditions was much wider for the Moderate-scoring group (173.18 to 263.1 points) and Top-scoring group (253.26 to 316.99 points) than for the Low-scoring group (that had a narrow range of 159.6 to 173.27 points). In other words, the manipulation of sound conditions seemed to have a rather negligible effect on performance scores for the lowest-scoring group.

There was also a significant relationship between sound condition and time duration rankings. This pertains to the item given to participants at the conclusion of the final session: “Please rank your sessions according to how long they seemed to be (1 = shortest; 4 = longest).” Sound condition had a significant effect on time duration rankings, chi-square (19) = 13.564, \( p = .004 \), phi coefficient = .614. Condition one was associated with the highest rankings (more ones and twos) and condition three with the lowest rankings (more threes and fours). In other words, participants indicated that the Full Sound sessions seemed shortest (Mean Ranking = 1.79), while the No Sound session felt longest (Mean Ranking = 3.32). Participants felt that the Partial-Sound condition (Mean Ranking = 2.42) and Non-Contingent Music condition (Mean Ranking = 2.47) were average in length. In other words, the level of sound affected participant’s perception of the length of play sessions.

Finally, there were no significant effects of sound condition on any of the ratings in our questionnaire. Surprisingly, sound condition did not have any systematic effects
for enjoyment of game, self-appraisal of performance, (tele)presence, focused attention, time distortion, flow, identification with avatar, or control and effectance. The wide variances in responses within sound condition showed that the same playing conditions led to very different ratings of subjective experience of the game with respect to these measures.

**Episode Effects**

Of secondary interest to this study was whether the video game episodes used had any effects on performance and immersion. The four episodes used in the experimental sessions are described in Table 3 in the Method.

For episode, a series of one-way, repeated measures analyses of variance were conducted. In each case, one of the performance scores was used as the dependent variable and the episode variable was the independent variable. All performance scores (and subscores) were significant: total score, $F(3, 57) = 15.01, p < .001$, time points, $F(3, 57) = 20.50, p < .001$, cluster points, $F(3, 57) = 16.55, p < .001$, hit points, $F(3, 57) = 9.12, p < .001$, and number of continues, $F(3, 57) = 13.21, p < .001$. The means are shown in Table 7. Participants did best in Episode 4 for all performance scores except hit points. Participants’ next best performance scores occurred during Episode 1 and then in Episode 3, although they reversed for certain performance measures. Participants did their worst in Episode 2, except for hit points.

<table>
<thead>
<tr>
<th>Episode Number</th>
<th>Total Score**</th>
<th>Time Points**</th>
<th>Cluster Points**</th>
<th>Hit Points**</th>
<th>Number of Continues Used**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
</tbody>
</table>

**Table 7**

*Effects of Episodes on Performance Measures*
Episode effects were also found for some measures in the questionnaire assessing the overall quality of participants’ gaming experience. One of the main variables of interest among the ratings were our measures of “(tele)presence,” or the psychological state in which the individual experiences virtual objects as actual objects. We focused on (tele)presence to determine to what extent participants felt present within the different sessions, which could possibly explain their experience of other aspects of immersion. It could also be used to see whether certain episodes possessed environments that facilitated this particular aspect of an immersive experience more so than others did. To assess the effect of episode on the (tele)presence items, a repeated measures multivariate analysis of variance was conducted. The session variable was the independent variable and the set of eight (tele)presence measures (which correspond with Questions 5 to 12 in Appendix I) were the dependent variables. A significant multivariate effect was found for (tele)presence, $F$ approx. $(3, 57) = 1.8$, $p = .018$. Follow-up univariate tests found a significant effect for Question 10, $F(3, 57) = 5.76$, $p = .002$. This item was “While playing, the world created by the game was more real or present for me compared to the ‘real world’” (Strongly disagree-Strongly agree). Means for this question steadily rose with each subsequent episode, beginning with episode 1 ($M = 47.65$, $SD = 24.64$). Means continued to increase in episode 2 ($M = 57.65$, $SD = 26.54$) and episode 3 ($M = 67.45$, $SD = 37.74$). Participants responded highest in their
final episode of play, episode 4 (M = 70.25, SD = 28.86). The means for this question revealed an upward increase in ratings with each episode. This suggests that increased interaction with the game over time may heighten the experience of perceiving the virtual world as more real, regardless of other factors such as sound.

Other variables of central interest to our study were the “Control and Effectance” ratings, which referred to the player’s perception of their ability to control their avatar and feel that they were a causal agent within the virtual environment. To see what effect episode had on experiencing “Control and Effectance,” a repeated measures multivariate analysis of variance was conducted on five measures (items 26 to 30). A Significant multivariate effect for Control and Effectance was found, F approx. (3, 57) = 2.96, p < .001. Follow-up univariate tests revealed a significant effect for Question 29, F(3, 57) = 3.83, p = .014. This item was, “While playing, I felt a strong sense of mission or clear goals in mind” (Strongly disagree-Strongly agree). For this question, participants felt that they had the strongest sense of mission in episode 2 (M = 110, SD = 20.08), followed by Episode 3 (M = 100.05, SD = 17.97), then in Episode 1 (M = 93.1, SD = 30.94) and finally in Episode 4 (M = 87.2, SD = 26.5). This finding is particularly surprising as participants tended to perform worst in Episode 2, but found it to be the episode where they had the clearest goals. The converse was also found, as participants felt they did not have a strong sense of mission in Episode 4, even though they performed best in that episode. This may suggest that having a strong sense of mission or clear set of goals during episodes may be independent of actual performance. It could also suggest that certain episodes supported feelings of control and effectance more than others.
Overall Rankings and Previous Gaming Experience

Only one item in the questionnaire addressing participants’ previous video game experience was found to serve as a reliable predictor for overall ranking and overall score for the 20 participants included in the study. The number of games previously played in the Legend of Zelda series represented the only reliable predictor for overall ranking, \( r(20) = -0.596, p = 0.007 \), and overall score (grand sum of performance scores for all four episodes), \( r(20) = 0.590, p = 0.008 \). In other words, the more Legend of Zelda games a participant had played before, the closer to rank 1 (top score) and the higher the overall score. The number of hours spent playing role-playing games, playing Nintendo Wii, and playing video games in general, were not significantly correlated with overall ranking or overall score.

Other General Findings

As we were also interested in performance and quality of gaming experience more generally, we conducted additional analyses that did not focus specifically on effects of sound. Analyses of these data yielded some interesting findings of more general interest to video game research, as the author discovered while presenting a portion of the results of this study at a research session for the Meaningful Play Conference (Michigan State University, October 9 to 11, 2008). These additional findings seem to be of particular interest to other video game researchers and game developers.

Enjoyment, Self-Appraisal, and Performance Scores. Whereas our main analyses focused on aspects of immersion, we also assessed whether relationships were found between the most basic aspects of game play: performance, enjoyment of play, and appraisal of one’s own performance. We conducted Pearson \( r \) correlations with three measures: enjoyment (Question 1), self-appraisal of performance (Question 3), and actual performance. Correlations revealed positive significant relationships between
self-appraisal of performance and actual performance, \( r (80) = .433, p < .001 \), and self-appraisal of performance and enjoyment, \( r (80) = .667, p < .001 \). There was also a marginally significant positive relationship between enjoyment and actual performance, \( r (80) = .217, p < .053 \). The positive relationships between self-appraisal and the other basic aspects of game play hint that many gamers are often astute in their self-assessments and these assessments are often related to how much they enjoy playing. However, the marginally significant relationship between enjoyment and actual performance suggests that enjoyment may not always be tied to actual performance, and that self-appraisal has a stronger relationship with enjoying play.

**Performance Scores and Ratings.** Correlations between any ratings and individual performance measures were also of interest. Pearson r correlations were conducted on all the ratings with the following performance measures: Total score (Total), Grand total (Grand), Time points (TP), Cluster points (CP), Hit points (HP), and Number of continues used (Cont). (Significant correlations between performance and number of continues have already been discussed in a separate section). See Table 8 for the list of ratings that were significantly correlated with performance measures.

<table>
<thead>
<tr>
<th>Table 8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Significant Correlations for Questionnaire and Performance</strong></td>
</tr>
<tr>
<td>Aspect of Immersion</td>
</tr>
<tr>
<td>Self-Appraisal:</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
### (Tele)presence:
8: While playing, I never forgot that I was in the middle of an experiment.
11: The world created by the game seemed to me only “something I saw” rather than “somewhere I visited.”

- .245*
- .27*

### Focused attention:
14: When interrupted by the research assistant, I felt annoyed.

.28*  .26*  .23*  -.26*

### Flow:
19: I was totally involved in what I was doing.

.24*  .235*

### Identification with avatar and emotion:
23: My character’s personality is a lot like my own.

-.49*

### Control and effectance:
29: While playing, I felt a strong sense of mission or clear goals in mind.

.24*

*p < .05, **p < .001

These findings illustrate a more complex view of how individual measures of performance relate to the different aspects of immersion, notably the negative correlation found between identification with the avatar and grand total score. This particular finding suggests that as participants did better overall they identified less with the avatar. In addition to these findings, we also found correlations between self-appraisal and individual performance measures, which reflect our previous findings between self-appraisal and actual performance. These particular findings suggest that players are not only attuned in their perception to how well they do overall, but also to specific areas of performance, such as time management.

**Enjoyment, Self-Appraisal, and Ratings.** We also assessed whether relationships could be found between enjoyment and self-appraisal of performance and the other
ratings of immersion that were collected. A series of Pearson r correlations were conducted on ratings of (tele)presence, focused attention, time distortion, flow, identification with avatar and emotion, and control and effectance. Correlations for all measures are in Table 9 below.

Table 9

<table>
<thead>
<tr>
<th>Aspect of Immersion</th>
<th>Items</th>
<th>Enjoyment</th>
<th>Self-Appraisal</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Tele)presence:</td>
<td>6: The television came to me and created a new world for me, and that world suddenly disappeared when the game ended.</td>
<td></td>
<td>.28*</td>
</tr>
<tr>
<td></td>
<td>7: While playing, I felt I was in the world the game created.</td>
<td>.22*</td>
<td>.25*</td>
</tr>
<tr>
<td></td>
<td>9: While playing, my body was in the room, but my mind was inside the world created by the game.</td>
<td>.26*</td>
<td>.28*</td>
</tr>
<tr>
<td>Focused attention:</td>
<td>13: While playing the game, I was not distracted.</td>
<td>.35**</td>
<td>.24*</td>
</tr>
<tr>
<td></td>
<td>15: While playing the game, I couldn’t seem to concentrate.</td>
<td>.41**</td>
<td>.43**</td>
</tr>
<tr>
<td></td>
<td>16: While playing the game, I was unaware of what was going on around me.</td>
<td></td>
<td>.24*</td>
</tr>
<tr>
<td>Time Distortion:</td>
<td>18: It felt like time flew while I was playing the game.</td>
<td>.27*</td>
<td>.22*</td>
</tr>
<tr>
<td>Flow:</td>
<td>19: I was totally involved in what I was doing.</td>
<td>.43**</td>
<td>.46**</td>
</tr>
<tr>
<td></td>
<td>21: I was really quite oblivious to my surroundings after I got going.</td>
<td>.23*</td>
<td>.29*</td>
</tr>
<tr>
<td></td>
<td>22: I felt less aware of myself and my problems.</td>
<td>.26*</td>
<td>.36**</td>
</tr>
</tbody>
</table>
Effects of Video Game Audio

Identification with avatar and emotion:
24: I felt many of the emotions that my character might have been feeling. .25*
25: While playing, I felt emotionally involved in the events happening in the virtual world around my character. .485**

Control and effectance:
26: It was easy to control the actions and movements of my character. .33*
27: After doing something or going somewhere, I often did not know where it was the right thing to do. .30*
29: While playing, I felt a strong sense of mission or clear goals in mind. .365**
30: While playing, I felt unsure about what to do or somewhat lost. .455**

*p < .05, **p < .001

We observed several interesting correlations between enjoyment, self-appraisal of performance, and all the ratings of immersion. Most items from each component were significantly correlated with both enjoyment and self-appraisal, suggesting that certain components, such as flow or control and effectance, are central to the experience of playing. For instance, the correlations observed from the (tele)presence category indicate that the feeling of being present in the virtual world is positively linked to both enjoying play and one’s perception of his or her own performance. Another similar positive relationship with enjoyment and self-appraisal was found for flow, signifying that feeling one is involved in his or her actions is related to the experience of gaming as well. From the overall results, it appears that a varied and rich immersive experience is related to one’s enjoyment and self-appraisal of playing.

Correlations Between Ratings. As we collected rich data on many aspects of game play, we also investigated whether certain aspects were significantly linked to one another. Some of these findings are of definite interest to gaming research and design, as determining which aspects of game play relate to one another contributes to the
understanding and creation of a cohesive gaming experience. All of the 26 ratings were analyzed with Pearson $r$ correlations, and relevant findings are presented in Table 10.

For a complete list of all questionnaire items, see Appendix I.

Table 10

<table>
<thead>
<tr>
<th>Aspect of Immersion</th>
<th>Items</th>
<th>Correlated Ratings*</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Tele)presence:</td>
<td>Q5</td>
<td>Q6 (.84), Q7 (.73), Q8 (.4), Q9 (.57), Q10 (.65), Q11 (.54), Q12 (.44); Q14 (.35), Q16 (.36); Q18 (.37); Q19 (.3), Q20 (.565), Q21 (.51), Q (.33); Q23 (.24), Q24 (.37), Q25 (.37)</td>
</tr>
<tr>
<td></td>
<td>Q6</td>
<td>Q7 (.69), Q8 (.45), Q9 (.45), Q10 (.58), Q11 (.625), Q12 (.46); Q14 (.37), Q15 (.26), Q16 (.35); Q18 (.34); Q19 (.39), Q20 (.57), Q21 (.54), Q22 (.38), Q24 (.41), Q25 (.39)</td>
</tr>
<tr>
<td></td>
<td>Q7</td>
<td>Q8 (.44), Q9 (.67), Q10 (.69), Q11 (.57), Q12 (.425); Q13 (.37), Q15 (.35), Q16 (.38); Q18 (.3); Q19 (.36), Q20 (.51), Q21 (.505), Q22 (.38); Q23 (.3), Q24 (.47), Q25 (.46)</td>
</tr>
<tr>
<td></td>
<td>Q8</td>
<td>Q9 (.25), Q10 (.32), Q11 (.5), Q12 (.34); Q14 (.4), Q16 (.28); Q19 (.25), Q20 (.31), Q21 (.26); Q23 (.26)</td>
</tr>
<tr>
<td></td>
<td>Q9</td>
<td>Q10 (.54), Q11 (.36), Q12 (.54); Q13 (.43), Q15 (.28), Q16 (.56); Q18 (.515); Q19 (.55), Q20 (.605), Q21 (.58), Q22 (.49); Q23 (.3), Q24 (.6), Q25 (.51); Q26 (.38)</td>
</tr>
<tr>
<td></td>
<td>Q10</td>
<td>Q11 (.33), Q12 (.285); Q14 (.225), Q15 (.25), Q16 (.52); Q18 (.26); Q19 (.24), Q20 (.565), Q21 (.565), Q22 (.28); Q23 (.29), Q24 (.39), Q25 (.455)</td>
</tr>
<tr>
<td></td>
<td>Q11</td>
<td>Q12 (.3); Q14 (.25), Q15 (.28); Q19 (.24), Q20 (.375), Q21 (.31)</td>
</tr>
<tr>
<td></td>
<td>Q12</td>
<td>Q15 (.33); Q18 (.28); Q19 (.475), Q20 (.35), Q21 (.31), Q22 (.29); Q24 (.41); Q25 (.53)</td>
</tr>
<tr>
<td>Focused attention:</td>
<td>Q13</td>
<td>Q15 (.42); Q18 (.29); Q19 (.43), Q21 (.22), Q22 (.49); Q24 (.3); Q26 (.3), Q28 (.23)</td>
</tr>
<tr>
<td></td>
<td>Q14</td>
<td>Q16 (.33); Q20 (.38), Q21 (.265); Q29 (-.32)</td>
</tr>
</tbody>
</table>
Finally, a complete matrix of correlations for all items revealed several significant relationships between the different aspects. Some of these relationships are very interesting and illustrate how different aspects can enhance each other when working in conjunction. *(Tele)presence* was a notable category as it correlated with several other categories of items positively. Items corresponding with *(tele)presence* were almost entirely correlated with items measuring *flow*, which was another notable category. Items in *(tele)presence* also had a considerable number of correlations with items in
focused attention and identification with avatar. All (tele)presence measures were also significantly correlated with one another. The (tele)presence category’s strong correlation with other aspects suggests that (tele)presence may have a particularly central influence in the enhancement of focused attention, flow, and identification with avatar. This may hint that one of the crucial aspects of immersion come from elements related to (tele)presence.

We also observed a rather surprising finding with control and effectance, as the category was not strongly correlated with any other categories. The lack of findings may suggest that control and effectance, which concerns the level one feels in control of his or her actions and possessing the ability to cause change within the virtual environment, may be mediated by the demands on the game and not have been as applicable to the RPG used in the study. However, the demands of the game did facilitate the relationships between the other aspects of immersion, signifying that the aspects of immersion experienced may relate to the type of game played and that the different aspects can occur independently of one another.

Discussion

The purpose of the present study was to investigate the effects of different levels of video game audio on players’ performance and quality of gaming experience in a Role-Playing video game. We employed a within-subjects design, and participants played through four sessions of The Legend of Zelda: Twilight Princess for the Wii console. Over the four sessions, we collected and analyzed data regarding performance and ratings of the gaming experience in four conditions: Full Sound (sound from both the television and the Wii controller), Partial-Sound (sound from only the Wii controller), No Sound, and Non-Contingent Music (unrelated musical tracks taken from other episodes of the same game).
Our study is relevant to the future of video game development and research, as few studies have investigated how sound influences players’ performance or gaming experience (Hébert et al., 2005; Tafalla, 2007; Wolfson & Case, 2000). As the video game industry becomes more accessible to mainstream markets, and simultaneously incorporates more complexity for more advanced players, it is essential to determine if sound affects performance or enhances the gaming experience. Understanding whether playing with sound facilitates game play or how one experiences the virtual world can lead to future development of sound and more immersive gaming experiences. It was our prediction that playing with less access to sound, or with non-contingent music, would have a negative impact on players’ performance and gaming experience. We predicted that players would play best and have a higher quality gaming experience in conditions that best resembled normal playing conditions.

However, our findings suggest that players’ interaction with sound does not occur in a systematic fashion, and that sound can have varied effects on gamers’ performance and quality of experience. Just as games create a virtual world for players to interact in their own way, video game sound factors into individual play differently depending on many factors such as the demands of the game or the skills of the player. Overall, the ways in which players interact with sound is more complex than originally conceived.

*Effects of Sound on Performance*

Although our original analyses appeared to show that lack of sound did not have a deleterious effect on performance, it was surprising because video game audio cues are designed to provide numerous cues and hints to the player. These enhance the performance of the player in completing tasks, such as those found in each episode. (See Tables 1 and 2 for a general catalog of all sounds found in the episodes used in the
present study and for a table listing how video game audio cues may facilitate task completion in each episode). However, our original analyses found that participants’ use of “continues” did vary significantly with sound condition. Participants used the most continues in the No Sound condition, followed by the Partial-Sound and Full Sound conditions, and used the least continues when playing with Non-Contingent Music. This suggests that without sound, participants played worse overall and were more likely to lose their lives.

This finding led us to realize that use of ‘continues’ may have served as an equalizer and may have allowed participants to compensate for weak performances in certain conditions, and thus inflate their scores for other performance measures. As a result, we recalculated performance data as if participants had not been able to use continues. When participants’ performances were examined without continues, participants completed significantly more tasks and played longer in the Full Sound condition, followed by Non-Contingent Music, and finally by Partial-Sound and No Sound (although these last two were reversed for length of play). These subsequent analyses revealed that sound did indeed significantly affect participants’ task completion and length of play. This significant finding echoes previous significant findings for sound enhancing gaming performance (Tafalla, 2007).

In addition, on closer examination of the overall ranking of our participants based on their total performance scores (as shown in Appendix G), we observed a difference between the top scorers and the rest of the participants. Specifically, we noted that five of the seven top players earned their highest or second highest scores of their four sessions when playing in the Full Sound condition, while only four of the remaining 16 participants earned their highest or second-highest score in the Full Sound condition. This includes the three low-scoring participants who were excluded from the
rest of the analyses (see Method section). Indeed, as noted in our results, the bottom two-thirds of the participants earned their second lowest score in the Full Sound condition. In other words, trends were seen in the expected direction for presence of sound in the top third of our participants, while scores were more randomly distributed among the four sound conditions for the rest of the gamers who participated in our procedure.

What this suggests is that the most successful gamers may pay more attention to audio cues and audio feedback during game play. Thus, providing full sound tended to lead to high scores, while removing sound seemed to have a deleterious effect on the performance of the top third of all our participants. The majority of participants, however, may not have paid as much attention to sound while playing, so that presence or absence of audio did not seem to facilitate or interfere with performance in a systematic fashion. Thus, one of the main differences between top gamers and more average players could be the degree of attention to sound cues and feedback, or their ability to respond effectively to these audio “clues” while playing. Previous research has asserted that competitive elements induce stronger performances from the most competent participants (Worchel et al., 1997), but the trends observed here suggest that better players may benefit from approaching the game differently as well. The best players may in fact be making better use of the audio aspects of interactive audiovisual games than the average gamer.

Indeed, it was interesting to note that the highest-scoring participant referred to sound in his responses to the open-ended questions (See Appendix I for Questions 2 and 4) for all sessions in which sound was directly manipulated. Participant 1’s remarks included: “Did not enjoy the game as much without sound” for the Partial-Sound condition; “I didn’t like it as much without sound” for the No Sound condition;
and “There was at least some sound today” for the Non-Contingent Music condition. It is also particularly interesting to note that his comment about sound for the Non-Contingent Music condition was the only comment he listed for the question! He was the only one of the 23 participants who were run through the procedure to mention sound in his responses to these questions for all sessions in which sound was manipulated.

Although the way sound can convey information ranges from dramatic to subtle, becoming a more effective player may rely on developing an ear for the subtle cues. The most subtle changes in sound, such as the difference between a successful or unsuccessful sword strike, give feedback to the player and allow them to adapt to their situation as well as they are able to interpret the feedback. Many players, regardless of skill, probably recognize dramatic changes in non-diegetic music and their messages, such as announcing the appearance of enemies. However, it most likely requires greater skill to detect smaller changes in the sound emitted from the game, and then decipher their meaning. Episode 2 contained many subtle sounds, and this incorporation and its results will be discussed later.

*Effects of Sound on Quality of Gaming Experience*

Whereas sound had a significant effect on performance, we observed no significant effects of sound on questionnaire ratings measuring the quality of gaming experience. However, post-session rankings of perceived length of sessions revealed that participants perceived the No Sound condition to last longest as opposed to the Full Sound condition, which was felt to be shortest. This suggests that, while a majority of ratings were not significant (including some time distortion ratings), sound did still have an effect on perception of episode length.
Even with this finding, one might expect that many aspects of the quality of the gaming experience – particularly with respect to enjoyment, immersion, and perceived control – would vary with presence or absence of contingent sound. As shown in Table 1, the sound effects and music in *Twilight Princess* are rich and varied, and are provided by many different sources both on and off screen (diegetic and non-diegetic). In addition, sound has been found to facilitate presence and emotion (Västfjäll, 2003), and also how individuals perceive the aesthetics of a game (Zehnder & Lipscomb, 2006). Surprisingly, however, no significant effects were found for sound condition on self-ratings for enjoyment of game, self-appraisal of performance, (tele)presence, focused attention, time distortion, flow, identification with avatar, or control and effectance. Indeed, the wide variances in ratings for the same sound conditions suggest that gamers are not a homogeneous group, but respond very differently to the same playing conditions, at least with respect to video game audio in role-playing games.

Many role-playing games incorporate non-linear game play into their designs, allowing participants to roam environments freely. *The Legend of Zelda* was one of the first series to incorporate this sort of play (Long, 2000; Vestal et al., 2008). As there is so much freedom in how one can interact with a virtual RPG world, one could understand why individuals respond to sound in such a diverse way. Completely unprompted, Participant 17 noted by his low rating for Question 11, “The world created by the game seemed to me only ‘something I saw’ rather than ‘somewhere I visited’” that there was, “No sound!” Just as participants used sound differently to impact their performance, participants may use sound or rely on other factors for immersion. It appears that sound may play a notable role for some in an open-ended game, but not for all.
Effects of Non-Contingent Music

An unexpected finding was that the highest means for total performance score, most performance subscores, and lowest number of “continues” (used when having run out of power before the end of the game), were in the Non-Contingent Music condition. This was interesting as several previous studies have not employed music that was unrelated to the game (Hébert et al., 2005; Tafalla, 2007; Zehnder & Lipscomb, 2006). Compared with normal playing conditions (sound from both the television and Wii remote) or playing with sound from remote control only, mean performance scores were lowest when playing with no sound at all. Although not reaching a level of significance, these trends are in the predicted direction. However, the highest performance scores were obtained when playing with background music that was unrelated to the participants’ actions or the onscreen events.

It was surprising that non-contingent music seemed to somewhat facilitate performance, as the music was not related to events on the screen nor actions of the participant. With respect to the lack of interactive sound, one might expect performance scores for playing with non-contingent music to be similar to those for the silent condition. However, these two conditions were the most dissimilar with respect to overall means.

A possible reason for this surprising finding may be that the non-contingent music unexpectedly played a role in helping certain players. As opposed to normal playing conditions, in which many players usually must pay attention to the sound effects and music, individuals in this condition only had to pay attention to the visuals on the screen with a wash of music in the background. The music was selected to not stand out or distract the player intentionally. This may have actually simplified gameplay, as players would be able to attend exclusively to visual cues rather than audio
cues as well. However, unlike the No Sound condition, players still had a constant stream of music to prevent the game from becoming mundane.

The finding that background music may have enhanced game performance is in line with other findings in the literature that show that music can have an enhancing effect on performance, most notably in spatial tasks (Nantais & Schellenberg, 1999; Rauscher & Shaw, 1998; Rauscher, Shaw, & Ky, 1995). Mazes were identified as a specific spatial-temporal task in which such cognitive benefits could be seen (Rauscher & Shaw). Thus, the enhanced performance of participants in the maze-like virtual worlds employed in *Twilight Princess* (2006) signify that music can enhance performance in virtual tasks as well. Despite the classical nature of *The Legend of Zelda* series’ musical scoring, research has shown that other kinds of sound, such as familiar music, can enhance performance at a creative task as well (Schellenberg, Nakata, Hunter, & Tamato, 2007). A recent study by Cassidy and MacDonald (2008) has found that game players performed best when playing a Wii Star Wars game with non-contingent music they themselves had chosen compared with experimenter-selected music, furthering previous research findings that preference plays a role in whether music enhances performance (Nantais & Schellenberg; Schellenberg, et al.).

As previous research has shown the importance of preferring the music played, it was also surprising to find that a majority of participants ranked the Non-Contingent Music condition as their most enjoyable session. Although this was a non-significant finding, it is still unexpected that gamers enjoyed playing with unrelated sound more so than they did with the original sound. Unfortunately, when participants commented on their enjoyment of sessions, few elaborated on why they particularly enjoyed the Non-Contingent Music condition. A possible explanation for both enhanced performance and increased enjoyment is that the Non-Contingent Music condition was reminiscent
of earlier video games, which employed non-contingent music, but were nonetheless engrossing. In a retrospective context, it appears that our study’s findings in regards to non-contingent music convey that the musical design of earlier games may still have relevance in modern game design.

Differences between Episodes

On closer examination of performance in the four episodes, participants tended to perform best in episode 4, similarly well in Episodes 1 and 3, and worst in episode 2 (See Table 7 for performance scores). The structure and challenges of the episodes could account for these differences. Whereas Episodes 1, 3, and 4 were linear in how game play was structured, Episode 2 was somewhat more open-ended (i.e., players could explore the level in any way they wished). However, a series of instructions were given to participants for each level, so participants knew the basic structure of their goals. Despite this, participants still seemed to struggle with the open-ended nature of Episode 2. As they played, participants tended to do better with every episode, but the challenges of Episode 2, such as playing as a wolf, served as a barrier for many.

One of the possible challenges that may have proved difficult in Episode 2 was the task of defeating a group of enemies at the beginning of the episode. If participants did not defeat all the enemies at the same time, one of the enemies would scream, effectively bringing all the others back to life. Participants were instructed on battle techniques during their practice session, which could be used to defeat the enemies, but many did not use the techniques taught to them earlier. Lack of sound for this episode would have removed the causal link between the enemy’s actions and survival, and the other enemies’ revival, and could have made this task additionally harder as well.

Another challenge for Episode 2 could have been the series of enemies players needed to defeat throughout the level. An interesting characteristic of these enemies is
that they were invisible and the only visual cues they would give to players would be pink sparks emitting from where they would be if one could see them (See Fig. 2). Their locations were also recorded on points of the players’ in-game map. In order to see and defeat them, players had to access a “sense” mode. Although players were given each enemy’s location and were told how to find them by in-game directions, participants also had trouble with this task. One of the difficulties of this task could be from the heavy reliance on audio cues for the enemies, which players may not have realized or adapted to quickly enough. This suggests that players may have difficulty in accomplishing tasks in which they are presented with audio cues, but no corresponding visual source. Similarly, few players could defeat an invisible ghost in Episode 4, which required similar techniques required to defeat the enemies of Episode 2. However, as opposed to the ghost in Episode 4, these enemies were a central component to earning points in Episode 2.

Figure 2
*Player Encountering a ‘Twilight Insect’ in Normal Mode and ‘Sense’ Mode*
Research into structural-associationist congruence theory has found that the eye will tend to focus on elements of the screen that are temporally or semantically congruent with elements of the music (Marshall & Cohen, 1988). However, what happens if no visual image congruent to the sound is present on the screen? When viewers of a film hear a sound attributed to nothing on the screen, they often find themselves searching for the source. In our study, it appears that players relied heavily on visuals to interact with an environment, but when presented with information conveyed via audio, found it difficult to proceed. Instead of looking for the source of the sound as they might when watching a film, participants often passed by the source of the sound without investigating. This may represent a new area of development for future video game sound design to create a more interactive experience. By using elements of structural-associationist congruence theory, future developers may encourage the player to investigate the virtual environment through sound rather than just visuals, creating an even richer game play experience.

Another finding related to Episode 2 was for the Control and Effectance item, Question 29, “While playing, I felt a strong sense of mission or clear goals in mind.” The results were unexpected, as the participants ranked Episode 2 as when they felt the strongest sense of mission and Episode 4 as when they did not. It seems that feeling one has a sense of mission may not have much to do with how one performs, but may relate to other factors. Taking the exploratory nature of Episode 2 into account, and how Role-Playing Games tend to gravitate towards more non-linear styles, gamers may feel a sense of mission when they are the ones responsible for structuring the mission. In other words, players may feel that they have clear goals when they are the ones establishing the goals or ordering their tasks (despite being given a basic structure of
tasks at the beginning of sessions). As opposed to the other episodes, which were mainly linear in how they could be completed, more freedom in the virtual world may give players more options to take ownership of their goals.

Some of our other findings for episodes included the steady increase of positive ratings for Question 10, “While playing, the world created by the game was more real or present for me compared to the real world.” With every session, participants reported feeling that the virtual world was becoming more real for them. Although the finding is not result of our experimental manipulation of sound, it does suggest that repeated interaction with a video game will increase one’s feelings of the game being real. *(Tele)presence* may then be linked to prolonged exposure to the game. However, our follow-up analyses found that Question 10 was correlated with several measures belonging to *(tele)presence, focused attention, flow, identification with avatar, emotion,* and feeling that time is flying. The item was not correlated with any *Control and Effectance* items though, which may indicate that increased feelings of the virtual world being real have less to do with feeling autonomous within that world.

*Innovations of the Wii Console*

When this study was conceived, the Wii console was included as an important feature for several reasons. The design of the motion-sensitive controllers allows for players to interact with the kinetic gestural aspects of games in the most realistic method available. Not only is this a novel experience for players, but, with this method, we believed that this console would facilitate a more immersive experience for players. This feature of the Wii remotes is especially useful with *The Legend of Zelda* series that incorporates such kinetic gestural movements. Traditional controller layouts also tend to feature longer learning curves, so we also wanted a controller that is easier to adapt to with limited time available for practice. In addition to these reasons, we wanted to
see if sounds related to the use of the controller (e.g., sword slashes) enhanced the actions or experience of the player.

As Twilight Princess' sound is integral to the design of the game, it did not offer players the option to manipulate either the background music or sound effects. However, the Wii remotes had the ability to produce sound, which allowed us to use the Partial-Sound condition to see how limited interaction with sound may affect gameplay. No other consoles had this capability at the time of the study. In the trends observed for performance, it could be seen that for the varying levels of interaction with sound, the Partial-Sound condition placed behind Full Sound, which was expected. The capability of the console to allow for limited interaction with sound allowed this manipulation to occur. This, in turn, allowed our study to begin investigating the role of sound in video games at a finer level.

Our selection of the Wii Console also considered the system’s popularity. As few video game studies had attempted a within-subjects design, we wanted to be sure that participants would be willing to attend multiple hr-long sessions. The relative scarcity of the system was also appealing as it minimized the chances that participants had played Twilight Princess. We believed that playing on the system would prove to be an incentive for gamers to participate in the study. However, while the choice of the Wii helped create excitement among our participants, this excitement may have had an unintended effect of inflating some of the enjoyment ratings. Several participants expressed excitement at simply being involved in video game research, which was reflected in their questionnaires. Another limitation to our study is that some results may be attributable to playing with the Wii’s unique interface, and future research should examine the effects of different interfaces on the experience of the player. If
differences are present for immersion between the two designs, then that may limit our findings to motion-sensitive controller layouts.

**Limitations of Study**

Although our study revealed sound’s significant effect on performance and also showed interesting trends, allowing players to use “continues” may have mediated players’ other performance scores and quality of experience responses. “Continues” may have washed out sound’s possible effect on other aspects of participants’ gaming experience, and future researchers may choose not to allow “continues” to be used. In that way, measures following a player’s loss would better accurately their feelings of playing the game rather than playing the game for a longer period of time, which may change some of the original feelings.

In addition, one of the trends observed, which suggests that better players may incorporate sound into their strategies more so than average players, could have played a role in the large variance of scores observed. We controlled for participants’ video game experience, but it appears that not all experienced players have effective strategies for the audio aspect of video games. Relying solely on self-reported measures of experience may not have accurately reflected players’ true skill. Future research may consider incorporating screening episodes, in which participants play levels that are used to assess players’ true level of experience and skill. If our study had included this screening process, we may have had less variance among participants so sound’s effects could be more accurately seen. Our study’s use of exclusively male participants also limits our research to similar demographics.

Other limitations of the study include the game, *Twilight Princess*, which was employed. As our research used a Role-Playing Game, our research may not extend to games of different genres. Sound is most likely used in unique ways depending on the
needs of the genre, so separate research is needed for those genres. In addition, due to
the limits on sound manipulation employed by *Twilight Princess*, the ideal conditions, in
which music and sound effects would be separated, were not available. Thus, our
results are only applicable to the level of overall sound players interact with, rather than
certain results’ variance being attributable to either music or sound effects. In the
context of the trends observed for non-contingent music, we only used music from
*Twilight Princess* and we do not know if similar trends will generalize to music not in
*The Legend of Zelda* style, music not designed for video games, or music of other genres.
Recent research has begun to address these questions, notably in regards to preferential
music enhancing game performance (Cassidy & MacDonald, 2008).

The difference in difficulty for the episodes also played a role in our lack of
findings. We selected episodes that would be comparable in challenges, so the
differences in difficulty, notably for Episode 2, were unexpected. Future research that
employs a multiple session design may prefer to select levels that are fairly similar in
their structure.

*Avenues for Future Research*

Despite our study’s limitations, it also has presented possible avenues for future
research. The trends seen for the best players suggest that they may possess strategies
that incorporate sound into how they process virtual environments and challenges.
Future researchers may consider investigating if sound plays a role in performance with
groups of gamers of differing levels of experience. Also, the unexpected results
involving non-contingent music should be investigated to determine whether or not
variations of the types of music used can impact performance. In addition, future
researchers may attempt to investigate the separate effects of music or sound effects in
addition to sound as a whole, to see if either music or sound effects are more readily
used by gamers. Investigating whether sound is used more by players in linear episodes or non-linear, exploratory episodes may also prove interesting. Also, determining whether certain types of players react to auditory cues or stimuli without visual cues and how they respond may also be interesting in understanding more about whether gamers pick up on those subtleties. For general video game research, our use of the Wii console inspires further questions of whether its unique interface better facilitates immersion than traditional interfaces.

With our study, we have begun to answer larger questions about the role of video game sound in the experience of players. However, while answering these larger questions, an even more complex picture of how sound influences the gaming experience has arisen. Originally assumed to be a simple systematic effect of interactive video game audio on game performance and quality of experience, it appears that the player can interact with and use sound in numerous ways. Just as one can choose his or her own path in the virtual world, gamers use sound in a variety of ways to enhance play. Unfortunately, sound’s relationship with video games and the gaming experience is still far from fully understood (Zehnder & Lipscomb, 2006). Hopefully, our findings will contribute to the path to future research and game development in the investigation of the expanding role of sound in video game play.
Effects of Video Game Audio

References


APPENDIX A

DATE, 2008

Dear Student,

You are invited to participate in a research study entitled ‘Interactivity and video game performance’. The purpose of the study is to examine optimal gaming conditions for video game performance.

If you are a participant, you will be asked to attend a practice session to orient you to a (non-violent) role-playing game, and four subsequent sessions to play the game as a participant in a tournament. Each session will take one hour or less, so you will be involved in the study for 5 hours or less. Today’s meeting is the Practice session, and will take about 45 minutes. Before you consent to participate in the study, we will schedule the remaining four sessions with you (all taking place between 6 and 10 p.m. on week nights of 2nd Week Winter quarter).

For each session, you will be asked to play a game for about 45-50 minutes, and then complete a short questionnaire which will take 5 minutes or less. All participants will automatically be entered in a tournament involving approximately 15 other participants. When all participants have completed the sequence, the participant receiving the top score will receive a prize (a video game worth about fifty dollars).

Your participation in this study is voluntary, and you may choose to leave the study at any point without penalty. No payments will be made for participating in this study. There will be no expected risks or discomfort involved, and the levels you will be playing include no graphic violence.

We will use a participant number or code to keep your name confidential, and will not use your name in any reports. Your identity will not be revealed in any presentations or publications that ensue from this study.

If you agree to participate in this study, please complete the form (see next page) and return the form to us. You may keep this letter if you wish.

Thank you—

Dr. Siu-Lan Tan  
Psychology Department  
Kalamazoo College  
tan@kzoo.edu

Note: This study has been approved by the Institutional Review Board of Kalamazoo College for research with human subjects. For more information about this research, you may contact Dr. Laura Furge at lfurge@kzoo.edu or Dr. Bob Grossman at grossman@kzoo.edu.
PARTICIPANT'S STATEMENT

I have read the above description of this research project, and willingly consent to participate in this study.

Name (please print): __________________________________________________

Signature:   _________________________________________

Today’s date:   ___________________________

What is your age? __________ (years) _________ (months)

This research has been approved by the Institutional Review Board of Kalamazoo College for research with human subjects. For more information about this research, you may contact Dr. Laura Furge at lfurge@kzoo.edu or Dr. Bob Grossman at grossman@kzoo.edu.
APPENDIX B

Video Game Study Contract

As a participant in this research, I understand that it is important for me to have no unfair advantage over other participants in the *Twilight Princess* tournament. I agree that I will not do any of the following:

- Play *Twilight Princess* at any time other than when participating in tournament sessions.
- Discuss the game with any persons other than the researchers conducting the study.
- Obtain information on the game from online or other print sources.

As a BYU student, I understand that signing this document indicates my agreement with it and that adhering to its conditions may be considered an aspect of my adherence to the BYU Honor Code.

Signed __________________________

Date ____________________________
APPENDIX C

Your Video Game Experience

1. How many hours per week do you play video games? (Circle one of the following responses.)
   a. Less than 2 hours.
   b. 2 to 4 hours.
   c. 4 to 10 hours.
   d. More than 10 hours

2. Which of the following Zelda games have you played? (Place a check mark next to any of the following games you have played.)

   ___ TWILIGHT PRINCESS
   ___ PHANTOM HOURGLASS
   ___ THE MINISH CAP
   ___ FOUR SWORDS ADVENTURES
   ___ THE WIND WAKER
   ___ FOUR SWORDS
   ___ ORACLE OF SEASONS
   ___ ORACLE OF AGES
   ___ MAJORA'S MASK
   ___ OCARINA OF TIME
   ___ MASTER QUEST
   ___ LINK'S AWAKENING
   ___ A LINK TO THE PAST
   ___ THE ADVENTURE OF LINK
   ___ THE LEGEND OF ZELDA

3. How many hours per week do you play Nintendo Wii? (Circle one of the following responses.)
   a. Less than 2 hours.
   b. 2 to 4 hours.
   c. 4 to 10 hours.
   d. More than 10 hours

4. How many hours per week do you play role playing games (RPG’s)? (Circle one of the following responses.)
   a. Less than 2 hours.
   b. 2 to 4 hours.
   c. 4 to 10 hours.
   d. More than 10 hours
APPENDIX D

Levels and Tasks: For each of the 4 sessions being scored, there will be 4 major tasks for the player to complete. Each of the 4 major tasks has been broken down into two minor tasks in order to more accurately measure game performance. (We will not score the Level 0.)

- **Level 0: Gerudo Desert (p. 275 of Brady Guide)**
  - Tasks:
    - Acclimate themselves to the game as best as they can
    - Learn how to use all items in their inventory
    - Learn how to use all the buttons and features of the Wii remote
    - Learn how to play in both human and wolf mode.

- **Level 1: Forest Temple (p. 68)**
  - Task One: Proceed through Forest Temple
    - Part 1: Reach Crossroads Hub
    - Part 2: Get Small Key
  - Task Two: Save 2\textsuperscript{nd} Monkey
    - Part 1: Save 2\textsuperscript{nd} Monkey
    - Part 2: Reach Staircase Cavern
  - Task Three: Save 3\textsuperscript{rd} and 4\textsuperscript{th} Monkeys
    - Part 1: Defeat Big Baba and save the 3\textsuperscript{rd} Monkey
    - Part 2: Save 4\textsuperscript{th} Monkey
  - Task Four: Defeat Ook the Bad Baboon
    - Part 1: Reach Ook the Bad Baboon
    - Part 2: Defeat Ook the Bad Baboon

- **Level 2: Eldin Province (p. 102)**
  - Task One: Enter Kakariko Village and meet the Light Spirit
    - Part 1: Defeat Twilit Messengers
    - Part 2: Speak to Spirit
  - Task Two: Find the Children and defeat 10 insects
    - Part 1: Access the Sanctuary and defeat 4 insects
    - Part 2: Defeat 6 insects
  - Task Three: Defeat 6 insects and Twilit Messengers
    - Part 1: Defeat 5 insects
    - Part 2: Defeat Twilit messengers and final insect
  - Task Four: Find horse, return to Ordon Village, and meet with the mayor
    - Part 1: Find horse
    - Part 2: Meet with the mayor of Ordon

- **Level 3: Goron Mines (p. 128)**
  - Task One: Proceed through Goron Mines
    - Part 1: Access Volcano Forge
    - Part 2: Access Domain of the Dogongos
  - Task Two: Get 1\textsuperscript{st} Key Shard
Effects of Video Game Audio

- Part 1: Get 1st Key Shard
- Part 2: Access Diamond Switch Chambers
  - Task Three: Get 2nd Key Shard
    - Part 1: Access Mine Loading Docks
    - Part 2: Get 2nd Key Shard
  - Task Four: Defeat Dangoro
    - Part 1: Reach Dangoro
    - Part 2: Defeat Dangoro

- Level 4: Sacred Grove / Temple of Time (p. 340)
  - Task One: Find Rusl and the Sacred Grove
    - Part 1: Speak to Rusl and get the Golden cucco
    - Part 2: Reach the Sacred Grove
  - Task Two: Find the Skull Kid
    - Part 1: Find the Skull Kid for the 1st time
    - Part 2: Find the Skull Kid for the 2nd time
  - Task Three: Defeat the Skull Kid
    - Part 1: Find the Skull Kid for the 3rd time
    - Part 2: Defeat the Skull Kid
  - Task Four: Find the Temple of Time
    - Part 1: Defeat the Twilit Messengers and enter the Temple of Time
    - Part 2: Defeat the 1st Armos of the Temple of Time

**Scoring:**

- **Tasks:** 180 Points
  - 90 of these points will be divided up proportionally among the tasks depending on their difficulty
  - Each task will then be broken into two minor tasks that will award the participants half of the points available for the given task upon completion.
  - For tasks 1-3 the total points available is 40, and for task 4 the total points available are 60. There are two reasons for this distinction. The first is that task four is always more difficult than tasks 1-3, and the second reason is that task four will always take more time to accomplish being that it is the final task to complete and thus is harder to complete.

- **Hits:** 50 Points
  - For every hit or fall, one point will be removed.

- **Time:** 180 Points
  - The amount of time taken for each minor task will be subtracted from the 22.5 points (a total of 45 points per major task) to obtain the time score.

- **Continues:** -(number of heart containers in session) Points
  - Whenever a player uses a ‘continue,’ they will lose a number of points equal to the number of heart containers that they have in that level. This way a proportionate amount of points will be subtracted for each level.

Total: 410 points available for each session.
APPENDIX E

CHECK LIST OF THINGS TO LEARN IN PRACTICE SESSION

✓ Learn to use all items in inventory
✓ Learn to change from Wolf form to Human
✓ Learn to use the “B” force-field attack while in Wolf form
✓ Learn to use spin attack while in wolf and human form (shake joystick attachment from side-to-side)
✓ Learn to use hidden skills
✓ Learn to use the map (button “1”)

Learn to use senses to see and find things while in Wolf form
APPENDIX F

| Judge's Name: |   |
| Participant's #: |   |
| Session #: |   |
| Condition: |   |
| Date: |   |

### Time and Cluster Scoring

<table>
<thead>
<tr>
<th>Cluster #</th>
<th>Time</th>
<th>22.5 - Time</th>
<th>Time points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster 1-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cluster 1-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cluster 2-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cluster 2-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cluster 3-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cluster 3-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cluster 4-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cluster 4-2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Total Time points |   |
| Total Cluster points |   |

### Damage Scoring

<table>
<thead>
<tr>
<th>Task 1 Hits:</th>
<th>Task 2 Hits:</th>
<th>Task 3 Hits:</th>
<th>Task 4 Hits:</th>
</tr>
</thead>
</table>

| Total Hit Points: |   |
| 50 - # of Hits |   |

### Continue Penalty

<table>
<thead>
<tr>
<th>Task 1 Cont'</th>
<th>Task 2 Cont':</th>
<th>Task 3 Cont':</th>
<th>Task 4 Cont':</th>
</tr>
</thead>
</table>

| Total Conts' used: | *10 = |

### Total Score

| Total Time Points | + |
| Total Cluster Points | + |
| Total Hit points | + | At 20 minutes |
| Continue Penalty | - | At 40 minutes |

**Game Experience**

- Participant Estimate
<table>
<thead>
<tr>
<th>Total Points</th>
<th>=</th>
<th></th>
</tr>
</thead>
</table>

Effects of Video Game Audio
APPENDIX G

Rankings and grand scores for all 23 participants. (Grand scores = Total of all 4 scores for 4 sessions)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Participant Number</th>
<th>GRAND Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1556.8</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>1410.11</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>1163.14</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>1018.11</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>1012.65</td>
</tr>
<tr>
<td>6</td>
<td>13</td>
<td>995.92</td>
</tr>
<tr>
<td>7</td>
<td>16</td>
<td>985.01</td>
</tr>
<tr>
<td>8</td>
<td>17</td>
<td>973.08</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>920.19</td>
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<tr>
<td>10</td>
<td>19</td>
<td>903.7</td>
</tr>
<tr>
<td>11</td>
<td>24</td>
<td>858.71</td>
</tr>
<tr>
<td>12</td>
<td>11</td>
<td>831.23</td>
</tr>
<tr>
<td>13</td>
<td>23</td>
<td>782.29</td>
</tr>
<tr>
<td>14</td>
<td>20</td>
<td>769.1</td>
</tr>
<tr>
<td>15</td>
<td>12</td>
<td>734.87</td>
</tr>
<tr>
<td>16</td>
<td>9</td>
<td>734.14</td>
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<td>17</td>
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<tr>
<td>22</td>
<td>8*</td>
<td>399.35</td>
</tr>
<tr>
<td>23</td>
<td>6*</td>
<td>217.59</td>
</tr>
</tbody>
</table>

Note: Participants 3, 6, and 8 were not included in the final sample of N=20. (See note under Participants in Method section for explanation).
APPENDIX H

Musical Materials Used in the Non-Contingent Music Condition

A 60-min compact disc was made comprised of the following music. The musical pieces were arranged in the following order: 1-1 2 3 2 4 5 6 2 3-3 2 1-1 2 3 2 4 5 6 2 3-3 2 1-1 2 3 2 4 5 6 2 3-3 2 (Numbers correspond to the tracks as listed below.)


APPENDIX I

Questions following today’s session

Please respond to the following statements by placing an “X” in the appropriate place along the line.

**General questions**

1. How much did you enjoy playing during today’s session?

   Very little                                Very much

2. Explain why you enjoyed or did not enjoy today’s session (briefly, in 1 or 2 sentences):

3. How well do you feel like you played during today’s session?

   Extremely poorly                          Extremely well

4. Explain why you feel like you did or did not play well during today’s session (briefly, in 1 or 2 sentences):

**Telepresence**

5. When the game ended, I felt like I came back to the “real world” after a journey.

   Strongly disagree                           Strongly agree

6. The television came to me and created a new world for me, and that world suddenly disappeared when the game ended.
7. While playing, I felt I was in the world the game created.

8. While playing, I never forgot that I was in the middle of an experiment.

9. While playing, my body was in the room, but my mind was inside the world created by the game.

10. While playing, the world created by the game was more real or present for me compared to the “real world.”

11. The world created by the game seemed to me only “something I saw” rather than “somewhere I visited.”

12. While playing, my mind was in the room, not in the world created by the game.
**Focused Attention**

13. While playing the game, I was not distracted.

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>

14. When interrupted by the research assistant, I felt annoyed.

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>

15. While playing the game, I couldn’t seem to concentrate.

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>

16. While playing the game, I was unaware of what was going on around me.

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>

**Time Distortion**

17. I was unconscious of the passing of time while playing the game.

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>

18. It felt like time flew while I was playing the game.

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>
Flow

19. I was totally involved in what I was doing.

Strongly disagree  Strongly agree

20. I seemed to be cut off from the “real world” that was physically around me.

Strongly disagree  Strongly agree

21. I was really quite oblivious to my surroundings after I got going.

Strongly disagree  Strongly agree

22. I felt less aware of myself and my problems.

Strongly disagree  Strongly agree

Identification with Avatar and Emotion

23. My character’s personality is a lot like my own.

Strongly disagree  Strongly agree

24. I felt many of the emotions that my character might have been feeling.

Strongly disagree  Strongly agree

25. While playing, I felt emotionally involved in the events happening in the virtual world around my character.

Strongly disagree  Strongly agree
Control and Effectance

26. It was easy to control the actions and movements of my character

Strongly disagree                                      Strongly agree

27. After doing something or going somewhere, I often did not know whether it was the right thing to do

Strongly disagree                                      Strongly agree

28. Many events happened often without warning and caught me by surprise

Strongly disagree                                      Strongly agree

29. While playing, I felt a strong sense of mission or clear goals in mind

Strongly disagree                                      Strongly agree

30. While playing, I felt unsure about what to do or somewhat lost

Strongly disagree                                      Strongly agree

Thank you for completing this questionnaire. Please hand it to the Research Assistant, who will ask you to sign a sheet and remind you of your next session time before you leave.
General Information about You

1. What is your age? ________ (years) ________ (months)

2. Are you Male or Female? (circle one)

3. How would you describe yourself? (Please circle one of the following.) (You may skip question # 4 if you wish).
   Caucasian
   African-American
   Hispanic
   Asian
   American Indian
   Pacific Islander
   Other (Please specify) _______________
APPENDIX J

Session Rankings

Please rank your sessions according to how long they seemed to be:

[1 = Shortest; 4 = Longest]

_____ Normal Music and Sound

_____ No Music, but Sound Effects

_____ No Music or Sound Effects

_____ Non-related Music, and No Sound Effects