The Dissertation Committee for Jason Allen Rosenblum Certifies that this is the approved version of the following dissertation:

What Is It Like To Experience Sound While Playing Educational Games?
An Interpretive Phenomenological Investigation

Committee:

Joan E. Hughes, Supervisor

Min Liu

Paul Resta

Ricardo Ainslie

Eugenia Costa-Giomi

What Is It Like To Experience Sound While Playing Educational Games?
An Interpretive Phenomenological Investigation

by

Jason Allen Rosenblum, B.S.; M.S.

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To Janet Swisher, for her love and seemingly endless patience.

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What Is It Like To Experience Sound While Playing Educational Games?

An Interpretive Phenomenological Investigation

Jason Allen Rosenblum, Ph.D.

The University of Texas at Austin, 2014

Supervisor: Joan E. Hughes

I took an interpretive phenomenological approach to examine what it is like to experience sound while playing educational games. I asked six people to play three educational games, for a total of 18 interview sessions. I analyzed 603 pages of interview transcripts and 22.68 hours of video recording using phenomenological research techniques to derive the meaning units analyzed in this study. I used NVivo to identify and code 1,738 meaning units across the three games studied. I organized these meaning units into related clusters and identified constituents of meaning for each game studied. I derived 27 constituents of meaning for Fate of the World, 22 constituents of meaning for Hush, and 27 constituents of meaning for Salamander Rescue. I wrote textural-structural descriptions to describe participant experiences in each game and performed imaginative variation to further provide a context to describe participant experiences. From these results, I derived essential meanings to situate a discussion about sound in each of the games studied and I discussed eight essential meanings that were shared across the three games studied. According to my analysis of these participants' responses, sound conveyed a sense of the game's interface in addition to the environment in which play was situated. Sound also supported the presentation of characters in the game and worked to communicate the game's narrative to the player. Music in the games studied helped to provoke thought and also conveyed an emotional context for play. Sound supported players' overall engagement in these games, but the absence of sound removed this engagement. Critically, people noticed when the visuals that they saw did not match the sounds that they heard. I present an applied phenomenological framework for sound in educational games to illustrate these essential meanings and to reflect how participants' experiences were affected by the ways they used game interfaces, interacted with game characters, experienced game narrative, and described the game's environment. This framework further illustrates the possibility space for potential experiences of sound in gameplay as determined by the choices players make, the game's state of play, and the degree of synchresis present between what players hear and what they see as they play.

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CHAPTER ONE: INTRODUCTION

Early Beginnings

When I first entered the Learning Technologies doctoral program in 2008, I was interested in exploring the role that music might play in designing learning experiences with instructional technology. As I described in my letter of intent to this program, I wanted to pursue these interests in the hope of learning about the relationship between music, cognition, and new media environments to promote heightened learner engagement. I was curious about the connections between music and cognition, and was interested in exploring the ways in which music might impact experiences with technology. I asked initial questions that included: *How can music help people to engage with and learn from their experiences? How do passive and interactive musical experiences affect the ability to learn?* To answer these questions, I proposed to explore several intersecting areas of research that included music, sound, and cognition as well as studies in music listening and design of educational technology. I had identified Bruce Mann's model for "Structured Sound Functions" (SSF) in multimedia as a starting point for this exploration (Mann, 2008).

Early Research

I began to explore this complex topic by immersing myself in the study of music, cognition, and game sound through a class in music psychology. In addition, I took a class in experimental performance interfaces and participated in a research assistantship to explore the possibility of designing dynamic, generative game and multimedia sound systems, in which background game music changed based on player interactivity (Cope, 2001). I applied the knowledge gained in these courses to design an early game sound system for Alien Rescue, in the hopes of providing a platform on which to base my research in music and sound. I started my research by first composing music for the introductory video for Alien Rescue and then conducting a 2009 pilot study in a psychology of music course to investigate the effects of music on video viewing.

As I discussed in my mid-semester program review, I was curious to see how participants experienced the video when hearing either one of two music soundtracks or hearing silence when viewing the introductory video to Alien Rescue. I asked people to select adjectives that best described their affective experience in addition to answering recall questions. These early results indicated that listening to music during the introductory video of Alien Rescue affected video viewing. People who heard a music soundtrack at the beginning of the video chose similar adjectives to describe the video, as compared with those who heard silence. In 2010, I performed a follow-up study in which I divided participants into three experimental groups who heard music that was “Strong,” “Weak” or absent. I aligned the design of this study with techniques from a film music study by Marshall and Cohen (1988). People who listened to music in this study provided significantly different adjective ratings than those who heard no music. Moreover, there were significant differences in adjective ratings between experimental groups who listened to different music. However, these results (as with the results from the early 2009 pilot study) are less tenable given the low sample sizes involved and lack of any information about player expectations for video viewing or player motivation.

Turning to Experience

As I considered the findings from these initial pilot studies, I began to reflect on anecdotal comments that participants made about the music during these initial studies. In doing so, I wondered how player contexts and expectations drove the way that participants listened to and experienced sound. In 2011, I compiled my first comprehensive draft of a literature review of this topic. The title of that review, written for a doctoral seminar, was “Sound and Our Experiences with Educational Software.” I was initially curious to know: *how does sound affect our experiences of learning in educational software?* Upon taking a qualitative research course in 2012, I realized that these questions of experience were less suited to quantitative inquiry, but more aligned with a qualitative, phenomenological research approach. In the spring of that year, I reshaped my research question to ask: *what is the essence of player experiences of sound, while playing educational computer games?* This reshaping of my research question reflected a methodological turn towards an interpretive, phenomenological approach to examine participant experience. Moreover, this reshaping also resulted in an ontological turn, which assumed that the knowledge to be gained from my research relied on what people described about their experiences, rather than on a positivistic lens through which I measured their participation. The construction of the research question therefore consisted of an open investigation of the lived experiences of sound while playing educational games. By design, this question also shifted the focus from learning within games to a broader question of experiences of gameplay as seen through perspectives defined by sound listening.

Phenomenology Pilot Studies

With this perspective in mind, I conducted a research study in a qualitative research course and used phenomenology to research sound in educational games during the spring of 2012. I initially interviewed one participant over several interview sessions and asked that she play games and describe her experiences as she listened to sound. According to my interviewee, sound helped to provide a sense of presence and direction as she interacted in 3-D game environments. Moreover, sound helped her to connect with characters in the games that she played, and the music she heard in game videos shaped the emotional messages that primed gameplay. I found these findings compelling and decided to follow up this study with an in-depth pilot study that I designed from the same descriptive phenomenology approach as the initial phenomenology research pilot study. Thus, in the fall of 2012, I interviewed three people as they played games with sound and asked them about their experiences of play. As in the first study, sound provided a sense of presence in the game environment. Furthermore, the sounds heard and the visuals seen created a *unified perceptual experience* that allowed these participants to connect with the narrative as communicated through in-game characters (Rosenblum, 2013).

These initial phenomenological studies of sound in educational games yielded rich participant descriptions of educational gameplay experiences as heard through the perspective of sound. In spring of 2013, I sought to further deepen my epistemological understanding of phenomenology and refine my methodological approach. I enrolled in a second qualitative research course that focused on hermeneutic approaches to qualitative research. I expanded my descriptive phenomenological approach in a research study with a single participant and incorporated rigorous phenomenological methodological approaches from Colaizzi (1978) and Robinson (1994) to ensure greater trustworthiness in the results. This study served as a continuation of the ongoing study from the previous fall and the findings were consistent with those obtained previously.

I presented the results of the fall 2012 study at the 2013 Games Learning Society 9.0 Conference, and a full manuscript of this research has been submitted for publication in a special issue of the journal *Games and Culture*. Following the success of this phenomenological research study, I was determined to deepen my understanding of the philosophical and methodological perspectives of phenomenology. Thus, in the summer of 2013, I completed a phenomenology workshop sponsored by the University of Georgia and led by Dr. Mark Vagle. As a result of my workshop participation, I better understood that phenomenology as a philosophical movement could be characterized as encompassing of a set of varied epistemological perspectives by thinkers who built upon one another's work. Consequently, I decided to reposition my approach to more closely reflect my ontological and epistemological perspectives as a researcher, and as a result I have adopted a more interpretive, hermeneutic approach to this research methodology.

Thus, I have taken an interpretive approach to investigating participant experiences of sound in educational games by asking: *what is it like to experience sound while playing educational games?* I now present a review of the literature that spans multiple areas of research to situate this study as a serious work of academic scholarship and articulate a methodology by which to explore this question.

CHAPTER TWO: LITERATURE REVIEW

Frameworks for Thinking About Sound in Software

There has been limited research into aspects of sound within educational games. The research conducted to date has focused primarily on investigating aspects of information processing including retention and cognitive load (Bishop and Cates, 2008; Moreno & Mayer, 2000; Moreno & Mayer, 1999). Bishop and Cates (2008) were the first researchers to conduct a comprehensive analysis of sound in educational multimedia and used an information processing framework to examine the ways that sound in these games support information retrieval and knowledge processing.

Moreno and Mayer (2000) studied sound as *entertaining auditory adjuncts* to instruction and recommended that instructional designers avoid using sound. These researchers failed to examine the decisions that led them to integrate sound into their applications of multimedia. However, cross-modal research by Chen and Spence (2010) helps to explain Moreno and Mayer's results. According to Chen and Spence, what people hear and what they see are connected such that sound can convey meaning when presented with visual content. Together, sound and visuals cohere to create a unified perceptual experience. Michael Chion (1994) describes this audiovisual relationship as *synchresis*.

Karen Collins (2008) and Kristene Jorgensen (2009) studied the relationship between sound and visuals in immersive commercial game environments. Collins (2008) offered a framework by which to study the functions of sound in immersive game environments, a facet of games not explored in prior research with sound. According to

Collins, one can look at aspects of sound that contribute to levels of player interactivity within games.

In this review, I closely examine frameworks such as those by Karen Collins (2008) and Bishop and Cates (2008) to inform an analysis of sound in commercial and educational games. I also review the scholarship in the use of sound within educational multimedia titles and offer an analysis of those findings through cross-modal research. I further explore the relationship between sound and visuals through the lens of film music theory and music psychology research. Finally, I explain the implications of these diverse areas of sound scholarship to my current investigation.

Commercial entertainment games have long incorporated sound in addition to visuals, animations, and video in the game experience (Collins, 2008). However, the use of sound in educational software (whether or not designed as a game) is less consistent. In their 2008 study of sound design in educational software titles, Bishop and Cates examined the types of sound used in twelve lessons within four educational software titles. Bishop and Cates (2008) used a "sound-use design strategies framework" (p. 469) that organizes the use of sound for knowledge acquisition, procession, and retrieval throughout three stages of information processing to select, analyze, and synthesize information. Although Bishop and Cates's review was based on a sound framework that was not originally empirically derived, it provides important insight into how sound has been used to manage attention, organize information, and support recall in educational software. Bishop and Cates also discuss the potential for sound in the form of narration, sound effects, and music to support learning. Bishop and Cates's study is unique and is the only such study available that examines use of sound in educational software.

Bishop and Cates examined specific lessons from four "winning software programs" (p. 472) for the ways in which they used sound to support attention, content organization, and recall. Using this lens, Bishop and Cates wanted to know how different software used sound to support learning based on this framework (Bishop & Cates, 2008). The software programs were Read 180: Show Me the Money!, Cornerstone, Success Maker, and the PLATO Web Learning Network. The software programs were sampled from award-winning programs by Quality Education Data, Inc. and were chosen for variation in grade levels and topics drawn from language arts. Bishop and Cates studied the frequency of sound events in 12 lessons from these programs to first qualitatively identify, contextualize, and code instances of sound use, then analyzed the results based on frequency of sound events in the software sampled. Bishop and Cates took a content analysis approach to analyze each application for its use of sound. Bishop and Cates found similar trends in the use of narration, sound effects, and music across all 12 lessons. Narration was used in every lesson, and in five lessons narration was the only sound event present. Sound effects and music were used in seven lessons. Based on the frequency of sound events in the lessons studied, sound was predominantly used to manage attention. However, in 13.2% of sound events, sound effects also supported information organization. One lesson (My Friend Leslie) within Success Maker used both sound effects and music to support screen transitions, and narration was used to deliver content and facilitate its recall. However, music typically played a limited role in most lessons and was used predominantly to accompany introduction and assessment activities. In 25% of the sound events examined, music was also used as an accompanying soundtrack to videos or as background to screen transitions. Bishop and Cates also noted that music was used to direct and hold attention and in 47.8% of events music was used to organize information (p. 477). It is unclear, however, what Bishop and Cates mean by using music to organize information in the software studied.

According to Bishop and Cates (2008), these findings illustrate how sound is underutilized "to support learning very extensively beyond the most basic information processing and instructional communication levels" (p. 479). Moreover, they question the decisions that guided the use of sound in the lessons studied and suggest that the heavy use of narration is a substitute for text.

The lack of a student perspective on the presence of game sound is a limitation in this study (Bishop & Cates, 2008). They could have used additional qualitative measures to observe participant uses of these applications and could have interviewed participants on their perceptions of sound. However, Bishop and Cates's research into the use of sound in educational software is novel and asks us to consider the ways in which sound can be and has been designed to support learning with educational software. Bishop and Cates ask, "If a picture can be used to tell a thousand words, then why cannot a sound be used to represent content? Or depict a context? Or illustrate a construct?" (p. 481). Through these questions, Bishop and Cates challenge designers to think differently about the use of sound to support learning. Such a perspective is important, in order to synthesize "practical guidelines for designing with sound" (p. 468).

Bishop and Cates's study is the first in this field to use a framework for sound to research the use of sound in educational multimedia. These researchers designed the framework used in this study. It is also only one of two such frameworks to propose how sound should be used to design multimedia. The second framework by Mann (2008) describes sound from the perspective of the possible functions that sound can serve in educational multimedia, as seen through the perspective of cognitive theory.

SOUND FRAMEWORKS FOR MULTIMEDIA

In 2001, Bishop and Cates proposed a framework for sound in multimedia and based the framework on a model of an instructional communication system. This model assumes that learners move through a process to select and analyze information before finally constructing new knowledge with the information presented. Bishop and Cates's sound model expands on this communication system and seeks to address problems introduced by *noise* in the system that occurs when learners work through problems to acquire, process, and retrieve information. According to Bishop and Cates, sound is able to direct attention, communicate information, and "elaborate on visual stimuli by providing information about invisible structures, dynamic change, and abstract concepts almost impossible to communicate visually" (p. 11). Moreover, sound can help connect learners to content while "creat[ing] a systematic auditory syntax for categorizing main ideas" in addition to focusing learner attention by "employ[ing] novel, bizarre, and humorous auditory stimuli" (p 15).

Bishop and Cates (2001) illustrate how to apply this framework to design sound by describing a potential multimedia module to teach the concept of information processing, as a way to describe aspects of their framework. In their example, they describe a "multimedia lesson equating information with a package-shipping center" (p. 14). On the surface, this framework is promising since it proposes that sound be used to communicate unique information. However, their example is limited to describing how auditory cues can be used to grab learner attention and provide a cue for future presentation of content. They do not discuss how these cues might be paired with visuals. Instead, Bishop and Cates suggest that characters in the lesson of the shipping center be introduced with sounds that include a buzzing fly, hissing spray can, and a moving file cabinet drawer. These sounds thereby provide what Bishop and Cates call an *auditory syntax* to associate characters with conceptual ideas that are repeated throughout the program.

Although auditory associations may be useful, Bishop and Cates' example does not address how sound might be used beyond this example to provide rich narrative or immersive visual contexts. Neither does it support other uses for sound beyond associating auditory cues with content. Bishop and Cates's 2001 framework is the first known attempt to describe a rationale by which to make decisions about integrating sound with educational multimedia. Although Bishop and Cates's framework is rooted in communication theory, their sound framework was not formed as a result of research. However, Bishop and Cates's subsequent 2008 study that used this framework is useful in helping us understand the ways that sound has been used to design educational multimedia.

Bruce Mann of Memorial University proposed a second framework to design sound for multimedia in 2008. Mann's Structured Sound Function (SSF) model for multimedia sound was intended to help designers "control attention to visual events" (Mann, 2008). Mann's model outlines a number of categories to describe a range of uses of sound to support temporal, point of view, location, and character-based sound functions. Mann's model proposes what German and Barrett (2005) describe as functionally fixed ways to apply sound with multimedia visuals. Mann's notion that sound should be paired with visuals is novel. However, Mann does not provide the theoretical grounding and flexibility needed to explain how sound and visuals work together in immersive environments in ways that support ludic engagement. Mann's model is predicated on the design of sound to manage cognitive load, and proposes five functions and three structures for sound to "help learners to focus their attention on visual events in multimedia" (Mann, 2008, p. 1165). Visuals events include the display of assets such as diagrams, photos, and animations in addition to text and video.

According to Mann (2008), sound functions to provide temporal cues, a point of view, location, atmosphere, and character information. Examples of sound functions in this context would be sounds to provide background ambience or play a message from a multimedia character. He further suggests that sound should be structured with a visual event based on the duration of a sound event (constancy), the frequency by which sound is paired with visuals (density), and the goal for pairing sound with visuals (p. 1167-1168). Mann proposes that instructional designers should "selec[t] a sound for a specific purpose or function" as defined by his model and should situate the "function into a suitable structure that determines how when and how often the sound will play that function" (p. 1166).

Mann (2008) presents the compelling idea that a process to choose sound in multimedia should be considered with the visuals presented. However, Mann does not provide a convincing rationale for how he chose the five sound function categories or the three structures that outline how sound should affect visual events in his model. The research available to codify this model is also limited. I found only one empirical study (Mann, 1995) in which Mann studied narration paired with visuals to provide a temporal context for visual information presented (what he called *temporal sound*). I was unable to locate comprehensive research on the SSF model as a framework for designing for sound in educational multimedia.

Mann's (2008) choice of discrete functions to describe sound lacks a clear rationale and the SSF model is limited to a cognitive perspective of using sound functions to direct learner attention in ways that manage cognitive load and increase retention. Similarly, Bishop and Cates (2001) turn to theories of cognitive load in their model to explain how sound can "communicate information when visual attention is focused elsewhere…or when the visual channel is overburdened" (p. 11). Kirschner (2002) describes cognitive load as resulting from interactions between the learner and the task, as measured by the amount of mental load, effort, or cognitive performance possible. According to Kirschner, there are two types of cognitive load, namely intrinsic load and extrinsic load. Intrinsic load arises as a result of the nature of the information and processing needed to complete a task. Extrinsic load arises as a result of presentation of the material and can include everything from task instructions to extraneous information not relevant to learning. Learners store information in long-term memory by using schemas to "integrate information elements" and automate rules, thereby "requiring less storage and controlled processing" (p. 3). According to Kirschner, schema formation helps to reduce cognitive load.

A key outcome in the frameworks proposed by Mann (2008) and Bishop and Cates (2001) is to help learners build cognitive schemas in ways that affect memory retention. However, neither Mann nor Bishop and Cates explain how sound and visuals relate to communicate information or create immersive experiences. Thus, neither of the two frameworks reviewed provide a suitable, comprehensive framework by which to guide the design of sound for educational games in ways that address how sound and visuals work together to affect how people experience gameplay. There is no available research within educational technology fields of study that examines participant experiences of gameplay. However, work within game audio studies provides a perspective that can help us to understand the role of game audio in player experiences within immersive games.

A Framework for Game Audio

Computer Game Audio – History and Player Interactivity

Game audio theories describe uses for sound in games from player perspectives in ways that explain how sound affects the content, interactions, and overall experience of playing with the visual gamespace. Game audio research asks: What types of audio are used in games and what does the audio convey? What are the established tropes for use?

How does game sound affect motivation and engagement, and how do players react to and otherwise perceive game audio in the form of music and sound?

The use of sound in computer games (and arcade videogames) is ubiquitous. The use of sound to draw attention and provide interactive cues can be traced to the interactive entertainment provided by pinball machines, slot machines, and the penny arcades of the nineteenth century (Collins, 2008). The use of music in videogames has had a similarly rich history since the 1980's in game titles such as Super Mario Bros (Nintendo R&D4, 1985) and The Legend of Zelda: Ocarina of Time (Nintendo EAD, 1998). Although short, repetitive sound cues and music passages have often been used to "reward" successful game interactions, games also trigger the type of sound played based on choices people make in games. For instance, in *Zelda*, "melodic foreshadowing" is used to integrate music with in-game puzzles, while melodic passages are used as environmental cues for the player prior to game encounters through subtle blending of "danger music" with "attack music" as the player approaches an enemy (Belinkie, 1999; Gibbons, 2009; Whalen, 2004). The professional standards for production of audio in modern game franchises such as Max Payne (Remedy Entertainment, 2001), Half-life (Valve Corporation, 1998), Grand Theft Auto (Rockstar Games, 1993), and Guitar Hero (Harmonix, 2005) are often high, and in the case of games like Guitar Hero, games serve as a vehicle to license and market music, a trend that raises a host of intellectual property questions (Collins, 2008; Karja, 2008). Recent games such as Heavy Rain take a cinematic approach to music design.

Heavy Rain (Quantic Dream, 2010) incorporates a rich branched narrative, whose design required multiple versions of the musical score. According to David Cage (2010), the game's director in *The Making of Heavy Rain: Music*, the music for Heavy Rain was more complicated to produce than music for a feature film, given the game's heavily branching narrative. The music in the game shifts as players take different paths in the story of the game. The music for *Heavy Rain* was also designed to closely augment the presentation of the visual environment. According to Cage, the music in the game contributed "…probably about 50% (if not more) of the impact [the audience experiences when viewing] the images [in the game]" (Cage, 2010). Sound, music, and narrative are therefore connected. As Steven Spielberg has pointed out, "sound and music make up more than half of communicating a story, greater even than what you're seeing…" (in Bush, Gershin, Klein, Boyd, & Shah, 2007 p. 4). Sound and music in games have been used to regulate player affective responses. Straightforward sound design techniques such as modulating volume levels and adjusting the timing of effects have been shown to increase anxiety, fear, and suspense in games (Toprac & Meguid, 2011). Conversely, giving players choices over the music they hear has been shown to reduce anxiety (Wharton & Collins, 2011).

Game Audio and Player Interactions

Karen Collins, research chair at the Canadian Centre of Arts and Technology at the University of Waterloo, offers a compelling analysis of game audio from the perspective of player interactivity (Collins, 2008). Collins provides a framework that explains how sound and visuals work together in games to provide players with immersive gameplay experiences. In Collins's framework, games use sound in ways that provide players with cues for action and feedback for choices. In addition, game design can also use sound to respond to player decisions, as well as to changes that occur during gameplay. Collins's framework organizes a discussion of game audio from the perspective of *diegesis* and "degrees of player interactivity" (p. 125).

Collins (2008) draws from film sound theory to describe diegesis as the way in which a game-player perceives the source of the sound being played at different points during gameplay. Sounds that are diegetic are ones that have a corresponding source in the game world, whereas sounds that are non-diegetic do not originate from the within the game world. For instance, if a game character controlled by a player is standing in a forest and hears the sound of a bird chirping, the player would assume that a bird in the game is making that sound. Conversely, if a player hears music playing in the background but there is no obvious source for the music, such as a radio or a musician, then the music would be characterized as non-diegetic. Michel Chion (1994) describes non-diegetic sound as sound "whose supposed source is not only absent from the image [on the screen] but is also external to the story world" (p. 73).

Another way to understand diegesis is from the perspective of characters that exist in a game. Sounds that both the player and game characters can hear are diegetic sounds. However, sounds that can only be heard by the player are non-diegetic. Game characters can be directly controlled in the first person by the player or can otherwise be part of the game world. In one example of a game character a player might be playing the private gun-for-hire character of Max Payne in Max Payne 3. In another example, a crowd of townspeople that appear in a game and who gather in a town square would be considered game characters even though they might not be directly controlled by the player. Collins (2008) further analyzes diegesis in game audio by the degree to which sound is "nondynamic, adaptive or interactive" (p 126). Interactive audio is dynamic and responds to actions that the player takes in the game. For instance, if the sound of galloping horses changes in volume by becoming louder as the player approaches a herd of rushing horses, the sound is interactive. Since the sound can also be heard by the character that the player controls and is therefore situated within the game, the sound is also diegetic. An example of sound that is adaptive would be background music that changes in intensity when a character is losing health and comes closer to dying. In this example, if the music is unrelated to the game world, then the music is both adaptive and non-diegetic since the character in the game does not hear the music as it changes in intensity. An example of non-dynamic sound is background music that does not respond to actions taken by the player. Non-dynamic music can either be diegetic or non-diegetic. I have adapted Collins's work and provided a summary in Table 1 (Collins, 2008 p. 125).

Table 1. Categories of Game Audio Diegesis

Category	*Diegetic audio*	*Non-diegetic audio*
Non-Dynamic	In-game audio plays, but game characters do not control it.	Non in-game audio is heard by player, such as in cinematic introductions or cut-scenes.
Adaptive	In-game audio changes and is heard in the game as the game changes occur.	Non in-game audio changes and is heard outside the game as game changes occur.
Interactive	In-game audio changes in response to character's action.	Non in-game audio changes in response to player choices.

Across any of these categories, game audio can serve a variety of functions to support gameplay. Collins (2008) suggests that "acousmatic" sounds "with no clear origin visually [in the game]" (p. 130) can be used as a cue to prompt players to figure out who or what is making the sound. For instance, a player who approaches a door might hear the acousmatic sounds of car approaching that he or she cannot see. Upon hearing the car, the player might then decide to change direction and run toward the car to get the attention of the driver. In this case the "off screen" sound of the car would be used to help change the decision that the player makes to open the door. Another type of sound that Collins terms as "sound symbols" can be used to direct attention to people or objects in the game. For example, someone playing a detective in a game pick up the phone at his desk when it rings, instead of opening a drawer.

According to Collins (2008), sound can also be used to "identify other characters, moods, environments and objects, to help the game become more comprehensible and to decrease the learning curve for new players" (p. 130). For instance, in learning to play Tomb Raider 3, the player must learn when the character is about to be in danger and when the danger has passed. Tomb Raider 3 accomplishes this by playing non-diegetic, adaptive music that progressively increases in intensity the closer the game character, Lara Croft, approaches to her enemies. The player can choose to make her run away, and if she runs far enough away from danger, the music subsides. Tomb Raider 3 also makes use of diegetic, interactive, acousmatic sounds in the form of a off-screen shouts, such as, "Hey Lara!" to signal to the player that friendly people are nearby amidst enemies, even if they are out of the player's immediate view. In Tomb Raider 3, the player is also given the opportunity to manipulate objects such as a radio with a jog-dial to signal for help. In this case, the player must turn a dial and find the correct frequency by listening for a clear radio connection amidst the static across the frequency band. In this instance, diegetic sounds of both radio static and a clear radio transmission are used as interactive sound symbols that change, depending on how the player rotates the dial. In these examples, sound in Tomb Raider 3 is designed to help the player to learn how to interpret whether the character is in danger, to find friendly game characters, and to use game objects with minimal on-screen text instruction.

Collins (2008) provides a framework to examine sound and games that describes how different facets of a game work together with sound to shape player experiences. As Collins points out, game audio helps to lend "cinematic realism…[to create] a sense of immersion and believability, or verisimilitude, within a fantasy world" (p. 134). Collins's perspective on game audio draws from theories of film sound. In turn, film sound perspectives focus intently on the relationship between sounds heard and visuals presented to create immersive experiences. Therefore, theoretical perspectives from film sound and empirical perspectives from sound perception and neurological research provide better understanding of the relationship between sound and visuals.

Relationship Between Sound and Visuals

SOUND CHANGES THE IMAGE

When people sit in a theatre to view a feature film or pick up a game controller to play Call of Duty, they watch images on a screen while listening to sound projected from speakers or through headphones. By doing so, they "agree to forget" (Farnell, 2010, p. 97) that the source of the visual is different from the source of the sound. Chion (1994) describes the experience of accepting this phenomenon as participating in "audiovisual illusion" (p. 5). This illusion, according to Chion is "not natural, but a kind of symbolic contract that the audio-viewer enters into, agreeing to think of sound and image as forming a single entity" (p. 216). Chion and Farnell both describe this relationship between sound and visual as an "audiovisual contract." According to Farnell, this contract remains in place so long as there is a "plausible synchronisation" (p. 97) between sound and visual, and as long as one can associate the sound with a visual source. Chion refers to this synchronization as *synchresis*, a phenomenon that occurs as a result of an "irresistible weld" (p.63) that is created when sound and image are triggered simultaneously. According to Chion, synchresis is the phenomenon that explains how people associate the visual of an on-screen action (e.g., a door appearing to open) with the sound of that action taking place (e.g., the sound of a door sliding open). The result of the action, therefore, is that the audience believes a door has opened. To illustrate this, Chion (p. 12) refers to the movie, *Star Wars: The Empire Strikes Back*. In this film, the illusion of a large door on the Death Star sliding open was achieved by displaying a still image showing a closed door immediately before a still image showing an open door. The illusion that the door on this space station slid open was achieved by pairing these visuals with a sound effect to indicate the door had opened. No special animation technique was otherwise used to achieve this effect.

Sven Carlsson (1994) elaborates on this idea of synchresis to include audiovisual synchronization that is purposefully designed to affect our perception of, and emotional connection to, a visual event. The famous "swoosh" sound made by lightsabers used in *Star Wars*, for instance, was designed by Ben Burt to change in intensity as the weapon accelerated during a fight (Industrial Light and Magic, 1993). Here, what Carlsson refers to as *perceptual* synchresis is achieved as the sound of a more intense *swoosh!* signifies that the light sabre is accelerating because it is being swung with greater force.

The notion that sound and image are interlinked is a central tenet of the art and practice of sound design for media. According to Larry Sider, sound designer and director of the Sound School in the United Kingdom "Sound changes the image—in fact, some would say it multiplies it" (Sider, 2003 p. 9). In this context, Sider is referring to the way in which sound affects the way that people not only see film, but also experience it. It is an experience that Sider suggests one might understand from viewing a film without sound. In doing so, one might be able to learn more about, "How [we] view the frame, what [we] look at, which actions stand out, how [we] interpret expressions" (p. 9). In this way, sound not only directs what people see but also affects how they see it. Music in particular "not only imbues the image with emotional or cultural resonance, it also guides the viewer's attention… Move the music a few frames and different movements show up; move the music again and a different set of actions will stand out" (p. 10).

What Chion (1994) and Sider (2003) present is a perspective on sound and sound listening that calls for an attention to how sound is paired with, and to a large extent dependent upon, visual images. Chion and Sider even suggest sound design techniques for people who need to make decisions about pairing sound with film. Chion suggests that designers engage in a process of *masking* in which they watch a film sequence in a way that hides the visual image at certain times, while hiding the sound at other times. Doing this allows designers to "hear the sound as it is, and not as the image transforms and disguises it; it also lets [them] see the image as it is, and not as sound re-creates it" (Chion, 1994, p. 187). The practice of masking is born out of traditions in film production and media practice to give us an important snapshot of pairing sound with image that is based on time-tested, phenomenal experience. One can also find empirical evidence to support the congruence between on-screen visuals and sound that Chion and Sider discuss, by examining cross modality studies in sound and music perception to examine how people perceive sound and visuals when they are presented together under experimental conditions.

SOUND AND PERCEPTION

Cross-modal perception studies quantitatively examine how sound and visuals work together at a perceptual level. A cross-modal study of sound in games might study the importance that players place on hearing game audio that is paired with game visuals that match the sound presented. Such a study might ask players to indicate when they hear the sound of a ringing phone after they walk into a room in the game. One condition of the study might pair the sound with a visual animation of a flashing red light on a phone on a desk, while in another condition might display an animation of a baseball bouncing on the ground at the same time that the phone-ringing sound plays. In this example, the condition with the visual of a phone with a flashing red light represents a congruent pairing of sound with visual, while the condition with the visual of a baseball bouncing on the ground represents an incongruent pairing of sound and visual. As Chen and Spence (2010) point out, if you drop a ball on the ground, you naturally expect it to make a sound when it hits (and one assumes the sound is not that of a ringing phone). Moreover, when the ball actually hits, what you learn through the visual and auditory senses includes a range of spatial, temporal, and semantic information. That is, you know when the ball hits, the type of surface struck, and how high the ball is likely to bounce. You can even tell something about the room you are in by the amount of echo generated by the impact. Chen and Spence's (2010) research indicates that auditory and visual modalities interact at a semantic level to help assign meaning to perceptual events that are both seen and heard. Chen and Spence studied how well participants identified a picture, based on whether they heard a *semantically congruent*, *semantically incongruent*, or white noise sound. Their results suggest that subjects were significantly more accurate when the sound played matched the picture viewed and that accuracy was hampered when the sound played did not match the picture shown. Moreover, this semantic congruency held as long as the visual and auditory events were timed to occur within about 300 ms of each other. What people hear affects what they see. In another cross modal perception study, Sekuler, Sekuler, and Lau (1997) demonstrated that people can perceive moving visual images that collide with each other as *bouncing* off of each other if they hear a click at the point in time at which they impact, or very near it. Sound can also help to “fill in the blanks” in what one sees. Väljamäe and Soto-Faraco (2008) found that auditory motion after-effects were observed when appropriately paired with visual flashes. Their results suggest that sound can “fill-in sparsely time-sampled visual motion” (p. 6).

In one experiment in a study by Vroomen and de Gelder (2000) participants had to select a specific visual target out of a series of visual targets. Researchers discovered that distinct sounds can be used to help “segregate” or detect visual stimuli when audio and visuals are triggered at the same time. The results from this cross-modal study are consistent with Chen and Spence (2010), Sekuler et al. (1997) and Väljamäe and Soto-Faraco (2008), in that audio and visual information are perceived in a way that is unified and “integrated into a coherent representation of the world” (Vroomen & Gelder, 2000, p. 1590). Cross-modal studies provide us with a basis to understand how sound and visuals are connected at a perceptual level, and provide insights into understanding Chion’s audiovisual contract (Chen and Spence, 2010; Chion, 1994; Sekuler et al., 1997; Väljamäe & Soto-Faraco, 2008).

Beyond cross-modal perception research, there is also a neural basis to support the idea that sound and visuals are processed concomitantly. Molholm et al. (2006) presented the "first direct electrophysiological evidence for audio-visual multisensory processing" in the superior parietal lobule of the brain (p. 721). This research therefore provides a biological basis to explain why people process sound and visuals together. In a neural study by Degerman et al. (2006), results from brain imaging using fMRI techniques reveal that attention to presentation of audio and visual materials elicited greater activity in regions of the brain when presented together than when presented separately. Of note, these researchers were able to identify areas of the brain responsible for perception of integrated audiovisual events. Sound perception research is crucial to understanding how sound and visuals relate at a fundamental perceptual level. Neurological research also helps us to understand how such perceptual processes manifest biologically in the brain. Thus, it seems clear that what people see affects what they hear, not only because it makes perceptual sense, but also because there are cognitive and physiological reasons for this phenomenon.

The research presented thus far has focused on perception of sound and visual events and has often involved the study of discrete sounds paired with the presentation of visual stimuli. However, educational game design ultimately involves the use of music in addition to sound effects. Since there is a paucity of research on the effects of music on our experience of gameplay, I also turn to research in music psychology to understand how congruence between music and image affects our experience of gameplay. To do that I draw on research from music and film viewing to help explain the relationship of music to film narrative, emotional meaning, character development, assigning meaning to film characters and to the "message" transmitted through visuals.

MUSIC, FILM, AND CONGRUENCE

Studies in film and music perception indicate that the selection of background music for a film affects the ways in which viewers attribute meaning to visual events. The expressions that people choose to describe film music are similar to those they use to describe the film. Moreover, if people hear music before a character appears in a film, they are likely to interpret the character's expression based on the emotional qualities of the film score.

In one well-established study, Marshall and Cohen (1988) examined the effects of music soundtracks on the perceived meaning of film characters represented by three animated geometric figures: a large triangle, a small triangle, and a circle. The results from the two experiments in this study strongly indicate that music is able to directly affect the perceived meaning of film. In one experiment, subjects were presented with two experimental conditions, "Allegro *(fast)* music + film" and "Adagio *(slow)* music + film," with "film only" and "music only" control conditions. Subjects were asked to describe the film and provide adjectives for each of the three film characters based on a bipolar rating system. One of the "dimensions" studied with this rating system asked subjects to rate each film character as being either calm or agitated (referred to as the "calm-agitation" dimension). The ratings for the calm-agitation dimension for these characters differed significantly across experimental and control conditions. Thus, subjects described the film characters as either calm or agitated across a five-point bipolar scale differently depending on whether they heard fast music, slow music, or heard only music without the film.

In a follow-up experiment (Marshall & Cohen, 1988), researchers grouped pairs of bipolar adjective ratings to study how subjects would attribute adjectives categorized as "evaluative," "potency," or "activity" to the film and music studied. Two different music scores were created to provide "weak music" and "strong music" as the experimental conditions. The results from this experiment demonstrated that subjects differed significantly between strong and weak music conditions in adjective ratings for potency and activity. These results led Marshall and Cohen to hypothesize that "a soundtrack changes the meaning of a film in a rather direct way," meaning that a soundtrack that demonstrates strong salience of a characteristic ("Allegro or "Strong" in these experiments) will "lead to a high level of this dimension in some aspect of the film" (p. 108). Marshall and Cohen conclude that music is able to do this if it is "appropriately paired" or "congruent" with film material, although it is worth noting that these researchers do not provide a rubric to guide the pairing of film and music in ways that are congruent. Related research by Lipscomb and Kendall (1994) further supports the notion that a congruent pairing of film and music soundtrack affects meaning in film—"regardless of visual stimulus" (p.60). Moreover, subjects were asked to select the most "appropriate" musical soundtrack for each of five film excerpts from a popular commercial film. The “composer-intended musical score” was chosen the most frequently.

The film and music perception studies by Marshall and Cohen (1988) and Lipscomb and Kendall (1994) indicate that music listening during film viewing can affect the way that people interpret film and assign meaning to visual events. In addition to influencing the meaning that people assign to film characters, music has also been shown to affect how people interpret facial expressions in film, otherwise known as *affective priming*. Moreover, music may have an effect on how people interpret film character expressions either before or after a character is shown, even if the characters are not speaking (Tan, Spackman, & Bezdek, 2007). In contrast to the bipolar adjective scaling in Marshall and Cohen (1988), subjects in a study by Tan, Spackman, and Bezdek (2007) were asked to supply an emotional label for each film viewed. Emotional labels were then normalized and grouped into four clusters: happiness, sadness, fear, and anger. In one finding, film character emotions were perceived to be “more intense when the main action sequences were preceded by the music than when the music followed the main action sequence” (p. 144).

Thus, as Lipscomb and Kendall (1994), Marshall and Cohen (1988), Tan et al. (2007) and Hung (2001) have noted through film and music perception research, music that is carefully paired with film visuals can help shape the meaning people derive from film. Moreover, music helps to modulate the emotional qualities that people attribute to characters in film. Researchers who study the effects of music on people who view advertising have also found that music impacts the way people interpret the ads that they watch and it can affect the how they remember the products in the ads they see.

MUSIC, ADVERTISING, CONGRUENCE, AND RECALL

Music helps advertisers to communicate different meanings for ads by varying the music selected to accompany the ad. Moreover, music can act as a cue to help ad viewers recall the ads they see and to associate the music they hear with the product sold in the advertisement. In a study of “teaser ads,” Hung (2001) suggests music helps ad viewers assign meaning to what they see by “connect[ing] with and accentuat[ing] selective visual events, as well as selective aspects of a visual event, to draw out the advertising proposition” (p. 39). Hung selected a “teaser ad” for “Raffles” (a shopping center) that lacked visual anchors such as product presence and clarity of video character movements. Two contrasting music soundtracks (by the rock band Garbage and by the Baroque composer Vivaldi) were then paired in each of two versions of the ad. Participants in experimental and control groups provided scaled ratings for “images” and “emotions” conveyed under each condition. Interviews were then conducted to further elaborate findings. Of note, Garbage and Vivaldi affected the image (“Ad Positioning”) conveyed by the Raffles brand—“young and hip” versus “upscale,” respectively. Interestingly, music was also found to affect the ad’s sense of pace. According to Hung (2001), “although the visual track(s) were played at an identical pace, viewers perceived them to be different when different music tracks were dubbed” (p. 46).

Music can act as a cue to retrieve film information by interacting with film scenes to accentuate and promote attendance to film visuals (Boltz et al, 1991). Music has likewise been shown to affect recall in advertisements. In a 2007 study, Alexomanolaki et al. found that music affected implicit recall of the product advertised under “low-attention” conditions. Four groups of undergraduates (three experimental plus control) viewed advertisements while watching a popular twenty-minute TV sitcom. One condition of the target advertisement was shown to each group. Participants viewed one of the following:

- an ad with a musical jingle
- an ad with music only (but musically similar to the jingle)
- an ad with music and voiceover
- an ad with sound effects and voiceover (no music) as the control condition

Three memory tests were then administered that included “free-recall” questions, indirect questions to test visual and verbal associations, and direct questions about the target product. Although music did not have an impact on the direct recall test, subjects in all music conditions—the jingle condition in particular—significantly outperformed control. According to Alexomanolaki et al. (2007), “music appears to increase participants’ implicit memory for words and images associated with the advertised product ” (p. 65). Research on the effects of music on film and advertising demonstrates that music significantly affects our interpretation of film information—the greater the congruence between music and film, the greater the effect (Hung, 2001; Marshall & Cohen, 1988; Tan et al., 2007). Research from film and advertising provides a compelling explanation of the effects of music in other visual mediums such as multimedia, suggesting that music that is designed to support its intended visual medium not only aligns best with the target message, but also affects implicit recall of the information presented (Alexomanolaki et al., 2007; Walter, 2004).

The research presented in this section addresses the role that sound and music plays in our perception of visual stimuli. Michael Chion's (1994) theoretical perspective of synchresis suggests that people interpret the presentation of audio and visual events as a unified audiovisual experience. Both cross-modal research in sound perception and neurological evidence support the perspective that hearing sound changes the way people perceive on-screen visuals. Moreover, music psychology experiments by researchers like Marshall and Cohen (1988) demonstrate that listening to music can change the way people interpret images they see. Research in music and advertising reveals that music can direct the way in which people interpret advertising in day-to-day life. The following section examines the role that sound plays in software design and specifically in the design of sound for games.

Sound and Engagement in Software

In this section, I apply William Gaver's (1993) theoretical approach of "everyday listening" to analyze sound in software. I then expand this theoretical approach through an analysis of game audio research. The research in this section focuses upon work that exists outside of traditional areas of educational technology scholarship.

In "What in the World Do We Hear?: An Ecological Approach to Auditory Event Perception," Gaver (1993) advocates for a sound listening strategy that takes an *everyday listening* approach to parsing what people hear, which takes into account the ecological context in which people hear sound. According to Gaver, an ecological perspective is one in which people perceive “complex events and entities in the everyday world” (p. 4). Gaver refers to an everyday listening approach as one in which people “experience…listening to events rather than sounds” (p. 2). This approach to listening to sound events means focusing on what the sound signifies, rather than on how it sounds (e.g.,*“boing!”*) or what instrument was used to create the sound (e.g., a bell). Gaver describes this approach to listening as part of a process to develop a type of “ecological acoustics…[to] describ[e] the acoustic properties of sounds that convey information about the things we hear” (p. 5). Gaver’s notion of ecological acoustics is consistent with what Schafer (1993), describes as acoustic ecology. R. Murray Schafer, known as the “father of acoustic ecology” (Razdan, 2005), defines this ecological perspective as “the study of sounds in relationship to life and society…[which] only be accomplished by considering on location the effects of the acoustic environment on the creatures living in it” (Schafer, 1993, Kindle Locations 4181-4183). Schafer discusses acoustic ecology from the perspective of a way to listen to sound in the everyday world. This perspective does not describe ways to use sound in software; however, it provides an important basis by which to describe an acoustic ecology for sound in complex game environments that attempt to represent the everyday world.

Gaver’s (1993) everyday listening approach to sound in software is one that considers the ways in which an audio event (described as an *auditory icon*) signifies something important in the software interface. What makes an auditory icon relevant from Schafer’s (1993) ecological perspective is how the sound people hear affects the way they use software. Gaver (1993) suggests that auditory icons help to “ma[p] sounds to events in computer systems" (p. 27) in ways that provide users with auditory feedback as they use software. Gaver and O'Shea (1991) examined the use of auditory icons within a simulation of a bottling plant in the Arkola Simulation (AS). In AS, auditory icons were used to supplement visual feedback, and graphics and auditory cues were used to help people work together in the simulation. These icons and cues were "effective in allowing people to monitor events and diagnose problems" (p. 5). According to Gaver and O'Shea, use of auditory icons is beneficial in helping software users to know not only that "*something* is happening (usually something wrong), but [also] *what* is happening" (p. 5). In this way, sound through the use of auditory icons is able to convey semantic meaning about a complex piece of software while "support[ing] the perceptual integration of a number of separate processes into one complex one" (p. 1).

Beyond the use of auditory icons to assign semantic meaning to computer interface events, Kwon, Jee-Hoon, Bae and Suh (2006) provides us with another example of a complex software application where sound was meaningfully paired with interactive elements in a driving simulation. In a virtual reality simulation, the addition of an engine sound enhanced how users perceived the sensation of velocity in a driving simulation. This effect occurred when sound and visual were paired during the simulation. From an everyday listening perspective, changes in an engine sound effect conveyed meaningful information about how hard the engine was working and thus provided the virtual driver with needed contextual information about the event at hand.

Ecological perspectives are also useful in considering the role that sound plays in participant experiences of gameplay. As Grimshaw (2010) points out, computer games enable a player to be “immersed in, and part of, an acoustic ecology and thus, through this immersion, is engaged and incorporated into the game world and the game-play” (p. 74). There is limited empirical research on the ecology of game audio and player immersion in game-play. However, one important study on game audio sheds light on these player experiences of gameplay. For “Left in the dark: playing computer games with the sound turned off,” Jorgensen (2008) conducted interviews and observations with players of Warcraft III and Hitman Contracts. Jorgensen describes the use of sound in the context of both the game environment and of the player’s experience in that environment. In this case, sound, visuals, and player interactions create a vivid gameplay experience. Jorgensen examined how people react when sound is taken away mid-way through gameplay. When interviewed, participants described feeling a loss of control such that they felt “in the dark” and in one instance referred to the experience as “losing a leg” (p. 166). Other participants described a loss of engagement following the loss of game audio. One participant initially held a dismissive view of the role of audio in games, which changed as a result of the experiment.

Reasons given by participants for their reactions fell into two categories: (a) the loss of sound resulted in a loss of information and (b) the loss of sound led to a decrease in the experience of “presence” in the gamespace. A loss of the information normally provided by sound meant that players had less information with which to make critical gameplay decisions. Further, players lost the ability to properly orient to objects, characters, and events in the game-space. The lack of sound effects and music removed “auditory realism” from the game environment (Jorgensen, 2008 p. 169-171). Further, since music can be used in ways that are location-based and provide engagement on an emotional level (Stockburger, 2003), the use of sound in games creates "presence" while its absence removes it (Jorgensen, 2008). Games can thus be designed and played without sound. However its omission results in a reduction of auditory information, audio-based cues, and player ability to engage with the gameplay experience, thereby potentially frustrating players (Collins, 2008; Jorgensen, 2008; Marks, 2002).

Jorgensen's findings are consistent with both ecological perspectives on the use of sound and the importance of the synchretic, audiovisual relationship described by Chion (1994). According to Stockburger (2003), the relationship between game audio and game visuals is consistent with Chion's notion of audiovisual synchresis, with one crucial difference. Game environments combine player interactivity with sound and visual presentation (Stockburger, 2003). Collins (see Table 1) refers to this type of interactivity in terms of either *adaptive* sound responses that come as a result of as changing game states (e.g., the health of a game character or level of the game) or *interactive* sound responses based directly on player choices. Thus, game audio is not only affected by visuals to which it is paired, but it can also be affected by the choices that players make and conditions that change throughout game-play.

Sound is used in games in ways that orient players, provide information, and make game-play authentic. Music can direct the emotional messages received during play and highlight important game changes. Game sound provides a crucial connection to the audiovisual illusion provided by the interaction of game visuals with sound, and at times is mediated by player choices and changes in the game. This illusion enables players to create semantic meaning from play and helps to establish a realistic game setting. Notably, Jorgensen (2008) and other game sound theorists describe the role of game sound from the ecological perspective of the events conveyed by sound, instead of from the technical perspective of the sounds themselves. An ecological, everyday listening approach to describing the role of game audio is crucial if, as Bishop and Cates (2008) suggest, designers of educational software hope to use sound to "represent content…depict a context...or illustrate a construct" (p. 481). A synchretic, ecological approach to examining sound as paired with visuals can also help to derive a framework by which to understand learner perspectives of their sound listening experiences while playing educational games. However, such a context-driven, learner-centered and synchretic perspective is missing from current research with sound in educational software.

Research with Sound in Educational Software

SOUND IN EDUCATIONAL MULTIMEDIA

Cognitive Load and Modality

Much of the literature related to sound within educational multimedia contexts centers around the impact of sound on modality and cognitive load. In the usage of Mayer and Moreno (2002), *modality* refers to the principle that text content in multimedia software is better presented as audio narration, rather than as on-screen text. Mayer and Moreno contend that using audio narration in multimedia software that also contains visuals such as animations helps students learn more than requiring that students read text and watch animations. According to Moreno and Mayer, students learn more because “visual working memory is not overloaded by having to process both animation and printed text” (p. 117). If students have to read printed text in addition to viewing on-screen animation or visuals, then the printed text “compete[s] for processing resources with animation in visual memory” (p. 117), which in turn impedes learning. Leahy, Chandler and Sweller (2003) further discuss a “modality effect” which can occur when a person’s visual and auditory cognitive channels are used to process multimedia information. Leahy et al. suggest that this “dual-modality instructional forma[t]” (p. 404) is effective at reducing cognitive load and increasing working memory.

Cognitive load was originally discussed by Sweller (1988) as a way to describe a learner’s cognitive capacity to solve problems. According to Sweller, it is possible for cognitive capacity to be overloaded to the point that a person’s ability to form generalizable mental models (schemas) is hindered. Sweller examined differences in cognitive overload that resulted from different problem solving strategies between novices and experts referred to as “forward and backward-oriented models” (p. 263). Sweller hypothesized that cognitive load is proportional to the amount of analysis required by different problem-solving strategies. Thus, cognitive load is affected not only by the number of discrete pieces of information that needs to be stored in short-term memory, but also by the number of hypothetical relationships (“statements”) that working memory needs to hold. Sweller’s analysis is based on problem-solving strategies needed to solve a simple physics problem. Sweller describes this process as centering around a “human production system:”

"[The learner must] attempt to match the known values with equations containing the goal to see if a solution is available; decide whether this is a futile exercise at this point; decide on the basis of available unknowns whether subgoals should be set up; decided on the basis of the knowns, unknowns, and equations which subgoal track should be followed; decide on the basis of the known values and available equations whether a value for a subgoal can be calculated; decide whether this is a futile exercise." (Sweller, 1988, p. 274)

Thus, Sweller's (1988) work indicates that cognitive load is not merely limited to issues of information retention; rather it involves the cognitive processes needed to parse that information and make decisions about its relevance to a goal.

Mayer and Moreno published two studies in 1998 and 1999 on the effects of multimedia learning on cognitive load. In these studies, Moreno and Mayer examined how narration, visuals, and animation in different combinations affect cognitive load and therefore performance on retention and transfer tasks. In the 1998 study, Mayer and Moreno compared retention and transfer performance by students who viewed two timed multimedia presentations: the first was a module on lightning; the second, a module on an automobile braking system. Participants were divided into a group that viewed an animation on the topic along with accompanying text and a group who viewed the same animation, but with spoken narration instead of text. Researchers base their assumption of working memory on Baddeley's (1992) model for working memory, which includes two "slave" systems, a "visuospatial sketch pad" (responsible for processing images), a "phonological loop" (responsible for processing speech) and a "central executive" (which regulates both systems). Mayer and Moreno set out to test the theory that working memory was governed by separate systems that process auditory and visual information, and hypothesized that students who were presented with narration accompanying the animation would perform better on performance measures than their counterparts who saw text accompaniment. Their study in "split-attention" was designed to examine how visual and auditory information are integrated in a multimedia presentation. Results from both of their experiments revealed that students in the animation and narration condition performed significantly better on all experimental performance measures than their counterparts who viewed text captions during each presentation. Effects sizes were calculated as >0.55 in the first experiment and >0.49 in the second experiment, indicating a convincing "split attention" effect for each experiment.

Moreno and Mayer continued their research into cognitive load in a 1999 study (using the same multimedia module on lightning) to clarify the split-attention results in their 1998 study, in two experiments that were designed to demonstrate the presence of modality and contiguity during multimedia viewing. The first experiment examined "spatial contiguity" (the effect arising from the relative locations of animation and text) and modality (the effect arising from the use of both auditory and visual channels of working memory). Conversely, the second experiment tested for the presence of "temporal contiguity" (the effect arising from presenting narration and other on-screen visuals at the same time). In the first experiment, researchers studied three groups: one group saw text captions at the bottom of the screen during the animation (group ST); one group saw text within the animation (group IT) and another group heard narration and viewed the animation (group N). The narration group significantly outperformed the text groups (IT and ST) on all three performance measures (recall, transfer and matching) with an effects size > 1.0. Likewise, significant effects for spatial contiguity were found on retention and transfer tests (but not on a matching test); with effects size calculated as > 0.47. Groups for the second experiment were divided according to whether they experienced narration and animation (NN), text and animation together (TT), narration that was temporally separated from the animation (AN or NA), and text that was temporally separated from the animation (AT or TA). Results from the second experiment indicate that there was no difference between groups that saw text or heard narration either before or after corresponding times in the animation. Thus, these narration and text groups were collapsed for subsequent analyses.

The second experiment also demonstrated significant effects for modality (with effects sizes > 0.63) on retention, transfer, and matching performance measures. However, the second experiment yielded significant temporal contiguity effects only for the text and animation groups (AT and TA); and only on the matching test, with a modest effects size of 0.33 (Moreno and Mayer, 1999, p. 365). The results from Moreno and Mayer's study point clearly to a modality effect while viewing timed multimedia presentations. Groups who heard narration that accompanied an animation repeatedly performed significantly better than their counterparts who viewed text with the animation. Moreover, the results from tests in contiguity reveal that split-attention is somewhat more accurately discussed as effects in spatial and temporal contiguity with the use of on-screen text in multimedia presentations. Thus, it would seem that Mayer and

Moreno's 1998 and 1999 experiments did demonstrate modality and split-attention effects among people who viewed multimedia presentations.

In 2004, Tabbers, Martens and Merrienböer examined modality and split-attention effects in an instructional design module, as studied in a classroom setting. Tabbers et al. analyzed results from student retention and transfer tests after the students used a one-hour self-paced multimedia module on instructional design. Students were divided into four groups according to whether students saw text in-line with the presentation (e.g., "visual cues"), and whether students heard narration or saw visual text captions. Contrary to the prior studies by Moreno and Mayer in modality and split-attention, Tabbers et al. found a "reverse modality" effect—that is, students who viewed text captions scored significantly higher on retention and transfer measures than their counterparts who listened to narration. Visual cues were found to be significantly effective only on retention, and were thus characterized by Tabbers et al. as a "weak cueing effect" (Tabbers et al., 2004, p. 71).

Kalyuga (2010) explains the effect of reverse modality as a byproduct of text content. According to Kalyuga, reverse modality can be "obtained exclusively using lengthy, complex, auditory textual material…[that] may overwhelm working memory" (p. 1055) and thus prevent a modality effect from occurring. In order for a cueing (split-attention) effect to be effective, Kalyuga suggests that the cue and the corresponding image be "unintelligible" unless considered as a cohesive pair. This notion is similar to one echoed by Koroghlanian and Klein (2004) when describing the effects of modality that work “if the text information must be integrated with the illustration for comprehension” (p. 27).

Still, other researchers have also found contradictory results for studies in modality and split-attention effects. A 2003 review by Lim on the effects of “multiple channel redundancy” suggests that differences in the effects of modality and split-attention may be due to differences in the combination of elements such as text, narration, and animation (i.e., “redundancy”), differences in the use of computer-based media (animation, diagrams, pictures, and narration) and television (video, pictures, text, and narration), and differences in the types of information used (e.g., “static images, animations, diagrams or maps”), and differences between individual learners. In a study on the effects of spatial ability when using animation and audio, Koroghlanian and Klein (2004) suggest that research in the application of audio and images is “scarce” and research into the effects of audio and animation is “contradictory.” Rather, the effects of animation may be related to the purpose that the animation serves, differences in learning outcomes and individual learner differences.

In fact, Koroghlanian and Klein’s (2004) research using a “computer-based instruction” module on cell biology revealed that students differed in practice and post-test performance based on their spatial ability scores, which were scored as a result of a paper folding test. The use of animation and audio narration did not have any effect on the performance of low spatial ability students, but animation and audio impaired the performance of high spatial ability students. According to Koroghlanian and Klein, although learners do not need to try as hard to understand the information presented, they may not invest as much effort to understand the information presented by images and audio. Thus, this lack of effect on performance might be related to learners' perception of what the purpose of animation and audio in media should be (p. 38).

Pacing

In addition to research in the effects of modality and split-attention on cognitive load as a result of audio listening, a recurring question in cognitive resources research examines both the quantity of information and the pace at which information can be given through audio narration. In one study, researchers investigated whether computer-based audio instructions could increase retention beyond equivalent print material. No significant difference was found in student performance. However, qualitative analysis suggested that factors that affect the use of audio include audio pacing and the ability to repeat audio segments (Beccue & Joaquin, 2001). This finding is noteworthy, particularly since it implies that decisions about how to present sound (e.g., pacing) are important in learning how to design sound for software, even if audio material is presented without visuals.

Moreno and Mayer on Audio Dual Coding, Coherence, and Arousal

As reported in their paper, "A Coherence Effect in Multimedia Learning: The Case for Minimizing Irrelevant Sounds in the Design of Multimedia Instructional Messages," Moreno and Mayer (2000) conducted two experiments that investigated the "role of auditory adjuncts such as background music and sound" (p. 117) to support learning. Researchers examined the role played by sound effects and background music on performance, as measured by retention, transfer, and matching tests. The purpose of both experiments was to test the applicability of two divergent principles: coherence and arousal. Based on the results of their research, the authors concluded that the coherence effect, as applied to the addition of music and sound, "overtax[ed] the limited cognitive resources, therefore hindering learning" (p. 124). In conclusion, Moreno and Mayer recommend that "instructional software designers should carefully limit the amount of auditory material in multimedia lessons rather than add auditory materials for reasons of appeal or entertainment" (p. 124).

According to Moreno and Mayer (2000), the Coherence Principle applies to using "few rather than many extraneous words and pictures" in multimedia since "auditory adjuncts can overload the auditory channel" (p. 118). As a result, any auditory material, "not necessary to make the lesson intelligible or that is not integrated with the rest of the materials" can cause cognitive overload and "interfere with the learning of the core material" (p. 118). In these experiments, overload therefore lead to reduced retention. The Coherence Principle is based on Paivio's (1990) cognitive theory of dual coding of information processing. Dual coding theory holds that there are two "symbolic systems" that process incoming information: a verbal channel to process both visual and auditory words, and a non-verbal channel to process everything else from other visual and auditory information and information from other senses. Sensorimotor systems (one's senses) are the vehicle by which information is loaded into these channels.

Moreno and Mayer (2000) assert that auditory adjuncts in the form of sound effects and music can overload "auditory working memory." The unstated assumption is that these adjuncts compete with auditory information delivered by narration in multimedia, and therefore result in reduced retention. According to Paivio's (1990) dual coding model, the use of sound effects would certainly fall within the non-verbal channel, while the use of music is arguably ambiguous. Moreno and Mayer (2000) contend that Arousal Theory supports the notion that "entertaining auditory adjuncts will make the learning task more interesting and thereby increase the learner's overall level of arousal" (p. 118). Moreno and Mayer also posit that arousal can positively mediate retention and transfer, and in their study, they sought to validate coherence theory as a rationale to explain the role of sound in multimedia. However, research from film and music perception demonstrates that music can clearly communicate emotion and intention when paired with images, findings that Moreno and Mayer's model are unable to explain.

An unstated assumption of Moreno and Mayer (2000) is that any use of sound effects and music to support learning is by definition both entertaining and separate from (i.e., an adjunct to) the presentation of visual information. Moreover, they assume that sound in the context of instructional software is useful if it is entertaining. In the two experiments performed in this study, Moreno and Mayer assume that the difference between "amateur multimedia program[s]" and ones that are professionally created "involv[es] the addition of bells and whistles like background music...and sounds" (p. 117). These researchers also equate background music with "instrumental music loop[s]" and illustrate the use of sound by describing "blowing wind and crackling ice" (p. 119). Clearly, there are multimedia applications that do use sound in this way. The multimedia programs used in their own study are examples of this application. Their study proposed that Arousal Theory might explain how "entertaining auditory adjuncts" could potentially be useful if they were able to increase attention, and thus retention. The results of their study were not consistent with Arousal Theory; the resulting implication is that the entertaining addition of non-narrative sound interfered with learning. However, as Bishop and Cates (2008) demonstrated in their analysis, sound can be used to serve a variety of purposes within educational software. By focusing on issues of retention and cognitive modality, Moreno and Mayer (2000) fail to address the relationship between sound and visuals in their application. Moreover, they do not mention the assumptions that drove their decisions to include the sounds that they chose for the study.

Moreno and Mayer's study in 2000 used the same "multimedia presentations" as their earlier studies in 1998 and 1999. In the 2000 study, Moreno and Mayer performed two experiments. The first involved learning through four versions of the multimedia module on lightning, while the second involved four versions of a multimedia presentation on the components and operation of an automobile braking system. Students were randomly assigned to one of four groups in each experiment and used one of the four versions of the program: narration only, narration plus sound effects, narration and music or narration with sound effects and music.

Audio, Procedure and Results Summary: Experiment 1

For the first experiment, Moreno and Mayer (2000) list seven sound effects that were paired with different portions of the animation used in the presentation on lightning. Effects (p. 119) included:

- a "gentle wind" to accompany movement of air;

- “water condensing in a pot” to accompany an animation of water vapor in cloud formation;
- “strong wind” to accompany presentation of “down drafts;”
- “static sound” for electrical charge buildup;
- “a clinking sound” to illustrate crystal formation within clouds;
- “crackling sound” to accompany animation of electrical charge moving from sky to ground and back;
- thunder to accompany lightning.

The music selected for the presentations was “an instrumental music loop” from a media clip CD-ROM, which lasted 20 seconds and was designed to play in the background of multimedia presentations. The music was “synthesized and bland” (Moreno & Mayer, 2000, p. 119). Students were presented with a participant questionnaire to assess prior subject knowledge in meteorology, demographic information, and questions on sound and music listening preferences. Following the three-minute presentation, participants completed a recall test. A second version of the program played back only the sound effects; upon hearing only sound cues, participants were given a cued retention test to assess how much the sounds played in isolation affected their recall. No significant differences were found on cued-recall. Four retention (transfer) questions were sequentially presented to participants, which were followed by a matching test. Univariate analysis in the first experiment revealed that students in groups who heard either music with narration, or music with sound effects and narration performed significantly worse on retention and transfer tests than groups of students who heard only narration, although no significant differences were found on a matching comprehension test. No significant differences were found between students who heard sound effects and narration and those who only heard narration. However, differences were highly significant ($p<0.0001$) for those who heard music and narration as compared with those who only heard narration in both retention and transfer tests.

Audio Chosen, Procedure and Results Summary: Experiment 2

In contrast to the sound effects used by Moreno and Mayer (2000) in experiment 1, the automobile brake program in experiment 2 included two types of sounds that matched the actions of the piston and the brake shoes. The same twenty-second synthetic and “bland” musical loop accompanied the presentation in the conditions with background music. The experimental procedure for the second experiment followed that of the first, except with differences in questions used for the participant data questionnaire. Instead of asking about prior knowledge about braking systems, participants were instead asked to rate their experience with automotive repair. It is not clear if acoustic listening preferences were collected. The second experiment also examined retention, transfer and matching test scores upon multimedia viewing. Those in the music and narration condition performed significantly worse on retention and transfer tests than students who heard narration alone, results that mirrored findings in the first experiment. On the other hand, students in the group who heard sound effects and narration performed significantly worse than those who only heard narration, a different result from that obtained from the same test between the same conditions in the first experiment.

It is curious that Moreno and Mayer (2000) chose to use seven clearly identified, specific uses of sound to illustrate the twelve instructional steps of the presentation in the first experiment, while only two different sound effects were used in the program to accompany seven instructional steps in the second experiment. I choose the word *illustrate* to describe the use of sound effects in experiment 1 because of the authors' specific language that describes the purpose for the use of each sound. This level of description differs from the use of "mechanical sounds" in experiment 2 to accompany the "movement of the pistons and the grinding of the brake shoes against the brake pad" (p. 122). The characterizations for the use of sound provided in experiment 1 (e.g., clinking to describe crystals in a cloud, static sound for electrical charges versus crackling sound for traveling charges) describe uses of sound that illustrate and are carefully paired with fewer than two-thirds of the animation events. The characterizations given for sound in experiment 2 (the grinding of brake shoes and movement of pistons) lack this illustrative quality and represent a little under one-third of the instructional steps in the animation. Interestingly, results from the retention tests in experiment 1 indicate that the addition of sound effects did not affect retention scores, while differences were found on retention measures in experiment 2. The authors do not provide an explanation for these differences.

It is plausible that a contributing factor rests in how well the sound effects were paired with the visuals presented. Cognitive research into the effects of visual and auditory congruence reveals that sounds which are semantically congruent (i.e., the sound and image share the same meaning (Kim & Iwamiya, 2008)) help us to more accurately identify visuals that are paired with the sound. As was mentioned earlier in this review, Chen and Spence (2010) conducted a series of experiments in a cross-modality study to examine semantic congruence. Chen and Spence explain that the reason that subjects were more accurate when they responded to semantically congruent audiovisual presentations is that short term memory is “not a unimodal visual structure;” rather visual information together with “other relevant semantic information [is] then consolidated in order to be encoded into memory” (p. 400).

Semantic congruence may have played a role in the use of sound effects within Moreno and Mayer’s (2000) study. The participants who heard sound effects in the second experiment fared worse on retention than those who only heard narration. Thus, Chen and Spence’s (2010) research findings seem to indicate that the sound effects used in Moreno and Mayer’s second experiment were semantically incongruent with the visuals presented. The abbreviated description of the use of sound in the second experiment suggests that little effort was made to appropriately pair visual elements in the animation with congruent sounds, and the resulting incongruence negatively affected recall. As a result, Moreno and Mayer were unable to achieve a proper synchresis between sound and visual. Moreover, the lack of significance found in the cued-retention test that followed an audio-only presentation might also be explained by incongruent timing between sound and visual. According to Chen and Spence’s research, any audio presented more than about a third of a second from the visual image would fail to yield any benefit from congruence. Therefore, it is not clear how the addition of audio without a congruent visual would have yielded greater recall of the presentation material. Chen and Spence's research suggests that the sound effects used in the first experiment may have matched the visuals; however it is unclear whether the addition of sound effects added to the semantic information in the multimedia presentation.

Another possible explanation for the difference in retention and transfer measures for students in Moreno and Mayer (2000) who heard sound effects as paired with narration in the first and second experiments is a lack of formal congruency between the presentation of the image sequence in the animation and the triggering of the sound. Kim and Iwamiya published a 2008 study in the journal *Music Perception* on auditory congruence using on-screen animated text (known as Telops). Kim and Iwamiya (2008) describe the synchronization between the presentation of visual images and audio playback as a “formal congruency” that provides a “consonant relationship” between sound and visual. Formal congruency can be achieved either through a similarity in “temporal structure” (i.e., the same timing) or by “similarity of changing pattern[s]” (i.e., patterns in audio material are aligned with patterns in visual presentation). The results of Kim and Iwamiya’s study suggest that the use of sound effects “contributed to enhancing the total evaluation of audio-visual productions” (p. 446). Moreover, formal congruency explains that combining auditory and visual material “creates a single perceptual unit” that provides a coherent listening and viewing experience to those involved (p. 446). Thus, congruency in both meaning and structure of audiovisual materials are needed in order to fairly assess their role as “auditory adjuncts” in instructional software. No attention is given in Moreno and Mayer’s (2000) research to the role of congruence between sound and visual images; thus, no clear conclusions can be drawn from their research into the role of sound effects in instructional software.

Moreno and Mayer (2000) also critique the use of music in instructional software, their results indicating that those who listened to music that accompanied the narration in the multimedia presentation did significantly worse ($p<0.0001$) than their narration-only counterparts. Moreno and Mayer conclude that the use of any background music in the multimedia should be at least limited, if not avoided, given the convincing statistical result. It is worth examining the basis by which music was included in the study. For instance, why was a background music loop of a twenty-second duration chosen? Moreover, why choose a "bland" and "synthetic" musical timbre—did the researchers think this would add to cognitive arousal? Dampen it? The answers to these questions are not clear. Researchers collected background information from participants on their music listening preferences. Participants were asked to select whether they preferred to study while: listening to TV, listening to music with lyrics, listening to instrumental music, or to study in silence. It is worth noting that none of the preference options given to participants included a listening condition in which they would listen to a 20-second loop of "bland music" repeatedly for 180 seconds (the duration of the multimedia presentation). However, researchers chose to include a 20-second, bland background loop in their presentations—with the same loop used for both presentations.

A substantial amount of research exists related to the role of congruence between music and the moving image. Kim and Iwamiya's (2008) research with sound and Telop patterns show that "synchronization of ... temporal structures of musical rhythm and images is effective in creating more effective multimedia content," and as such "are useful for understanding the role of music in multimedia contexts" (p. 446). If Moreno and Mayer (2000) chose an "instrumental music loop from a media clip CD-ROM" that was "designed to play in the background of multimedia presentations" (p. 119), it is unlikely that any congruence was achieved between the moving visual images of the animation and the music. Based on research in semantic congruence, it is not surprising that students failed to retain information during the Moreno and Mayer experimental treatment. Moreno and Mayer characterize the difference between amateur and professional multimedia productions by their use of "bells and whistles" in their use of sound. Moreno and Mayer's assumption that professional audio production can be reduced to the application of bells and whistles seems unconvincing. At best, this statement reflects a lack of understanding of professional audio production—at worst it reflects researcher bias in the use of sound. I further propose that it is plausible that by including bells and whistles in the design of sound for their experiments, Moreno and Mayer created an experimental environment that subsequently biased their results. The question therefore is not whether audio should be used in multimedia, but how.

All of this research raises questions about how both sound can best be used to design educational multimedia. In particular, Moreno and Mayer (2000) provide very little information about the rationale they used to select music for each of the multimedia modules in their study. Moreno and Mayer could have made different choices with the use of music in the multimedia modules used in their study. Since students performed poorly when they heard music, one question that remains is whether students might also perform poorly in a multimedia presentation that used music that was different from the music used by Moreno and Mayer.

MUSIC DESIGNED FOR INSTRUCTIONAL SOFTWARE

Although there are studies that examine the role of audio in designing educational multimedia, less educational research focuses on music as a mechanism to support multimedia. A ProQuest search revealed one thesis that researched music's potential role to support the instructional design process. This study (Walter, 2004) examined the effects of "designed background music" in a multimedia-based module, "How Lightning Works." Walter's study replicates Moreno and Mayer's (2000) study of sound in multimedia, but focuses on comparing the effects of "designed music" versus "bland music" to accompany the multimedia instruction. The premise for Walter's study is the theory that music can be designed in ways that complement multimedia. Walter argues that Moreno and Mayer's opposing theories of coherence and arousal can complement one another. Designed music can thus facilitate "complementarity" in ways that allow multimedia to retain its qualities that promote Moreno and Mayer's notion of arousal (entertaining adjuncts can improve retention), while still fostering coherence (audio used to support specific purposes). Walter contends that "designed music" is needed to match the rest of the multimedia presentation and positively affect learning. Walter suggests that music is best paired with educational software when it is purposefully composed, or "designed" to match the multimedia presentation. By taking this position, Walter also assumes that the presentation of sound (in this case music) is linked to presentation of software visuals.

For his study, Walter (2004) manipulated musical characteristics such as melody, harmony, dynamic range (loud or soft), tempo (speed) and rhythm—characteristics that Walter describes as musical prosody. Since Walter's study was designed to replicate one of the experiments in Moreno and Mayer's (2000) study in a way that focused on the role of designed music, Walter closely mirrored the original experiment. The same multimedia topic was chosen (a module on lightning), a similar bland, looped music track was used in one experimental group, sample sizes were consistent between the studies (approximately 75), and participants were chosen from undergraduate student populations. Walter also used the same retention, cued-retention, and transfer tests as in the original study, while collecting information on prior content knowledge and preferences for music listening. The only measure eliminated was the transfer test, since significant results were not found in Moreno and Mayer's original study. Walter compared three groups in his study: those that heard only narration with the presentation, those that heard looped and bland background music, and those that heard designed background music. Each presentation was 180 seconds long, again to mirror the length of the presentation in the original study. However, unlike the original study, Walter chose only to compare the effects of designed music in a single presentation, "How Lightning Works," instead of a second comparison using a module on automobile braking (as was present in the original Moreno and Mayer (2000) study). As in the original study, participants completed a timed retention test following an initial presentation viewing. Participants then listened to (but did not view) a repeat of the presentation. They were asked to add additional answers to the retention test using a different color pen, thereby replicating the strategy in the original study and thereby administering the cued-retention test. Participants were then given a timed transfer test consisting of a series of four questions, again replicating the procedure from the original study. In contrast to the results in Moreno and Mayer's original study, univariate analysis in Walter's study revealed significant differences ($p<0.05$) on the effects of background music on measures of retention and cued-retention. Walter did not find significant differences between groups on transfer test scores.

A critical limitation in Walter's (2004) replication of Moreno and Mayer's (2000) study is the lack of access to the original multimedia module. Therefore, Walter had to reconstruct the multimedia module based on researcher descriptions in the original study. Walter also made an educated guess as to the nature of the "synthesized and bland" music from the original study. Walter's choices for musical style, tempo, instrumentation, etc. were made to convey music that was synthesized and bland. However, no attempt was made to validate the musical choice based on inter-rater reliability—an unfortunate oversight.

Another threat to the internal validity of Walter's (2004) study is his selection of the strategy with which to design music for his study. Prosody is the mechanism by which Walter chose to achieve complementarity between music's effects on arousal and on coherence. The basis for Walter's strategy of designed music is the connection between musical and linguistic prosody. That is, Walter's music was structurally designed in ways that corresponded to linguistic cues such as stress and intonation. Walter refers to designing for a "syncopa[ted]" learning rhythm (p. 33). Further, Walter proposes that music can be designed in ways that match prosodic linguistic patterns of narrated speech, thus "juxtapos[ing] prosodic elements of the narrated message" with carefully written musical content (p. 15). While the idea of a musical and linguistic prosody is an interesting concept that deserves more attention, Walter does not substantiate its use and neglects to present research that explains how the "prosodic balance of a musical design for a multimedia event" can be achieved (p. 32). By his omission, Walter leaves the basis of his study open to critique. Upon reading Walter's study, someone interested in designing music to support learning might ask: How does a composer determine the sequence and form of musical structure that will best correspond with linguistic structure?

Linguistic and Musical Prosody

To explain Walter's (2004) misuse of the notion of musical prosody, I now momentarily turn to an analysis of prosody, a concept that Walter introduces but only briefly explains. According to the Oxford Dictionary, "prosody" (2010) is a linguistic concept originally derived from both the Greek word, *prosoidia* meaning "song sung to music, tone of a syllable," and from the Latin word *prosodia*, meaning "accent of a syllable." In common vernacular, linguistic prosody refers to patterns of speech such as intonation or emphasis. According to Palmer and Hutchins (2006), linguistic prosody is "acoustic changes in frequency, amplitude and duration that form grouping, prominence and duration" (p. 246). Palmer and Hutchins offer a complex analysis of musical prosody and suggest that musical prosody "is a complex, rule-governed form of auditory stimulation [that] can move listeners emotionally in systematic ways" while "captur[ing] general principles of musical expression" (p. 269-270). In short, "prosody is the music of everyday speech" (Wennerstrom (2001), cited in Palmer & Hutchins, 2006, p. 245).

To be sure, the question of linguistic and musical prosody is relevant and has been raised by a number of linguists and music theorists alike; unfortunately Walter (2004) neglects to draw on such research. Lerdahl and Jackendoff (1996) provide a foundational analysis of musical structure and discuss "prosodic structure" to describe a "deep parallel between music and language" (p. 314). Lerdahl and Jackendoff offer a detailed analysis of the parallels between language and music, in terms of syntax, phrasing, and the rules that drive use. These researchers draw upon the work of Noam Chomsky, who is well known for proposing the linguistic theory of generative grammar. Generative grammar assumes that a predictive, syntactical, rule-based structure exists for language. Musical theorists Lerdahl and Jackendoff base their work in generative music on generative grammar theory (Chomsky & Halle, 1968; Lerdahl & Jackendoff, 1996). Other generative music researchers have also been interested in systems that can predict musical structure and create music to replicate certain musical styles (Cope, 2001). Lerdahl and Jackendoff go even one step farther and suggest that a case can be made for "music theory as a cognitive science" (p. 332).

Thus, Walter's (2004) explanation does not dive into quite the depth of research needed to make specific claims about how musical structure should be paired with linguistic structure in ways that support the verbal message. According to Walter, participants in the designed music condition performed significantly better than the narration and bland music groups on retention and cued-retention tests. Thus, Walter suggests that designed music "…effectively supports higher levels of memory, recall or retention learning when incorporated into multimedia instructional designs" (p.72). I am unconvinced, however that the results from Walter's study can be explained by the use of musical prosody to design background music for a multimedia presentation.

Designed Music, Synchresis, and Congruence

I suggest reconsidering the approach used by Walter (2004) to separate the use of designed music from bland music. The results on retention and cued retention tests are not well explained by syntactical similarity and the specific pairing of musical and linguistic syntax. Walter leaves a large theoretical gap in his description of musical prosody and his theory of complementarity, as he presents no experimental research to substantiate either theory. However, Walter's results are still compelling, given their contrast to results from Moreno and Mayer's (2000) research, particularly as Walter carefully crafted his study to replicate the original researchers first experiment.

Walter's (2004) comparison is therefore valid, but for the wrong reasons. In place of complementarity, Walter's results are best examined by exploring the audiovisual congruence that characterizes the synchretic relationship between Walter's designed music and the visual and interactive components of the multimedia presentation itself.

The research of Tan, Spackman, and Bezdek (2007) and Alexomanolaki, Loveday, and Kennett (2007) shows that music affects recall, thus supporting Walter's findings. In addition, Lipscomb and Kendall (1994) show that composer-intended soundtracks provide congruence between music paired with visuals. Thus, Walter's designed music likely helped to assign value to the visual presentation, which in turn affected how learners experienced music in Walter's study. It is therefore plausible that the bland music chosen for Walter's study (and by extension, Moreno and Mayer's (2000) study) did not demonstrate a congruent pairing of music and visual stimuli, while the "designed" music did.

The sound research within educational software environments presented thus far primarily centers around issues of cognitive load and modality. Sound perception studies, on the other hand, emphasize the importance of a congruent presentation of sound and visuals in helping people to assign meaning to audiovisual events. Audiovisual congruence is therefore consistent with Chion's (1994) synchretic notion that sound and visuals form a unified audiovisual experience. Research on the use of sound to support virtual reality environments within simulations and museums can be helpful to better understand how sound and immersive visual displays work together to form interactive experiences.

SOUND, VIRTUAL REALITY, AND SYNCHRESIS

Sullivan, Ware, and Plumlee (2006) studied how users responded to different strategies to pair narration with on-screen visuals in a 3–D virtual reality museum exhibit. These researchers designed a museum exhibit called GeoExhibit, in which users can learn about a marine environment. A key goal of this project was to help users "make audio-visual connections easily, quickly, and naturally" (p. 218) without impeding their use of the system. These authors grounded their review of literature in cognitive load theory and were interested in studying whether active or passive interactions were beneficial in triggering audio in the exhibit. Users used a steering wheel to navigate the exhibit and visit multiple locations in which audio clips were paired with visual information. Multiple sound activation methods were examined and included playing audio when users passively wandered into a zone in front of the image as well as active approaches in which users triggered audio either by pressing a button or by driving into a zone in front of an image and having the software adjust their visual perspective so that they were optimally facing the image. The latter approach was called the "tractor-beam" (p. 228) approach.

Sullivan et al. (2006) tracked the amount of time that users spent in front of an image in addition to the number of zones they encountered, with the assumption that more time facing an image meant more engagement by people who use the exhibit. Interestingly, people spent more time in front of images when they took an active step to either press a button to play sound, or when the tractor-beam approach was used to move them into an optimal position.

Sullivan et al. (2006) do not make the claim that sound is either good or bad for the display or that it interferes with learning. The results of this audio activation study hold implications for virtual reality interface design. These researchers make the assumption that one should consider how best to connect the display of images with the presentation of sound. By doing so, these researchers raise the question of synchresis. In this case, researchers chose to give exhibit users greater control over when they heard sound, even as they were concerned about increasing cognitive effort. As Sullivan et al. point out, "dynamic activation of audio may encourage the cognitive binding between the audio and [on screen] text" (p. 237) which would be beneficial even at the cost of cognitive load. Although Sullivan et al. do not address the issue of either congruence or synchresis, their research strategy nevertheless examines these ideas.

Research with other virtual reality environments that incorporate sound also indicates that the use of an “audio modality extends the realistic impression of the virtual environment” (Mihelj et al., 2012, p. 7). Mihelj et al. (2012) designed a virtual reality “message in a bottle” (MIB) (p.3) exercise to help with rehabilitation of patients following injuries that cause motor control problems. The MIB virtual environment combined visual, haptic, and auditory modalities to help patients relearn motor control skills. The application provided patients with acoustic feedback in the form of “environmental sounds, music, and spoken instructions or encouraging statements” (p. 1) to help structure their treatment. The virtual exercise was situated on a beach of an island. Patients were given control of a robotic mechanism, which they used to grab a bottle that contained instructions for a series of exercises for them to complete. Although this study did not focus on the efficacy of sound, these researchers have placed a priority on carefully integrating visual, haptic, and acoustic feedback. Sound was presented in the form of music, environmental sounds, and constructive feedback in order to “giv[e] the user a sense of control and engag[e] him or her” (p. 7). As with the simulation by Sullivan et al. (2006), sound was carefully designed to match both haptic and visual needs in the virtual environment. By doing so, the inquiry of Mihelj et al. is consistent with the strategy of designing an environment that is audiovisually congruent and prioritizes the importance of a synchretic relationship between audio and visual presentation within a virtual reality context.

IMPLICATIONS FOR RESEARCH

Why study sound? The current body of research in sound and educational software is limited. Studies in cognitive resources that measure retention and transfer performance have largely defined sound-related research in the body of educational multimedia research. To date, the majority of the research available to guide the design of audio for multimedia environments has been defined largely by the effects of narration on cognitive load, as seen through the lens of information storage and retrieval. Findings from this body of literature have yielded enduring themes such as modality to describe how auditory and visual information channels mediate cognitive load. Designing educational software in ways that optimize modality means substituting the use of visual text material with narration, particularly for presentation of discrete chunks of information. However, no empirically-validated framework has been produced from this research that informs the design of audio elements other than narration (Bishop & Cates, 2008). Perhaps one reason for the lack of a framework is the assumption that if sound does not directly deliver narrative information, it is not relevant to learning. Studies like Moreno and Mayer's (2000) study on auditory adjuncts make assumptions about sound that are based on an incomplete understanding of the synchretic role that sound and music play in visual interpretation, meaning-making and decision-making.

Some of the findings associated with Moreno and Mayer's (2000) theory of spatial and temporal contiguity could be described as an example of congruence between visual events, with a temporal or spatial disruption of that congruence resulting in reduced cognitive performance. Moreno and Mayer do not however apply this notion of congruence to research with sound other than narration. Other researchers have been interested in the effects of "spatial congruence" between auditory and visual events (Rogers, Chan, & Newell, 2010), and the notion of both "semantic" and "formal" congruency between visuals and sound is a well-studied area of research. Much can be learned from research into audio's effects on pacing, into modality, and into split-attention effects of narration on cognitive load. However, much more still needs to be learned about the ways in which audio might affect the design of engaging, computer-based learning environments, and the mechanisms by which these effects might occur. Bishop and Cates's 2008 review of sound design in educational software is perhaps the first study to illustrate the potential for sound to support acquiring, analyzing, and synthesizing information and as such illustrates the importance of considering how sound can be used to support learning in educational software.

Research available on the use of sound for complex, immersive environments such as educational games is therefore limited. Studies on educationally oriented virtual reality environments begin to hint at questions of how sound and visuals are best paired in complex software systems to achieve instructional and therapeutic goals. However, these studies still do not provide a workable framework by which to design sound for educational games. Mann's (2008) structured sound framework proposes a cognitive modality perspective for sound but lacks a learner-centered, synchretic, ecological perspective, and is not derived from empirical research. Bishop and Cates's (2001; 2008) sound framework is primarily focused on the use of sound to gain attention, process content, and stimulate recall, but lacks the ecological, synchretic perspective needed to support sound design for immersive educational game environments. Additionally, Bishop and Cates's framework lacks a research foundation. Thus, neither Mann's nor Bishop and Cates's proposed framework is sufficient as a model to explain participant experiences of sound in complex educational game environments. The lack of a coherent framework is a critical gap in educational sound research.

Researchers like Collins (2008), Jorgensen (2008), and Gaver (2005) offer compelling research from which one can derive a framework for sound. However, these researchers do not individually provide the components necessary to articulate a coherent framework. Collins (2008) describes game audio from the perspective of player interactivity, but lacks a holistic, ecological perspective that explains how sound is relevant to player experience. Jorgensen (2008) offers a promising phenomenal analysis of game audio that is rooted in empirical research and is thus crucial to providing a key perspective for this dissertation but is still limited in its ability to articulate a framework that can be readily applied to games within learning environments. Jorgensen's perspective has thus far been limited to a description of sound in commercial games and doesn't provide a researchable framework for applications of educational games. Gaver (2003) offers a useful ecological perspective to address the everyday-listening experience of sound in software systems. However, Gaver's research is limited to software environments and does not directly address the unique acoustic environment within immersive games, as otherwise described by Collins and Jorgensen.

An inquiry into the experiences of sound in educational games must begin somewhere, and the individual perspectives presented thus far collectively offer a unique starting point to examine participant experiences. After all, as Shanahan (2012) points out, one need an alternative besides "maintain[ing] the status quo of using sound as an add-on or decoration" (p. 281) in order to make the best use of the capabilities of sound to design educational games.

Participant experiences of sound in educational gameplay give us an opportunity to better understand the potential for sound to create immersive, engaging learning environments. These experiences can offer a path by which to examine the ways that sound can be used to create engaging, interactive experiences. As this review demonstrates, an ecologically sensitive, synchretic perspective that examines how sound and visuals work as a unified, congruent perceptual experience offers fertile ground for researchers who wish to create game-based immersive learning experiences with sound. As more is learned about how sound and visuals convey information, researchers will be better able to ask: What can participant experiences tell us about the relationship between game sound and game visuals? In what ways do people find value in the use of sound in educational games? Such understandings will enable us to explore how to design immersive game-based learning environments that are both engaging and motivating.

CHAPTER THREE: METHODOLOGY

In this chapter, I describe the philosophical underpinnings of my phenomenological research method and the implications of different philosophical trains of thought for specific methodological choices. I then describe the design of the current study, the participant selection criteria and the participants selected, the research protocol, my approach to data reduction, and my view of the trustworthiness of the results.

Philosophical Background

I am curious about the ways in which sound affects people's experiences as they play educational games. Because, as described in Chapter Two: Literature Review, there are no suitable frameworks by which to research sound in educational games, I chose to conduct a phenomenological study to build a framework that will serve as a basis for future research in this area. Thus, I am asking the question: *What is it like to experience sound while playing educational games*? Phenomenology is an ideal research methodology for this inquiry since it necessarily focuses on individual experience (Giorgi, 1997; Moustakas, 1994; Cilesiz, 2010). Cilesiz (2009) demonstrates that phenomenology can be a useful research strategy in educational technology research, because it helps researchers to open up to the lived experience of using educational technology. In this chapter, I position myself primarily as an interpretive, qualitative researcher interested in learning about the ways that sound in educational games affects people's experiences of play and learning.

Phenomenology is at the same time both a psychology and social science research method and a philosophy. Phenomenology helps us to examine phenomena of what Husserl termed *lebenswelt* or “life-world,” the everyday world that Ricoeur (2007) describes as a “matrix of our existence” (p. 45). As a philosophy, Husserl’s phenomenology seeks to explain our experience by relating the *noema* of phenomena to the act of experiencing phenomena, otherwise known as *noesis* (Dourish, 2004). For example, the phenomenology of listening to piano music describes the relationship between the presence of a piano being played by someone (the *noema*) and the process that one goes through to consciously experience the performance (*noesis*). Vagle (2010), Dahlberg, Dahlberg & Nystrom (2008) and Dourish (2004) refer to the diverse ways by which consciousness can be described when relating to phenomenal experiences as *intentionality*. The perspective that one uses to define intentionality helps to shape the phenomenological method through which one can understand the world. One way to look at intentionality is through what Vagle (2011) describes as a *Husserlian lens*, which assumes that one can be “conscious *of* something” (p. 61). Thus what one knows about a phenomenon, one gains through direct experience (Dourish, 2004). For instance, for me to know what something sounds like, I need to have an experience of sound. It is not enough for me to imagine what the properties of the sound (e.g., timbre, pitch, loudness) might conceptually be like; nor is it enough to collect data (e.g., frequency, amplitude) about sound patterns. Those facets are indeed important if I want to understand what I hear, from either psychoacoustic or acoustic perspectives (Farnell, 2010). However, a Husserlian phenomenological perspective maintains that to know about the phenomenon of sound, I also need to have the experience of listening to it. This perspective on the intentionality of experience asserts that "abstract and formalized reasoning" alone is not enough to know the world (Dourish, 1994 p. 106). Instead, what one knows is necessarily experiential. As I elaborate in the next section, this Husserlian philosophical view of intentionality thereby leads to a *descriptive* phenomenological approach to studying sound when using phenomenological research methods.

However, as Dourish (1994) points out, the Husserlian view of intentionality in which "mental phenomena [are] separated from the physical phenomena" is itself limited, since "one need[s] to *be* in order to *think*" (p. 106). Dourish, along with Vagle (2010) and Dahlberg, Dahlberg & Nystrom (2008) reveal another perspective on intentionality as described by Heidegger. In this noematic perspective, the experience of being conscious in the world is inseparable from the world itself. This perspective is reflected in the concept that Heidegger called *dasein*, or "being-in-the-world" (Dourish, 2004, p. 108). According to Vagle (2011), this interpretive, intentional perspective on phenomenology is a process of "*finding-oneself-in* relation to the world" instead of being "conscious *of*" it (p. 61). As one listens to sound, one brings along assumptions of sound derived from past experiences, expectations and other contexts, during the listening experience. The experience of listening thus informs one's perspective, even as expectations influence what and how something is heard. What one hears and how one listens are therefore inseparable. Although it is possible to be conscious *of* sound, the experience of listening also requires that one find oneself in relation *with* what one hears. This Heideggerian philosophical view of intentionality thus leads to an *interpretive* approach when applying phenomenological perspectives to study sound.

DESCRIPTIVE VS. INTERPRETIVE PHENOMENOLOGIES

Philosophical phenomenological perspectives provide researchers with entry into questions of participant experiences. In doing so, phenomenology enables researchers to focus specifically on a particular phenomenon—for instance, experiences of sound. A *descriptive* approach to phenomenology research is one by which researchers conduct a phenomenological investigation "of" a particular phenomenon. In descriptive phenomenology research, I as a researcher am separated from the phenomenon being studied. Giorgi and Giorgi (2003), Giorgi (1997) and Moustakas (1994) take this approach by asking researchers to *bracket*, that is, to set aside their prior assumptions about a phenomenon before engaging in research.

Conversely, an *interpretive* approach to phenomenology research does not require the researcher to set aside their prior assumptions, but instead incorporates their assumptions into the research process. According to Dahlberg, Dahlberg & Nystrom (2008), the knowledge of the world does not sit "ready to be encountered." Rather, "meaning has to be understood in the relationship between humans and their world" (p. 94). In other words, researchers are bound to interpret the world as they observe it. An interpretive approach compels one to be open to a phenomenon, to "conduct [one's] research on behalf of the phenomenon" and retain the "capacity to be surprised and sensitive to the unpredicted and unexpected" (p. 98). Thus, an interpretive approach to a study of sound requires that researchers remain open to the possibility of diverse descriptions that can inform how participants experience sound. Interpretive phenomenology thus stands in ontological contrast to the descriptive phenomenological approaches as described by Giorgi (1997) and Moustakas (1994), since what is considered "real" in descriptive phenomenology is the product of direct experience, instead of the product of both past and present experiences, as in interpretive phenomenology.

Phenomenology as Method

WHY PHENOMENOLOGY?

The central question to my research is what is it like to experience sound while playing educational games. Phenomenological approaches open the way for me to address this question, and enable me to explore participants' lived experiences as a way to gain entry into lived experience of sound while playing educational games. I have chosen this approach because phenomenology helps examine questions of experience. Cilesiz (2010) proposes that educational technology research can benefit from phenomenological approaches; the research studies she conducted on experience were primarily focused around questions of the student experiences with "the learning environment, materials, and/or instructional design or on assessing the quality of or satisfaction from experience" (p. 5). Cilesiz proposes that phenomenology is uniquely suited to examining questions of experience because its epistemological commitments lead to a broader exploration of experience that includes contexts for learning as well as other aspects of lived experiences related to the phenomenon; what Husserl describes as *erlebnis*, or *experience*. As Cilesiz (2009) and Miller, Veletsianos and Doering (2008) demonstrate, phenomenology can be a useful research strategy in educational technology research because it helps to present the lived experience of a particular phenomenon.

In the case of sound research, a phenomenological approach can help to address questions such as "what are the experiences *of* sound in educational games," "what are the participant experiences *with* sound in games" and "what are the experiences of sound *through* the use of educational games." I have positioned myself as an interpretive, qualitative researcher and as such I am committed to attending to and acknowledging the biases formed by my prior knowledge in this area. Likewise, I am also committed to incorporating participant perspectives that arise out of their immediate descriptions of sound in games, even as they reflect on past experiences and relate personal significances. A phenomenological perspective enables me to derive a framework by which designers can better integrate sound to support educational games. I have applied an interpretive phenomenological approach as described by Dahlberg, Dahlberg & Nystrom (2008), together with the descriptive approach discussed by Giorgi (1997), Giorgi and Giorgi (2003), and Moustakas (1994). Combining these phenomenological approaches allows me as a researcher to learn about the *structure* and *essential meanings* of my participant's experience of sound during educational gameplay. According to Merleau-Ponty (2002), "The structure of actual perception alone can teach us what perception is" (p. 4, Kindle Edition). The way then to derive this structure is to first gain access to the "totality of lived experiences" (p. 2) of sound in games as described by my participants.

Descriptive approaches to phenomenological research also require that I identify as many *horizons* in the data as I can. According to Moustakas (1994), “Horizons are unlimited. We can never exhaust completely our experience of things no matter how many times we reconsider them or view them” (p. 95). Thus, unlike grounded theory approaches that result in a building a theory based on the data collected, I make no assumption that building such a theory is even possible, given the complexity of participant perspectives. Phenomenology research methods offer multiple philosophical positions from which I as researcher can address the question of participant experiences of sound while playing educational games. Therefore, I now describe my own ontological and epistemological commitments as a phenomenology researcher.

POSITIONING

From prior pilot studies on this topic, I learned that it was unrealistic to set aside my own assumptions as a researcher, since it was necessary to let my own interpretations of participant descriptions guide the flow of subsequent interviews. As I interview people who listen to sound and describe their experience, my perspective as a researcher informs how I listen and make meaning from their descriptions. As a game sound researcher I bring with me a set of assumptions about the ways that sound affects the experience of gameplay. I believe that sound and visuals work closely in games to shape the way in which players derive meaning from playing games. Sound and music can help to direct how one plays games and assigns meaning to game characters, and they help to inform how one experiences game narratives. Sound design and music are both critical in helping to shape our affective experiences during play. These assumptions are built upon theories in sound perception, music psychology, and theoretical perspectives on game sound. Moreover, my own experience in designing sound and composing music for commercial and educational games further serves to characterize my orientation as a sound researcher. It is therefore inevitable that I should bring these assumptions to bear during the research process, and in particular during the process to gather data during interview sessions.

Bridling

I therefore choose instead to gradually, and perhaps gently allow these assumptions and theoretical frames into the research process by using what Dahlberg, Dahlberg & Nystrom (2008) describe as a process to “bridle” my assumptions. For Dahlberg et al., *bridling* is a process by which researchers can control the ways in which theoretical assumptions (in this case of sound in games) should guide their interpretation of what people say, and the ways that they in turn form interview questions. By bridling, I choose to make a conscious choice about when, and by how much, to let theoretical frames guide my research. In taking this perspective, I assume that I come to know the world by searching for essential meanings of phenomena that I see through my own epistemic frames. In this study, I chose to bridle my assumptions by periodically “tightening the reins” to bracket knowledge during data collection, while “loosening the reins” during analysis to allow my assumptions and interpretations to guide my research.

Between Descriptive and Interpretive Approaches

As a phenomenology researcher, I have therefore chosen to position myself in between descriptive and interpretive approaches as I search for and derive a structure for the essential meanings that characterize participant experiences of the phenomenon of sound in educational games. I bring to the table a theoretical frame that informs this perspective and I acknowledge that my participants bring their own diverse perspectives to the study of this experience. Thus, as I parsed data for analysis, I embraced the notion that people necessarily bring with them the substance of their individual contexts and expectations. As Dourish (2004) points out, "meaning adheres in the world as we find it (p. 108). The *Dasein* experienced by listening to sound must necessarily include one's individual history with sound and the expectations for sound naturally brought to the listening experience. Thus, the process to analyze data includes both descriptions of participant experiences of sound and descriptions of other affective, biographical, or phenomenological associations that arise as a result of those experiences.

Study Design

Overview

I selected and interviewed six participants for this study. I asked each participant to play games and participate in interviews over three temporally separated interview sessions (Cilesiz, 2010). I pre-selected educational game titles based on an analysis of game sound from the perspectives of acoustic ecology and player interactivity (Gaver, 1993; Schafer, 1977; Collins, 2008). In each session, I asked people to play games and asked them questions about their experiences of gameplay. I used *criterion sampling,* as recommended by Cilesiz (2010), to select people who had experience in playing games, who were interested in a study about sound, and who were interested in talking to me about their experiences of gameplay for up to six hours of total interview time. I took a descriptive phenomenological approach as outlined by Robinson (1994), Colaizzi (1978) and Moustakas (1994), coupled with an interpretive phenomenological perspective recommended by Dahlberg, Dahlberg and Nystrom (2008) to provide a basic framework to analyze the data for this study. I began this process by identifying *meaning units* to reflect the *horizons* of participant experiences with sound for each educational game, organizing these meaning units into tentative clusters of meaning and identifying the *constituents of meaning* that structured and described these experiences. I then derived *essential meanings* of the phenomenon of sound in educational games as seen through the experiences of these participants and interpreted through my lens as a researcher (Dahlberg, Dahlberg & Nystrom, 2008). I then connected these essential meanings to current theoretical foundations in game sound research.

EPOCHÉ , BRIDLING, AND MEDITATION

As part of the process to bridle my assumptions, I also incorporated an aspect of what Giorgi (1997), Giorgi and Giorgi (2003) and Moustakas (1994) recommend as a process to engage in *epoché*, or suspension of judgment, during the interviews to "bracket past knowledge about the experienced [phenomenon] to experience this instance of its occurrence freshly" (Giorgi & Giorgi, 2003 p. 249). For this interpretive study, I narrowly define my use of epoché as a process in which I bridle by "pulling back on the reins" to temporarily set aside prior knowledge from other participant interviews, so that I can focus on the interview at hand. As Ihde (2007) describes, epoché is a Heideggerian approach that "*lets be* that which shows itself" (p. 104). Therefore, based on this interpretation of epoché, I began the interview sessions by hearing participant descriptions with fresh ears first before "letting the reins out" and inserting prior assumptions and knowledge back into the interview process. Prior to participants' gameplay, I used Moustakas's recommendation to ask that each participant join me in a brief bell meditation to engage in epoché to clear the "perceptual palette" and create a "relaxed and trusting atmosphere" (Moustakas, 1994, p. 114) during the interview.

SOUND AND SILENCE

A key outcome in this dissertation study is to design a research methodology in which I ask participants to explore their experiences of sound as they play different types of educational games. One of the challenges in this process is to take a qualitative approach to design a phenomenological investigation that will enable an "opening up" of the phenomenon of sound. From an ontological perspective, the experience of sound may be thought of in what Don Ihde terms as "auditory horizons." Ihde's (2007) auditory horizons are an extension of Husserl's idea of phenomenological horizons, which connote the background of understanding within which one explores a given phenomenon. One way to demarcate horizons is to identify their boundaries. For auditory horizons, one such boundary that Ihde describes is silence. As Ihde observes, unless one is bereft of hearing, one does not really lose the ability to hear sound: even in perfect silence one hears the sounds that characterize one's physical being, such as breathing and heartbeat. However, an interesting aspect of silence is that is even if one does not passively receive auditory input through one's ears, one exercises what Ihde and others have described as an "auditory imagination." That is, one hears "inside" one's own head even in the absence of sound.

Such a distinction becomes critical to note, especially given the role that auditory imagination plays in asking people to explore horizons related to their experiences of sound. I incorporated both sound and silence in the design of a phenomenological study of sound in educational games. In a prior pilot study (Rosenblum, 2013 manuscript submitted), I asked that participants play games first without sound, and then with sound in each interview session. However, upon reflection, I concluded that this approach is problematic. In the next section, I present an analysis of the role of silence and sound in this phenomenology study and describe a different approach to using silence in this study.

WHY SILENCE?

It is difficult for people to describe what they hear (Jorgensen, 2009). As Jorgensen (and others) point out, humans have no “earlids” with which to filter (and therefore evaluate) perception of sound. As Don Ihde (2007) points out, it is difficult to describe sound because the listener is *situated* in a *horizonal field* while experiencing sound. Ihde describes phenomenological horizons as the descriptions and perspectives that shape how one perceives an experience. Ihde characterizes and illustrates this horizonal field as a “Focus Field Horizon Structure” (p. 106). Moreover, the boundary of this horizonal field is a point where the phenomenon is not relevant to our experience. In the case of sound, this boundary is delimited by what Ihde (2007) calls a “horizon of silence” (p. 52). Taking Ihde’s Focus Field Horizon Structure, I interpret his notion of a horizonal field to describe all possible sound horizons, and his notion of focus within this field to describe the immediate focus on sound. I pair this interpretation of sound horizons with Ihde’s notion of silence as a horizonal boundary to illustrate the placement of the listener's focus on sound within a space of potential sound horizons (Figure 1). In this illustration, the large circle represents a possibility space for events that comprise one's possible experiences of sound at any given time; in other words, it encompasses what someone might say about sound. The small circle in the middle of Ihde's field represents the immediate focus on sound as it is experienced. A horizon, therefore, is a point within these circles that represents one of many facets of experience.

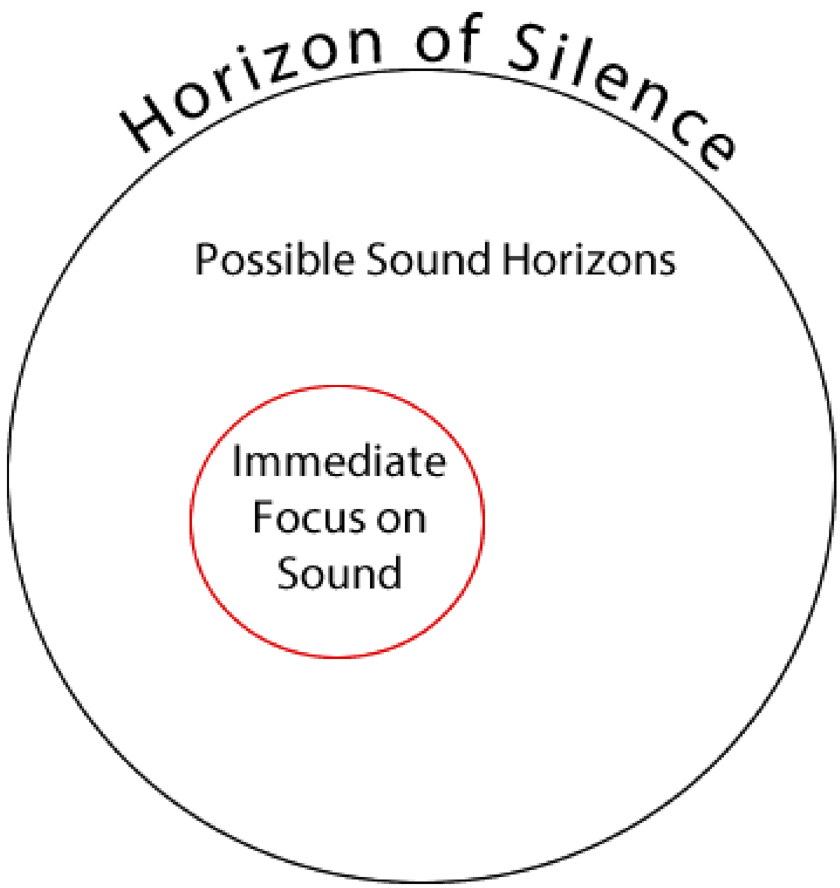

Figure 1. Sound horizons, based on Ihde's (2007) Focus Field Horizon Structure

However, herein lies a paradox. According to Ihde, one cannot turn off the perception of sound. Sound is what Merleau-Ponty would describe as an *embodied* *experience*. If one is physiologically capable of hearing—and even if one were to completely muffle sounds that can arise as a result of sound waves impacting the ears—one would still have the experience of hearing the physical self—i.e., the heartbeat. From a philosophical perspective, Ihde (2007) maintains that instead of silence, one experiences "auditory imagination" in which one fills in the perceptual blanks in the absence of sound. This perspective on auditory imagination is in turn borne out in neurological studies by researchers like Kraemer, Macrae, Green, & Kelley (2005) and Zatorre and Halpern (2005), who conducted brain imaging studies on people who listened to music and who experienced "gaps" of silence in the music. Interestingly, the auditory cortex of study participants continued to remain active throughout the experiment.

According to the results of a brain imaging study by Voisin, Bidet-Caulet, Bertrand & Fonlupt (2006), the areas of the brain that are responsible for anticipating the presence of sound are activated regardless of whether a sound is heard. Voisin et al. (2006) describe this phenomenon as "listening in silence." Therefore, asking players to play a game silently would naturally lead them to "listen in silence" to the game as they played, even as they missed the cues and information normally provided through sound. People bring with them the sum total of their individual expectations and perspectives for what they think (consciously or not) they should hear (Neuhoff, 2011). Moreover, auditory imagination enables one to form a mental "template" for what one expects the sound to be (SanMiguel, Widmann, Bendixen, Trujillo-Barreto & Schroger, 2013). For example, when I see fish in a large home aquarium, in the absence of sound I might imagine the bubbling sound of the aquarium's water filter.

Thus, it is likely that when one is in situations where one "expects" to hear sound, one does so—even if no sound actually comes. San Miguel, Widmann, Bendixen, Trujillo-Barreto, & Schroger (2013) explains this characteristic as having developed as a coping mechanism by which people are able to process complex perceptual input. Therefore, there is a neurological basis for the phenomenological process of experiencing sound and silence described by Ihde. These perspectives are crucial to understanding how sound and silence may affect gameplay.

Prior Research Design: Silence and Sound

I previously conducted pilot studies on this topic in which I asked participants to play entire games first with sound, then without sound and to then describe what they heard. My original justification for this model was to use game silence to help people focus on sound in subsequent play. Thus, I used silence as a phenomenological "tool" by asking people to focus upon their sound experience by contrasting the experiences of listening to sound with an initial experience of playing the game without sound. This model has some benefits, namely that the results from these pilot studies resulted in participants describing their sound experiences by contrasting it with prior play without sound. In these rich descriptions, people offered a comparison to their experiences of play without sound. In one case, a participant described the experience of walking the corridors of a silent space station as "creepy," since without sound she expected the station to simply "float off" (Rosenblum, 2013). Her description is compelling since it signals the importance of sound to convey a sense of place that in turn is tied to the fantasy element of this game (Alien Rescue). However, there are distinct disadvantages to this approach. First, participants had to learn to play the games for the first time without the benefit of hearing sound. Thus, I was unable to capture the ways in which sound helps to shape participants' initial experiences of gameplay. Second, by playing the game without sound for the first time, the experience naturally activates the auditory imagination of game players in ways that might lead them to experience and expect sounds that are not there.

According to Ihde (2007), a necessary horizon to phenomenologies of sound is temporality. Sound, by definition, has duration. Thus, it is likely that what is compared between game interviews is limited by what people remember between play sessions. Moreover, it is also likely that people would substitute their own imagined sounds or music soundtrack in the absence of such sounds. Thus, the experience they convey through description may be affected by this comparison. In an early (2008) unpublished pilot study on game music in the introductory video to Alien Rescue, one participant casually (once the study was completed) expressed surprise when I told him that he was part of the non-music condition in a study on sound. He was *convinced* that he had heard music as he watched the opening video, and I had to assure him this was not the case. Thus, in the case of this participant, watching the introductory video to Alien Rescue activated his auditory imagination and as a result he applied whatever soundtrack he thought appropriate as he watched the video. This anecdotal evidence is compelling, and suggests that participants in my pilot study likely "filled in the blanks" of their experience of silence as they played.

Current Design: Silence and Sound

I took an alternate approach to incorporating silence into my current study by asking that people play games with the sound turned on and interviewing them, while allowing for the natural silences present in the game to form the horizons that they experience. The advantage of this approach is that the horizons that they identify are derived from the game's individual design strategies for sound use. Descriptions therefore are less likely to be affected by large gaps of silence and participants are less likely to describe or compare their experiences based on what they imagine. Another (perhaps equally important) advantage of this approach is that they can climb the learning curve of the game more readily with sound (Jorgensen, 2009).

None of the participants in my previous pilot studies had the advantage of learning to use the game with sound. As such, the alternative approach in the current study has a critical advantage. However, a serious disadvantage to this approach is that I reduce the chance that people attend to differences in their own experiences in the absence of sound since, again it is difficult for us to narrow in on our experiences of sound (Ihde, 2007; Jorgensen, 2009). Therefore, as a compromise, I let people play games with sound, but used silence in ways that helped people to *cleanse their perceptual palette*. Thus, I bracketed my experience as a sound designer and sound researcher and periodically turned off sound when participants indicated difficulty in describing their experiences with sound. In this way, I purposefully activated their process to *listen in silence* and in doing so used the contrasting experience as a perceptual prompt to enliven their descriptions of sound in educational games. Such an approach has the phenomenological effect of shifting the focus of their perception of sound in their experiential field (Ihde, 2007). In doing so I moved their focus from the “middle” of the horizontal field to its boundary (i.e., silence) and back again. This process of purposefully shifting the phenomenological focus thereby helps ensure that people experience multiple possible horizons for sound during their play of educational games. A key goal of phenomenology research (Giorgi, 1997) is to identify as many possible horizons of an experience as possible. I assert that this strategy can be critically useful in helping to open up the phenomenon of sound in educational games while also having the intangible benefit of helping to make people more aware about the ways in which they perceive sound.

In practice, I asked people to play games with sound. However, I also periodically turned off sound during play when I encountered areas in the game that either raised additional interview questions or were otherwise difficult for people to describe what they were hearing. In this way, I could use silence as a fine-tuned tool to help people to clear their perceptual palette and attend to what they heard.

Participant Selection

Phenomenology approaches are tightly focused on participants’ lived experiences. Thus, phenomenological perspectives are constrained primarily to one type of data source, namely participant interviews. Such an interview process can (and arguably should) be informed by ethnographic approaches to in-depth interviews (Spradley, 1979). Other data sources such as surveys and participant observations without interviews are generally not included in phenomenology studies (Giorgi, 1997; Moustakas, 1994). Thus, I did not include those in my research. Participant descriptions lie at the heart of this phenomenological study. As such, I selected adult participants based on:

- ability to hear,
- having attended college,
- scheduling convenience,
- experience in playing games and
- ability to articulate their experiences.

I followed Cilesiz's (2010) recommendations and asked six people to play games in three different interview sessions, and by doing so reached saturated descriptions of sound in gameplay.

RECRUITMENT

I included people in my research population that I know generally, in addition to students at the University of Texas at Austin. Specifically, I recruited students from the School of Music, with the help of Professor Eugenia Costa-Giomi, in addition to former students of Professor Joan Hughes in the College of Education. I met with each potential study participant in an informal pre-screening to determine their interest in the project and their willingness to talk (Appendix A). In this screening, I explained the purpose and format of the study, asked them about their experience in playing games and their willingness to play games and to talk about their experiences during gameplay over three separate interview sessions.

PARTICIPANTS CHOSEN

Once the pre-screening process was complete, I chose six people for this study: Andrea, Austin, Donna, Gabriel, Leah, and Sarah. To help protect their anonymity, I gave participants pseudonyms at the start of their first interview session. I also reviewed background questions about each participant during either the first or the second interview to capture information related to their educational, professional, or musical background and their interest in games. I therefore selected the following six people for this study:

- Andrea: an undergraduate pre-pharmacy student
- Austin: an undergraduate engineering student
- Donna: a game design professional
- Gabriel: a graduate student in Education
- Leah: an undergraduate business student
- Sarah: a professional data scientist

Andrea

Andrea is an undergraduate student who is studying to be a pharmacist. Andrea grew up in the southwest U.S. and enjoys playing role-playing games, "basically games that…have a story." She described her enjoyment playing a PC mystery game, "To the Moon." Said Andrea, "I…like games that…like you don't really know what's going on, but then like as you progress and like the story like comes together and then you just kind of get to the ending" (Andrea, first interview). She also plays mobile game titles such as

Flappy Bird, in addition to PC titles on Steam. Andrea has a musical background and grew up playing musical instruments (flute and violin). She described noticing music soundtracks and noticing how music can evoke emotions as she plays. According to Andrea, "[when] something sad is happening then they'll be like kind of like emotional music that [I] can like really like…It just triggers it more and…it just makes a better experience." Andrea described also noticing sound effects when she plays, "for me personally I play better with sound on because like it kind of like—if you do something right and then…there's like a 'ding-dong' or something. That kind of gives you…validation like that you did something right…" (Andrea, interview 1).

Austin

Austin is an undergraduate student at the same university as Andrea, who grew up in the US and is majoring in electrical engineering. Austin is a self-described long-time game player. He transitioned from playing console games to strategy and first-person shooter games on the PC such as League of Legends and Counter-Strike. When I asked him about whether he notices sound and music as he plays, he remarked, "a lot of times in the action and adventure games, the sound like music really provides the atmosphere of…the area you are in." Interestingly, when I asked if he ever plays entertainment games without sound, Austin responded, "Um I don't like to play games without sound…just because like it adds…I just leave it on just because it's part of the game, I realize it's part of the game" (Austin, Interview 1). Austin added only one exception to his rule and described that he turns off music only in titles where he has to listen carefully to sound effects like gun shots or footsteps.

Donna

Donna is a professional game designer and is a self-described “pioneer” in the early days of game design. Said Donna, “my background begins with computer art before they had standardized…art programs…So, I go into interfaces and started to design the interfaces and most of them were not visual. Most of them were pre-mouse. They were all text.” She related a brief history of the early uses of sound in games, when special computer hardware was needed to listen to sound, saying, “So, it was thought of as a very extra kind of component to any software at the time.” Donna is a long-time game player, who is experienced with playing everything from kids games to “comedy games like, you know, raunchy stuff, silly stuff, some of the classics like Toe Jam and Earl and, uh, Leisure Suit Larry.” Donna also plays current first person adventure games like Star Bound, City of Heroes and (when it comes out) City of Titans. When asked about sound and music, Donna described noticing the sounds effects and the theme music in Star Bound. For Donna, this soundtrack “is probably inspired by the musical theme to *Inception*, which I think is one of the most beautiful movie pieces.” She went on to describe instances where music can be interfering, “if it starts to grate on me because it’s becoming an ear worm and it’s repetitive then I’ll notice it in a negative sense and I will turn the music completely off because it’s too grating” (Donna, interview 1).

Gabriel

Gabriel was a student in a Master’s program in the College of Education, studying learning technologies. Born in England, he grew up in the US and likes to collect older video game titles that he hasn’t yet played. As he reflected on the games that he played, he described how important the graphics originally were to his experience of games, and how that's changed. Said Gabriel, "you know…my interpretation of the quality of the gameplay always really rested on how good were the graphics because we were always evolving over time. And then when I started going back and playing these old games it became more about the sound." Gabriel continued by describing how he focused on sound and music in games like Need for Speed, Mario and Grand Theft Auto 5. As Gabriel pointed out, not all music is good; "there are certain games now…some of them are just mindless music. Like the Need for Speed game it's just techno music in the background, and…sometimes I actually will mute that kind of music out…[if] it doesn't add anything but noise...I'm just like, *shut up*, you know what I mean?" By contrast, the sound in Grand Theft Auto 5 is more complex: "I'm primarily playing [that] now and there's a lot of sound in it…there's cursing, there's arguing, there's sirens, there's, you know, dialogue between the characters, and the voice acting is always really good in these games. It's just gotten better and better in the Grand Theft Auto series." Gabriel also notices when sound in games is "underutilized" and "just really simple like, you know, Mario game back in the day was just a very simple repetitive melody" (Gabriel, interview 1).

Leah

Like Andrea and Austin, Leah is an undergraduate, and is studying in the business school. Leah enjoys playing kinetic games that are, as she puts it, "fun ones that can get me to move" and include titles such as Wii Fit. She also plays mobile games like Candy Crush. When I asked her about her experiences of sound in the games she plays, she thought that, “the sounds really reflect what the…authors of the games want you to feel.” Furthermore, sound “really puts you more into the realm and um what the game is about. It’s — it makes it more interactive in a way” (Leah, interview 2). She also continued by describing the ways she thought sound and visuals can “mesh together very well.”

Sarah

Like Donna, Sarah is a working professional. She has a PhD in computer science and has been playing games since she was about six years old, first with the Atari and then the Commodore console systems. In addition to playing puzzle games on her computer, Sarah also recalls playing first person shooters as arcade games, in addition to older PC titles such as Area 51 and Castle Wolfenstein, and newer titles like Unreal and Call of Duty. Although she still enjoys playing games, she focuses much of her gameplay on mobile games that she can play anywhere. As Sarah reflected upon sound in games, she recalled the advances that sound has made in the games that she’s played. Said Sarah, “I notice that when the sound is better when the music that comes out is better,” and that there are times when “in more recent games [there are] recognizable songs that have…radio play…those are definitely things I notice.” Like Leah, Sarah mentioned noticing how sound and visuals are sometimes connected, particularly “when the music doesn’t match at all what's going on the screen…Or you have some really weird sound or jarring key or something like that that is something that… kind of takes you out of the game.”

Research Protocol

RESEARCH SITE

I conducted my research in three different university locations. I configured the site using components from a mobile research lab that I carried in with me for each session. The mobile lab setup included two computers, two cameras, hard drives to store copious video data and a camera mount for my iPhone 5S. A photo of one of the research sites, complete with the mobile lab setup is found in Figure 2.

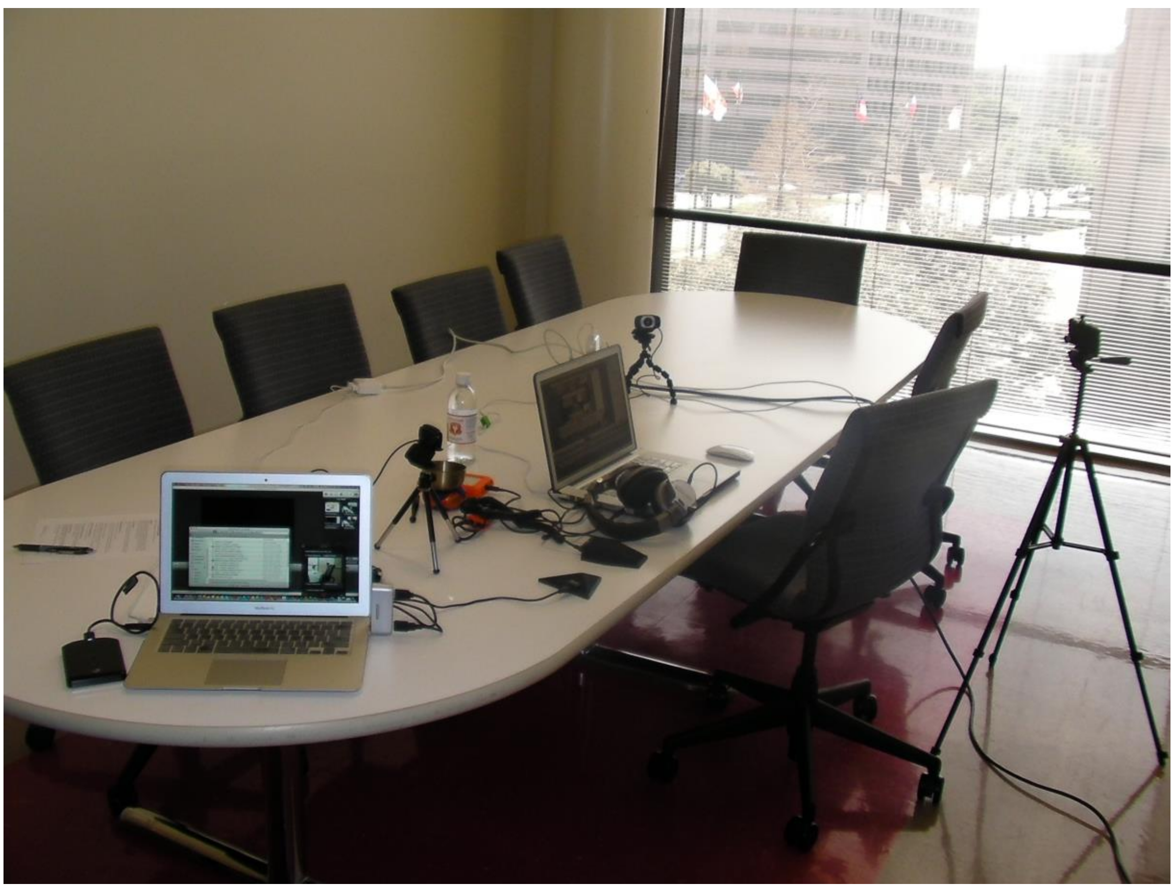

Figure 2. Example research site configuration

I captured computer gameplay by each participant using a screen capture utility on my Macintosh computer, and I recorded both audio and video of each session. Transcripts were created from the audio/video recordings and formed the basis of the data analyzed in this study. Information from audio/video recordings provided a reference for relevant non-verbal gestures and facial expressions related to the participant's gameplay experiences.

GAME SELECTION

I asked participants to play a variety of educational games that incorporated sound as an element of their design. In their analysis of games designed for educational applications, Liu, Rosenblum, Horton and Kang (2014) provide a review of educational games that include "digital games to support learning" (p. 84). For these researchers, "games and game-like environments can provide students with opportunities for experiential, authentic learning" (p. 85). Educational games, in their analysis, include those that embed knowledge in the game's design and provide what Squire (2006) describes as "designed experience[s]" (p. 19). Liu et al. (2014) suggest that games with an educational focus can also present "opportunities for learning both as an outcome of gameplay and as a platform for critical inquiry into sociocultural issues…[while] help[ing] students develop critical media literacies…" (p. 86). Thus, I constrained the scope of this study to games that were designed for educational purposes or that were otherwise designed for "social impact." Social impact games are those that are expressly designed to raise awareness about social problems, such as can be found on the website

Games for Change (http://gamesforchange.org) (Burak, Byrd, Treat, Ramos, Levine, & Wei, 2012). I also selected games based on the extent to which they incorporated sound as part of their design and the degree of player interactivity represented by game sound.

After considering a number of potential titles, I chose Fate of the World, Salamander Rescue and Hush for this study. Fate of the World and Hush are designed for social impact, while Salamander Rescue is expressly designed for educational purposes. In selecting these titles, I conducted an analysis of game sound for each title chosen. This analysis was rooted in perspectives of acoustic ecology, as described by William Gaver (1993) and R. Murray Schafer (1977), in addition to perspectives of player interactivity as outlined by Karen Collins (2008). I incorporated perspectives on acoustic ecology and player interactivity to create a *soundmap* of the sound events and acoustic environments to select the games used in this study (Appendix E). The three games selected for this study were chosen because they shared two components: they contained a type of soundscape, and they each represented a different level of player interactivity, namely non-dynamic, adaptive, and interactive sound (Table 1).

As described in Chapter Two: Literature Review, acoustic ecology is a perspective on sound listening that focuses on the information conveyed by the sounds that people hear. For Schafer (1993), an ecological approach to listening encourages one to focus on listening to the acoustic world that one inhabits. This world is embodied by Schafer's notion of the world as a *soundscape*. For Schafer, "a soundscape consists of events *heard* not objects *seen*" (Kindle Location 218 of 6308). Notably, Schafer prompts us to consider three facets of soundscapes that include *keynote sounds*, *sound signals* and *soundmarks* (Schafer, 1993; McBride-Charpentier, 2011). Keynote sounds convey general background ambience (e.g., the sound of an urban city street at rush hour). Sound signals convey sound events clearly heard (e.g., the closing of a car door nearby) while soundmarks denote a specific place (e.g., the tolling of a cathedral church bell). Although Schafer's description of a soundscape is intended to convey the acoustic spaces of the world in which people live, McBride-Charpentier (2011) extends Schafer's analysis to describe the acoustically complex worlds represented by 3-D commercial computer games. Schafer (1993) and McBride-Charpentier's (2011) perspective on acoustic ecology is consistent with Gaver's (1993) focus on the use of acoustic ecologies to construct auditory icons that convey events heard in a computer interface. I thus used this perspective to choose each of the three games in this study. I chose Fate of the World because it uses auditory icons to reinforce complex events heard in an in-game interface. I chose Hush because it layers key sound signals atop a rich auditory keynote track to create an ecology consistent with a war-torn environment. And, I chose Salamander Rescue because it incorporates sound signals in addition to a keynote track to create an auditory ecology consistent with the 3-D island environment of the game.

I also incorporated Karen Collins's (2008) game sound framework in the development of a soundmap for this study. Collin's framework is based on the extent to which games incorporate sound as a function of player interactivity and presence of sound in and out of the game space. As described in Table 1, Collins classifies game sound according to whether game is audio is dynamic and if it is, whether it changes based on player actions or changes within the game. Collins' notion of diegesis also helps us to identify whether game sound is heard within the game space. This distinction is critical, as it signifies whether sound is designed as a component of the game environment rather than for other reasons, such as with auditory icons that support in-game graphic user interfaces. As a result, I selected the three games in the study because they were playable by an adult audience and because they represented each of Collins's degrees of player interactivity. Following a sound content analysis for each game (Appendix E), I concluded that Fate of the World contained primarily non-dynamic uses of sound, while Hush contained primarily adaptive uses of sound. While Salamander Rescue did contain some non-dynamic sounds, it incorporated more interactive than non-dynamic sound elements. The educational software studied by Bishop and Cates (2008) demonstrates a limited range of uses for sound, such as to manage player attention. Thus, based on my sound content analysis, this study reflects each degree of Collins's (2008) player interactivity with sound.

Fate of the World

Fate of the World (FOTW) is a strategy game from game developers Red Redemption Ltd. (2013). The goal of FOTW is to immerse players in a "real social and environmental impact of global climate change over the next 200 years" (Red Redemption, 2013). Notably, Fate of the World uses educational strategies that pair science and problem solving with the goal of social impact, and has also been incorporated as learning tools in schools (Red Redemption, 2013). Players are positioned as leaders of a fictitious global organization charged with implementing policies that address a number of critical environmental problems in areas like northern and southern

Africa. Fate of the World is organized using a turn-based system in which players are presented with a set of cards from which players must make choices during each turn (Figure 3).

Figure 3. Cards in Fate of the World

Fate of the World presents players with a series of missions, with unique objectives embedded into each mission. The first mission begins with an opening cinematic to situate gameplay. Following the cinematic, players are provided hints on how to complete the first round of play.

Due to the complexity of the game and the length of time needed to complete one mission, I chose to ask participants to only play one mission of the game. The first mission in Fate of the World asks that players raise the Human Development Index (HDI) rankings of both northern and southern Africa, while keeping social conditions peaceful. Players can check on progress towards their goal (Figure 4) and use this data and player approval ratings in the form of red and green colored hearts (Figure 5) as a basis to make decisions about cards to play.

Figure 4. FOTW: data overview

Figure 5. FOTW: approval ratings

The time needed to play the first mission varies, depending on the amount of time that players take to make decisions during each of the four rounds of gameplay.

Gameplay ends with the presentation of a summary of the cards played (Figure 6) and either a win or lose screen (Figure 7).

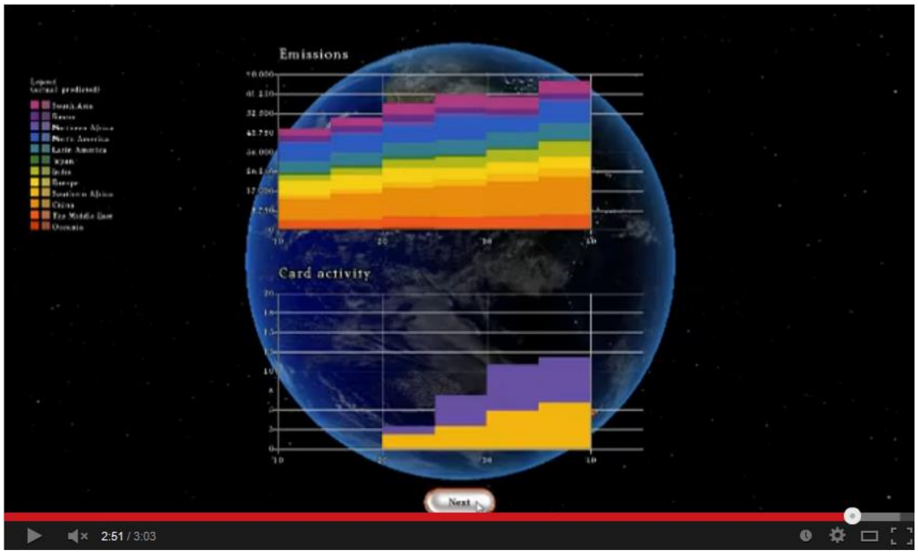

Figure 6. FOTW: card activity

Figure 7. FOTW: example win screen

Hush

Hush is a social impact game that uses a design strategy that demonstrates what Ian Bogost describes as “procedural rhetoric” (Bogost, 2007). This approach, according to Bogost (2008), is found in games that can otherwise be dubbed as “persuasive games.” Procedural rhetoric is a design strategy that provides these types of persuasive games with their design structure. This structure enables games to adopt and challenge “existing social and cultural positions” (Bogost, 2007, location 43) and in the process promote social change. Jamie Antonisse (n.d.), the creator of Hush, describes it as “an experimental game in which you play a young mother trying to calm her crying infant with a lullaby” (Figure 8).

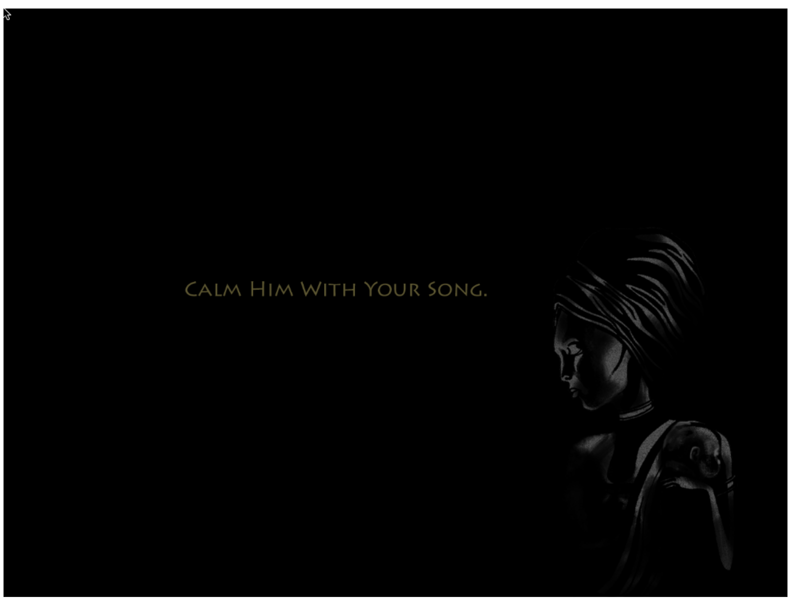

Figure 8. Hush: calm him with your song

Originally designed by game design students at the University of Southern California, Hush raises awareness of the genocide in Rwanda by providing players with an “aural and visual ambience” (Bogost, 2008, page 1) to situate play (Figure 9).

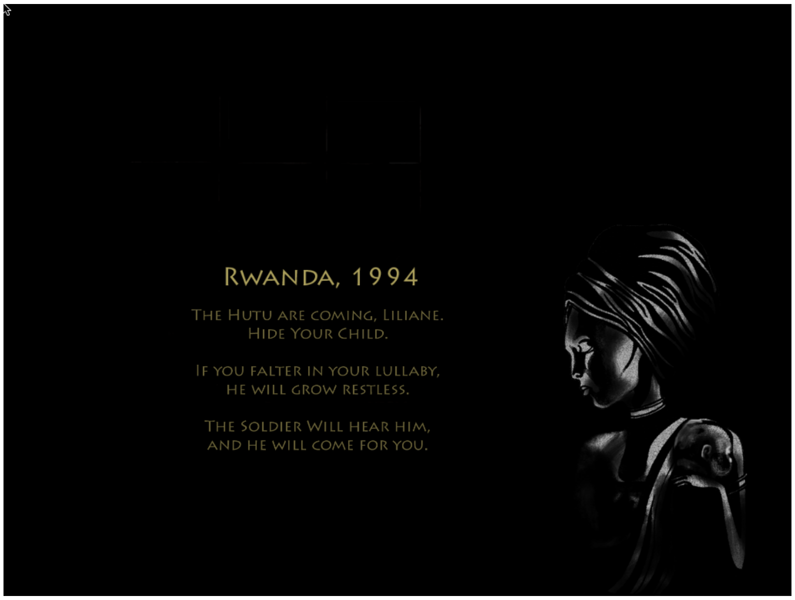

Figure 9: Hush: setting

The game uses a rhythm game format (Bogost, 2008) that asks players to type letters at a slow pace as they fall across the screen. Players must type the letters with the correct timing as they appear on the screen, even as they hear the ambience of the soldier's footsteps, gunfire, and the sounds of people dying. Missing letters results in louder crying on the part of the baby, which in turn affects the length of the game and the likelihood of whether players win or lose. If players type letters correctly, the letters turn blue on the screen. Letters typed with poor timing turn red (Figure 10).

Figure 10. Hush: soldier outside window, with player's incorrectly timed typing

The longer the player plays, the more the story intensifies, and the player hears increased gunfire, sounds of people being mortally wounded by slicing machetes, and the cries of men and women suffering. If the player loses the short game (a common occurrence among study participants), they see their screen fade to red, "a not-so-subtle implication of the pair's bloody end" (Bogost, 2008, page 1) (Figure 11).

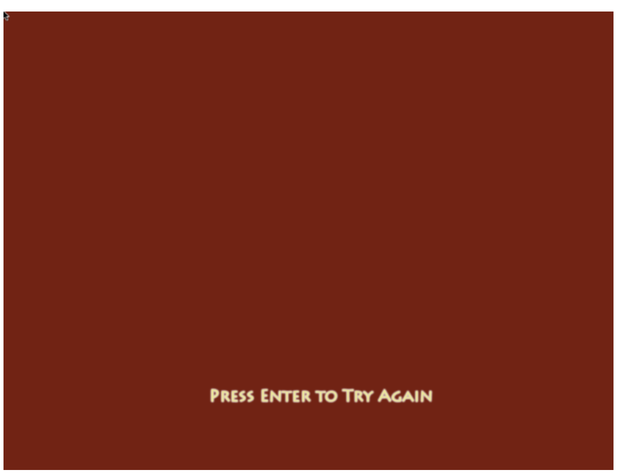

Figure 11. Hush: lose screen

Salamander Rescue

Salamander Rescue (SR) was developed by researchers at the University of Texas at Austin, and is an example of what Liu, Rosenblum, Horton and Kang (2014) describe as a game-based approach to designing science learning. Salamander Rescue uses a similar problem-based learning (PBL) approach to Alien Rescue (AR), a well-established game to support science learning. Students who play SR are asked to help figure out what is causing the salamanders to die on the island in the game (Figure 12).

Figure 12. Salamander Rescue: opening screen

The game is situated in a 3-D virtual environment that includes a lab and an outdoor space that contains a lake (with the salamanders), trees, a small building, bridges, and three scientists who serve as in-game characters (Figure 13).

Figure 13. Salamander Rescue: island

Players are also provided with an on-screen iPad interface that serves as a cognitive tool by which they read information from the scientists and take readings from the lake (Figure 14). The iPad also provides players with a tool to manage the list of tasks they must perform before proposing a solution to the problem, and it provides a ready reference for important information about the game.

Figure 14. Salamander Rescue: onscreen iPad

Players must speak with each of the three scientists in the game, collect samples of artifacts on the island, take readings of the lake water, and perform scientific tests using a water tank in the lab (Figure 15). Each of the three scientists has a different theory about what might be causing the salamanders to die. It is up to the students to decide which of these scientific theories is thus the most plausible.

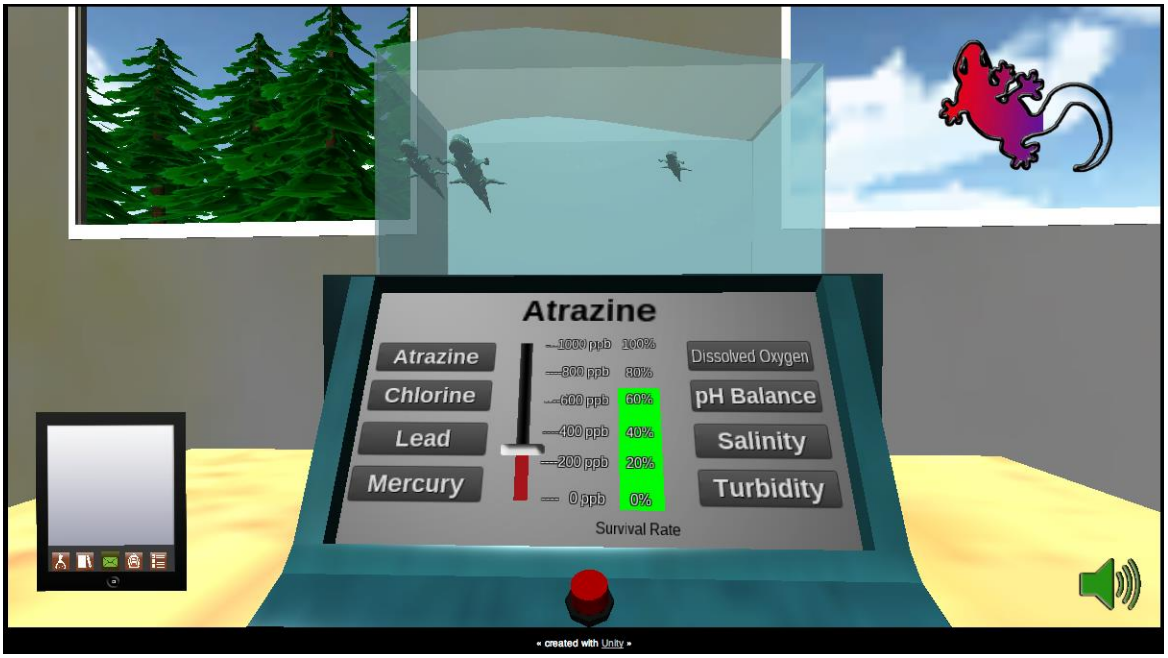

Figure 15. Salamander Rescue: water tank tester

After analyzing the information from the tests with information provided by the scientists, the players (who themselves are functioning as scientists) use the computer in the lab to choose a theory that best explains why the salamanders are dying (Figure 17). Students can also use the computer as a reference to research information on the chemicals or properties of the water (e.g., atrazine) that might be affecting the mortality of the salamanders.

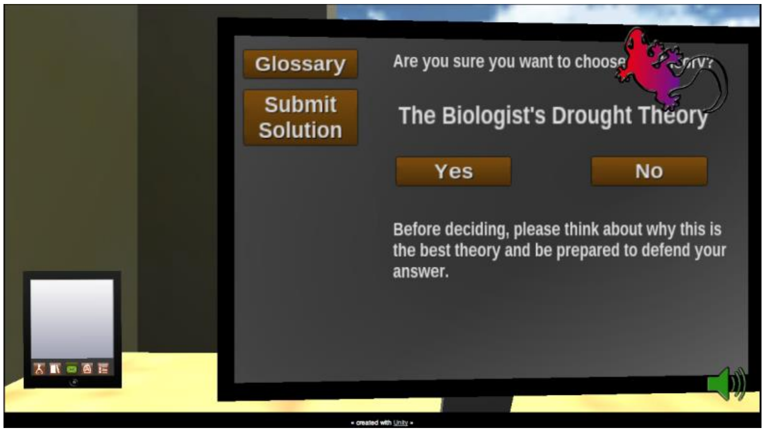

Figure 16: Salamander Rescue: computer

INTERVIEW STRUCTURE

I asked each participant to play one game in each of the three sessions, as recommended by Cilesiz (2010). I structured the sessions such that each participant played Fate of the World first, Hush second, and Salamander Rescue third. I chose this order for a number of reasons. Primarily, I wanted to structure the study to match Collins's (2008) degrees of player interactivity. Thus, I wanted people to play the least dynamic game first (Fate of the World), the game that uses adaptive audio second (Hush), and the game that uses interactive audio third (Salamander Rescue). However, there were other reasons that made this ordering of games important. First, Fate of the World was professionally developed, while the other games were developed by students at two universities. Second, Fate of the World's interface would likely seem familiar to people who had previously played educational games. Third, Hush contains intense and potentially emotionally laden uses of sound and thus I concluded that it should not be the first game that people played. Finally, if participants did have an emotional reaction to playing Hush during the second interview session, I wanted to end with Salamander Rescue, which contains a visually rich, 3-D environment and is arguably less emotionally laden than Hush. Therefore, I concluded that playing Salamander Rescue would likely allow study participants to end their participation in the study on either a neutral or a positive note. Placing Salamander Rescue last in the sequence also placed the most visually interesting game at the end of the study. Thus, participants would be less likely to compare the other games played with Salamander Rescue, based their degree of visual immersion.

Overall, it was my goal to design a research protocol for this study that would allow each person to provide perspectives of their experiences of sound across each of the sonically diverse educational games studied. Thus, in addition to crafting the order in which people played games, I also structured the interview session in ways that would provide people with the space to play games, while also supporting their descriptions of their experiences of play. I therefore structured each session according to the following format.

Step 1: Follow-Up on the Previous Session and Introduce the Current Game

In each session I gave each participant the opportunity to reflect upon our prior meeting, and to add additional thoughts that might deepen their prior descriptions. For the first interview session, I asked participants if they could revisit their descriptions of their experiences with games from the pre-interview, and about their initial thoughts regarding sound they might recall hearing in prior gameplay. Although these descriptions were not analyzed directly, they provided a useful context for analysis. For the second and third interview sessions, this introduction to the session gave them the chance to voice any reflections they might have had between the first and second session. In addition, it gave me as a researcher a critical opportunity to ask questions that I derived from studying the transcripts from the first and second interview sessions. At times, I asked people to replay portions of games or review clips from the recordings of the prior session, as a way to help them refresh their memory between sessions. This process allowed me to clarify and confirm previous descriptions and thus support the trustworthiness of my interpretation of participant experiences.

Step 2: Opening Meditation

As mentioned earlier in this chapter, I engaged in a brief meditation prior to each interview session. This step, recommended by Moustakas (1994), enabled me as a researcher to bracket any thoughts from activities prior to the session and it offered the participant a chance to have a moment of silence with which to start the session. At least one participant remarked that he found this experience helpful in transitioning from driving through traffic to the interview site. After reviewing the video recording from each session, it is clear that each participant engaged in silent meditation.

Step 3: Gameplay

Following the meditation, I launched the game to be played and allowed people to complete the game. It was possible for people to either win or lose each game, and thus I took as much time as was needed for someone to complete the game. In the case of Hush I consistently let all participants replay the game once they were finished. The rationale for this is that Hush takes only a few minutes to play, and people often had a hard time in beating the game. Since the gameplay in Hush relies heavily on sound, I also wanted people to experience playing the game without sound. Thus, all participants played Hush a minimum of two times and in most cases people played the game several times.

In the case of Salamander Rescue, I also gave people who won the game a chance to play the game again to lose so they could hear the difference between music that accompanied the lose screen versus the win screen. Because Salamander Rescue requires that people analyze and solve a problem, I chose not to ask people who lost the game the first time to replay, as that would have introduced added pressure on people to succeed, and might have thus affected their descriptions of their experience.

Step 4: Stimulated Recall

Once people had either won or lost a game, I momentarily stopped recording the session to save the file of the recording. I then replayed the clip that had been recorded and also restarted the recording. This process enabled me to prepare for an interview dialogue that was guided by a stimulated recall technique. This approach can help participants to recall what happened when they played a game and stimulate reflection of their experiences of play (Liu, Yuen, Horton, Lee, Toprac & Bogard, 2013). Once I re-opened the clip, I offered people a chance to reflect on the game overall, began the playback of their recording and asked that people walk me through their in-play experiences of sound as reflected in the recording.

INTERVIEW QUESTIONS

In each session, I asked the participant to play an educational game and I spoke with him or her about the experiences of sound during the session. As I took an interpretive approach to this study, I was committed to gently “bridling” what would be an open-ended interview format in which I asked participants to play games and describe to me their experiences of gameplay, and in particular their experiences of sound (Appendix B). I allowed their responses to help shape my questions during each of the interview sessions, which lasted 60 to 120 minutes each. I also allowed the structure of subsequent interviews with the same participant to be partially guided by the responses from prior interview sessions. My open-ended interview questions were guided by Dahlberg’s process to “bridle” my assumptions and understandings of the theoretical aspects of sound in games. Thus, if I sensed that a participant was “knocking at the door” of a familiar idea, such as by reacting to a sound but not noticing their reaction, I bridled the interview process to follow-up on their reaction and to ask whether they could tell me more about the event. Likewise, if they failed to notice sound in the form of background music, I also used my familiarity with background music in games and bridle the interview. I asked if they noticed the phenomenon and whether they could describe what thoughts, if any come to mind during the process of noticing, to encourage them to engage in a noematic process. This interview strategy to bridle open-ended interviews allowed the participants to express their lived experiences and uncover the phenomena of sound in the educational games studied. In doing so, this approach to bridle the interview created a dynamic, engaging interview process for the participants involved.

Data Reduction

Overview

One advantage of phenomenology is that it leads to data analysis and reduction approaches that vary diversely by study, as seen through Cilesiz (2009), Miller, Veletsianos and Doering (2008), Moustakas (1994) and Robinson (1994). Even as Dahlberg, Dahlberg & Nystrom (2008) position themselves as interpretive, hermeneutic phenomenology researchers, their work builds upon frameworks set by Giorgi (1997), who is a descriptive phenomenology researcher. Therefore, I used both descriptive and interpretive methods in my research. I used elements of a descriptive phenomenological approach as outlined by Robinson (1994), Colaizzi (1978) and Moustakas (1994) to provide a basic descriptive structure to approach this analysis, and I applied an interpretive lens to derive the constituents of meaning and finally the essential meanings of people's experiences of sound in educational games.

As in my previous pilot study (Rosenblum, 2013), I first identified horizons of meaning by identifying meaning units in the data. This step is recommended in the Van Kaam method outlined in Moustakas (1994) and refers to a single descriptive perspective on the phenomenon as identified in transcribed text as a discrete unit of meaning. As Dahlberg, Dahlberg & Nystrom (2008) describe, meaning units signify the "the division of the whole of data into parts [that are] not carried out randomly, but with respect to the meaning that one sees" (p. 243). To search for horizons of meaning is to search for meaning units that describe participant experiences.

I then organized these meaning units into what Dahlberg, Dahlberg & Nystrom (2008) call clusters of meaning, and I further grouped the clusters into constituents of meaning that then served to provide a structure to describe the essential meanings of the experiences of the people in this study. I then assembled textural-structural descriptions that pair the constituents of meaning with data in narrative form. From there, I situated the these descriptions of experience using a process of imaginative variation to explain participant experiences (shared and otherwise) and finally, explained the essential meanings of the experience by connecting the results of the research to current theoretical foundations in game sound research. To best organize the analysis for this study, I repeated every step of the analytical process for each of the three games included in this study.

CONSTITUENTS OF MEANING

The constituents of meaning for an experience provide a structure by which that experience can be understood, and from which essential meanings can be derived. I first aggregated the data from participant interviews and identified meaning units from the transcribed interview texts to search for horizons of meaning in the data (Moustakas, 1994). For Moustakas, the process to *horizonalize* the data means to consider all utterances of a phenomenon with equal weight, regardless of the frequency with which that phenomenon is described. I thus took a broad perspective by which to analyze interview data and to identify all the meaning units that could help to explain people's experiences of sound. I used the qualitative research software NVivo to parse interview transcripts and recorded video to identify and tag these meaning units.

As Moustakas (1994) suggested, I first eliminated incomplete meaning units and meaning units not directly relevant to the analysis. However, I also saved meaning units that helped to provide further context to understand people's descriptions (e.g., their background with games and their overall reflections of the research study). I then took an interpretive approach to further group and organize the meaning units into thematic categories of experience. Instead of taking a descriptive approach to reducing the data as recommended by Moustakas (1994), Giorgi and Giorgi (2003), Colaizzi (1978) and Robinson (1994), I instead incorporated Dahlberg, Dahlberg & Nystrom's (2008) interpretive approach to derive clusters of meaning as a first step to organizing the constituents that describe participant experiences.

According to Dahlberg, Dahlberg & Nystrom (2008), these clusters are tentative and serve as an "important intermediate landing on the way to a structure of meanings" (p. 244). Moreover, according to Dahlberg et al., they are not presented as part of the findings; rather they serve to temporarily organize the meaning units into related piles of data and are critical to deriving what these researchers call "constituents" that serve as the "particulars of the structure" of the experience (p. 255). I refer to Dahlberg et al.'s notion of constituents as *constituents of meaning* in this dissertation to distinguish their use from the term *invariant constituents*, used by Moustakas (1994). Thus, I derived constituents of meaning through a process that involved a constant comparison of the data to derive thematic categories. A summary of data sources is provided in Appendix C. A sample walkthrough of the steps using a sample of data from this study is found in Appendix D. The difference between the notions of invariant constituents and constituents of meaning is that invariant constituents refer to those constituents of the experience that are unique and that don't overlap. The term, "invariant" may also be misleading as it implies that the constituents derived do not vary in their meaning across participants. Because of the interpretive focus for this study, the constituents of meaning derived do not fall into absolute, discrete categories. They are also not necessarily absolute between participants for the study, nor for others who are not involved in this study.

Throughout the process to identify constituents of meaning, and as a tool to help identify essential meanings, I adopted a rigorous structure to organize meaning units, which was informed by Robinson's (1994) psychological study. Robinson advocates that once identified, meaning units should be clustered in such a way that preserves the association of the cluster with the original interview protocol. I took the approach that I originally adopted in an unpublished pilot study in Spring 2013 to gradually move away from the participants' words to my own descriptions of the constituents. Colaizzi (1978) cautions researchers that moving away from participant descriptions to researcher interpretation involves what he called a "precarious leap" (p. 59). I sought to minimize the distance in this leap by constantly evaluating the meanings ascribed to the sorted categories relative to the meanings of the text. To manage this process, I used Microsoft Excel to sort and organize clusters, and to pair them with their related constituents of meaning and their original interview protocols. This step enabled me to check the clustered protocols with their initial groupings to ensure that consistency was maintained between the original meaning units and their related constituents. I also incorporated

Cilesiz's (2009) approach to identify overlaps in shared meaning units across participants and generated frequency tables in Excel to guide me as I derived constituents of meaning.

I used a rigorous process to accomplish what Dahlberg, Dahlberg & Nystrom (2008) describe by citing Gadamer as "interrogating [the] data" (p. 252). This step allowed me to "explor[e] and illuminat[e]…hidden meanings" in the data, as I sorted and grouped meaning units into their respective constituents (Dahlberg et al., 2008, p. 252). It is my hope that this hermeneutic approach to analysis will further boost the trustworthiness of this research by building both credibility and transparency.

ESSENTIAL MEANINGS

Dahlberg, Dahlberg & Nystrom (2008) describe constituents as the "particular[s] of the structure" (p. 255) of the essences of a phenomenon. My epistemological goal is not to derive generalizable, *transcendental* (Giorgi, 1997; Moustakas, 1994) essences of experience. Rather, I seek to describe what Dahlberg et al. (2008) refer to as *essential meanings* of a phenomenon. As Dahlberg et al. (2008) point out, "essences *are* their phenomena, the phenomena *are* their essences" (p. 247). Furthermore, essences are not open to interpretation by the researcher and "are not the outcome of interpretation" (p. 247). Dahlberg et al. instead clarify that "an essence could be understood as a structure of essential meanings that explicates a phenomenon of interest" (p. 245). In other words, essential meanings provide a way to explain a representation of the phenomenon, rather than pointing at the phenomenon directly. If, as Dahlberg et al. assert, "researchers are part of the same world as, and involved with, the phenomena of investigation" (p. 242) and if different participants may offer different perspectives of experience, then the essential meanings of a particular phenomenon are heavily context-dependent and open to interpretation. Thus, I took Dahlberg et al.'s interpretive perspective in analyzing my data to derive essential meanings since they assume that the meanings inscribed by the constituents identified through analysis are dynamic and open to change throughout the process of analysis.

With the essential meanings of the phenomenon identified, I provided a textural-structural narrative of participant experiences that connect the constituents of meaning, together with supporting descriptions of non-verbal cues from the video recordings, back to the original meaning units as a way to provide a descriptive structure of the experience in which I integrated interview text and groupings of constituents. I then engaged in what Giorgi (1997), Giorgi and Giorgi (2003) and Moustakas (1994) describe as *Imaginative Variation* to form "essential intuitions" (Giorgi, 1997, p. 10) to place the constituents of meaning within a broader context to describe my overall impressions of participant experiences of sound.

As a result of these analyses, I am able to explain the essential meanings derived from all three games in this study through the lenses of existing theories in sound perception and game sound. It is from these meanings that I derive a framework for sound in educational games, discuss the relevance of the findings from this study, and by this framework, I explain what it's like for people to experience sound while playing educational games.

Trustworthiness

A number of questions came to mind as I considered how to approach questions of objectivity and validity in this phenomenological study. Dahlberg, Dahlberg and Nystrom (2008), suggest that in order to address questions of objectivity and validity one needs to "go to the things themselves" as a way to be "open, susceptible, and sensitive to…phenomena in focus" (p. 337). That is, researchers need to prioritize the process of openness in their work as phenomenological investigators. For Lincoln and Guba (1985), notions of objectivity and validity are less applicable to qualitative perspectives in part because the focus should be placed "on the data themselves" (p. 300), rather than on the researcher. This distinction is crucial in that it also reflects the philosophical chasm that exists between post-positivistic perspectives that position knowledge as artifacts to be discovered and phenomenological perspectives that assume knowledge of a phenomenon is gained and constructed through experience. Given my philosophical positioning in this study, I place priority on my commitment to be open, susceptible, and sensitive to participant descriptions of sound. As I remained open to people's description of their experiences, I also strove to maintain trustworthiness in the collection and analysis of the data for this study. I therefore adopted Lincoln and Guba's (1985) perspective for trustworthiness to address issues of credibility, transferability, dependability, and confirmability.

CREDIBILITY

My strategy to establish credibility rests first in the extended engagement that I had with each participant. I asked people to play several games over three interview sessions. By using multiple games with each person, I thereby had multiple opportunities to collect data about different experiences with sound from the same person. An extended engagement also meant more opportunity to build rapport and trust with each participant, which in turn opened up the possibility for a deeper exploration of the phenomena. I also let the results of one interview help to shape the design of subsequent interview sessions with the same participant. This format also opened an opportunity for informal member checks with each participant, both during and in between interview sessions.

TRANSFERABILITY

As Lincoln and Guba (1985) suggest, I am less concerned with other researchers being able to generalize my research findings to other settings. Rather, as a qualitative researcher, I "can provide only the thick description necessary to enable someone interested in making a transfer to reach a conclusion about whether [it] can be contemplated as a possibility" (p. 316). Thus, I hope this study makes it possible for future researchers to readily build upon my work and have thus provided a rich data set that thickly describes participant experiences.

DEPENDABILITY

As part of the process to reduce data collected from participant interviews, I used a detailed approach as outlined by Dahlberg, Dahlberg and Nystrom (2008) and Colaizzi (1978) and Robinson (1994). As I analyzed the data, I first identified and categorized meaning units into clusters of meaning, then gradually moved away from participant descriptions to researcher interpretations of the data through constituents of meaning and finally, essential meanings of experience. This process provides a significant audit trail, as evidenced first through the use of coded meaning units in NVivo and later as clusters of meaning that were organized into groupings in Excel and sorted by game, category, and person. I also identified overlaps in shared meaning between participants and used this information to collapse related categories, revise existing categories, and create new categories to reflect the constituents of people's experiences of sound in educational games. Finally, I identified essential meanings by once again grouping the constituents of meaning by identifying both semantic similarity and shared perspectives on experience.

CONFIRMABILITY

As a researcher who is grounded in the theoretical and phenomenological landscape for this study, I have addressed the questions in this investigation in a rigorous, honorable, and effective manner. I thus am offering the product of that rigorous analysis. By doing so, I have contributed to the dialogue in this field of inquiry. And, although I have attended to a process to address steps to embed trustworthiness into this research process, this work is not strictly "confirmable."

That said, as I progressed through the process to collect and reduce data, I kept a reflexive journal as a way to reflect on the research process. I found that recording my observations in a journal also allowed me to reflect upon and readily adjust my interview strategy and allowed me to tweak the research process in ways that helped me to more readily connect to participant experiences with sound. As I journaled, I recorded my own observations after each interview and after I had closely studied each interview transcript. This process allowed me to clarify comments that participants made in prior interviews, and it enabled me to adjust my strategy for subsequent interviews based on prior interviews with the same participant. I also sought regular feedback from my committee members to help maintain perspective on the process to identify constituents of meaning and explain the essential meanings of the experience.

CHAPTER FOUR: RESULTS

Overview

As I interviewed the six participants in this study, for a total of 18 interview sessions, I had the recorded interview dialogue transcribed. I studied and proofed the transcripts between each interview session with the same participant, and I updated an online interview journal, stored in Google Drive, between the first and second interview sessions and immediately after the final session. I also added journal entries to reflect upon the processes of recruiting people, setting up the research study, and on the research process at its beginning and midpoint. Journal writing served to chronicle the interview process and allowed me to reflect upon interview responses prior to visiting with participants for the second and third interview sessions. The reflections on the research process were also critical, as they provided me the chance to look at all of the interview sessions in aggregate, to reflect upon patterns of bridling my knowledge and to note problems encountered throughout the process. By the end of the process, I had accumulated a total of 603 pages of interview transcripts that in turn, reflect 16.05 hours of interview dialogue out of a total of 22.68 hours of recorded gameplay, camera footage, and transcribed interview dialogue. Once the interviews were concluded, I used NVivo to conduct a line-by-line coding of each interview transcript and organized the meaning units by person and by game (Figure 17).

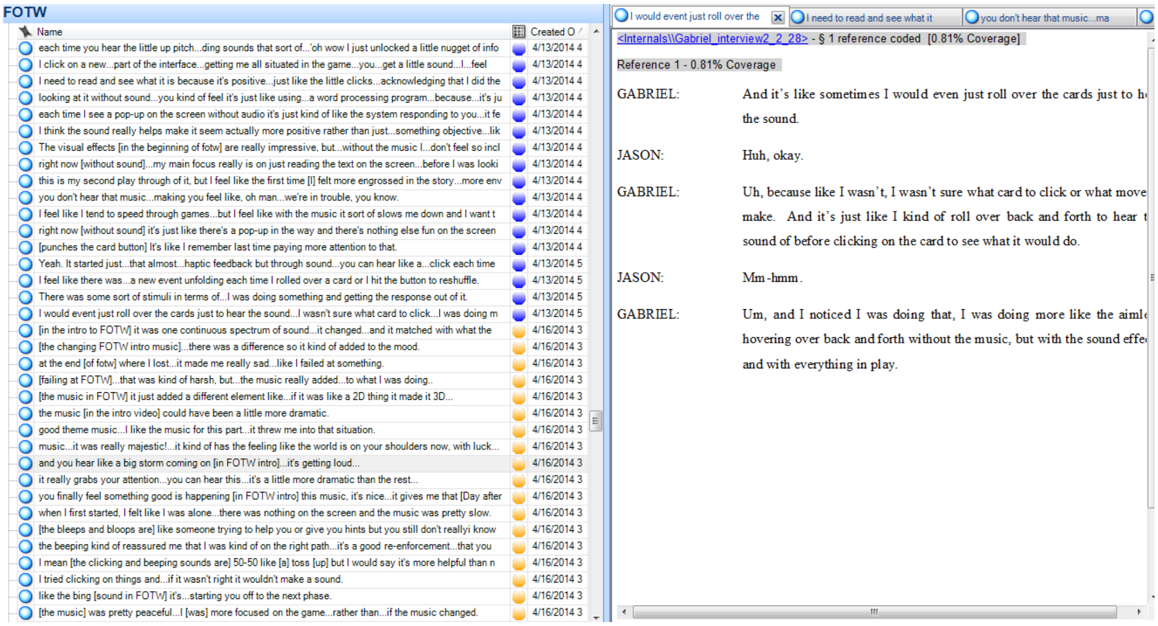

Figure 17. Coding meaning units in NVivo

This coding included identifying units of meaning in the text, as well as occurrences of clear non-verbal gestures by participants from the video recordings to illustrate a point, such as miming a movement with their hands or covering their face with their hands as they talked about their play. I integrated data from the video recordings into the structural descriptions, once the analysis was complete. My broad goal for coding was to search for all possible horizons of meaning in the data by searching for all possible units of meaning that I believed reflected the participants' experiences of sound in the games they played. Once this process was completed, I exported my data from NVivo into Microsoft Excel to organize and group all the meaning units from the three games studied into related constituents of meaning. I have provided an example of this analytical process using sample data from FOTW in Appendix D. I started my analysis with a total 1,738 meaning units in the groupings shown in Table 2.

Table 2. Meaning Units by Game Title

Title	*Meaning units*
Fate of the World	534
Hush	614
Salamander Rescue	590

With these groupings, I categorized the meaning units first into clusters of meaning, and then into constituents of meaning. With the constituents in place, I provided a textural-structural description of player experiences, in addition to writing an imaginative variation for each game. I used the process to write the imaginative variation as a stepping-stone to derive the essential meanings for each game. Imaginative variation enabled me to aggregate descriptions of player experiences for each game and helped me to move from participant descriptions of these phenomena to my interpretations of them as a researcher. I then finally derived essential meanings of experiences of sound in the each of the games studied. A comprehensive phenomenological analysis for each game is presented in the following sections.

Fate of the World

Clusters of Meaning

Once the data were imported into Excel, I organized all the meaning units by game and used unique worksheets within one Excel workbook to store the meaning units for any given game. I then sorted the expressions by person and formed preliminary meaning unit clusters to organize the data. Thus, I organized the 534 meaning units that I had identified in Fate of the World into 50 initial clusters of meaning, and I proceeded to further group the clusters into related categories of meaning. Examples of these tentative clusters for FOTW include:

- I noticed less of the sound and music.
- If I could change sound in this game, I would…
- What I hear sounds the same
- You get immersed…because you have that music
- Sound takes you into the game

Meaning unit clusters with less than three participants were grouped with other clusters wherever possible or were otherwise eliminated, and the perspective given by the combined clusters was expanded to make room for the added data. Clusters with more than three participants were also grouped with other clusters wherever possible, but were left standing alone if the meaning they conveyed as a constituent conveyed a clear and relevant perspective on sound that stood apart from the other constituents.

CONSTITUENTS OF MEANING

I derived 27 constituents of meaning from the initial clusters of meaning uncovered while studying participant descriptions of their experiences of sound in Fate of the World. The complete list of constituents can be found in Table 3.

Table 3. Constituents of Meaning in FOTW

Number	***Constituent of meaning***
1	Overall the sound in FOTW is pretty good and feels complete
2	Without sound, I would have felt something was missing. I wouldn't know if my click registered, and I would've been confused about whether I was doing the right thing.
3	I didn't notice several sounds in FOTW, including the rollover sounds and the ambient background music. I was busy playing the game and after a while of listening to the same sounds, I kind of tuned them out.
4	The intro music was dramatic and also hopeful. It helped me predict what the game was going to be like and helped to throw me into the game
5	The intro music makes me feel like I'm going on an 'epic' quest to help fix what's going on in the world.
6	The intro music is changing and is getting more intense as I watch the video. Occasionally, what I heard didn't match what I saw on the screen
7	The music that I heard when I lost didn't strike me as being particularly sad and somewhat neutral. Furthermore, if the background music had gotten more intense before I lost, then it would've told me that I'm about to lose.
8	The music I heard when I lost was sad and made me feel as if I failed.

Table 3 (continued)

Number	***Constituent of meaning***
9	This game is very modal. The background music tells me when the game changes and occasionally it told me whether I was doing badly.
10	I would change the sound effects so that players could hear sound that would tell them they are doing something wrong. I also think it would be neat if they heard sounds when they lost or gained a heart.
11	There are times in FOTW when the visuals could have had been paired with different sounds. These include changing the music during the intro video, giving me audible cues to direct me to different locations as I play and changing the sound in the news section to reflect that I'm reading bad news.
12	I don't think the animations of people talking in the news section actually need narration because I think the vocals would distract me from reading
13	What I saw and heard in the news area didn't match. There were animations of people of people moving their mouths but not speaking. I'm also reading bad news but what I'm hearing doesn't sound like anything that should concern me.
14	At times, usually when I didn't hear sound, I wanted to skip the intro video entirely
15	Music is part of my experience and helps to draw me into the game. It helps me to be immersed as I play and it helps make a 2D game more of a 3D game. Playing without music would probably be awkward.

Table 3 (continued)

Number	***Constituent of meaning***
16	The sound effects that I hear help to keep me engaged as I play. Sound helps me to feel more a part of the game and makes it more interactive. Playing without sound would probably be boring.
17	Without sound this game doesn't feel the same anymore. It's awkward, cheesy and boring because nothing's going on and you're not engaged.
18	Without sound I would have been less engaged. I might get distracted by things around me, and I just want to read and dismiss what's on the screen.
19	Sound in FOTW is not distracting me as I play
20	The background music added a lot. It was engaging and served as fuel for my thoughts as I played.
21	The background music doesn't provoke much emotion, nor does it give me details that help me to play the game.
22	The music I hear is much like a communication from the game to me. It helps me feel comfortable with what I'm doing, like when I make choices in the game.
23	I really noticed when the background music suddenly stopped playing. It seemed like a really long pause and I thought that either I was too slow or that I now I'm on pause too.

Table 3 (continued)

Number	***Constituent of meaning***
24	The clicks, whooshes, and dings that I hear tell me that I successfully selected something, that I have something to pay attention to, that I've just unlocked a nugget of information, or that I'm progressing in the game.
25	The dings, clicks, and confirmation sounds I hear tell me that my feedback has been acknowledged, that I've affected some kind of change, and that the interface is working.
26	The beeps and dings I hear after I click on something tell me I'm doing what I've been asked to do and that I was clicking on the things I should be clicking on.
27	The bleeps, bloops, and dings are like someone trying to give you hints, but they don't tell me where to look on the screen or how to put things together.

Textural-Structural Description

I now present a textural-structural description to illustrate each constituent of meaning that I derived from participant descriptions of Fate of the World. I have paired each constituent with quotes from the text and descriptions of non-verbal responses taken from the video recordings to highlight and illustrate the meaning of each constituent.

Overall the sound in FOTW is pretty good and feels complete

Half of the participants reflected on the sound in FOTW and described how they thought the sound was put together. As Gabriel put it, "the choice of sound of music was good…I'm not looking for a break like, get me out of here…" Similarly, Andrea and

Donna described the sound as being “pretty, pretty good” (Andrea) and that it “feels very complete” (Donna).

Without sound, I would have felt something was missing. I wouldn’t know if my click registered, and I would’ve been confused about whether I was doing the right thing.

When I asked people to view the video of their gameplay without sound and reflect on they thought playing without sound would affect them, all of the participants except for Leah described feeling either confused about their play or whether their click registered. Said Donna, “[playing without sound] would’ve felt like something was missing…just not there.” She further described how her prior viewing of television as a child in the 70s primed her with an expectation that “everything has a soundtrack or a laugh track or a commentary [on TV]…You’re going to have a voice over that explains the entire plot.” Others, like Sarah, described that a lack of sound would lead to confusion because “you’re not totally sure whether or not [your click] registers the scroll or something like that…it would be hard to know whether or not my actions were [having an effect] unless I see something change visually on the screen.” Austin, Gabriel, and Andrea described a similar confusion. Said Austin, “so if it had no sound or like feedback I would probably click on that, click OK then click on the other things…” Similarly, playing without sound meant that “I wasn’t sure what card to click or what move to make…” (Gabriel) or being “a little bit more confused…if I’m doing the right thing or not” (Andrea).

I didn't notice several sounds in FOTW, including the rollover sounds and the ambient background music. I was busy playing the game and after a while of listening to the same sounds, I kind of tuned them out.

As players continued to play FOTW, all of the participants in some way described either tuning out the music or not noticing in-game sounds because they were focused on the task of playing the game. "I feel like I don't notice it as much as I play more and more. Because you are focused on more of the content and what you want to do…" (Leah). "After a while," remarked Gabriel, "you have the same music playing…" and "it's a different thing, the point at which I am, kind of tuning music out, is when I am absorbing lots of new information [after the intro]" (Donna). Said Austin, "maybe just because it's just kind of ambient music…you don't really…it's not important to pay attention to."

The intro music was dramatic and also hopeful. It helped me predict what the game was going to be like and helped to throw me into the game

Every participant viewed the introductory cinematic to FOTW as part of their introduction to the game. The cinematic offers animation and visuals, along with background music to present players with the context for the central global environmental problem in FOTW and to situate the player as the leader of a fictitious global organization. All participants ascribed qualities to the music such as "warm and welcoming. And hopeful" (Donna). "It kind of like gave it like this 'epic' kind of feeling to the game" (Austin) and "Bam! Like Fate Of The World! [while exuberantly raising both fists]" (Andrea). As Leah pointed out, the music "fits the point it's trying get across…the fate of the world is on your shoulders now…it threw me into that situation."

The intro music makes me feel like I'm going on an 'epic' quest to help fix what's going on in the world.

Most of the participants, with the exception of Gabriel and Donna also described how the introductory music in the opening cinematic made them feel that "it definitely has that sort of like, 'hey, let's you know, we are going on a quest'…" (Sarah). "It's like a quest is about to start" (Leah) and is "really epic I guess…just kind of like Bam! Like Wow! Like it's in your face! [laughing]" (Andrea). According to Austin, "basically it's kind of just telling me like there's a bad conflict going on…and then that before music was like okay it's your job to just bring hope to the world and fix it all." As Andrea put it, "there was just more to that part and I think that kind of like reflects what you saw on the screen like…this needs to be a global effort or something, like everyone is like getting together and they do it." As Leah put it, "With the sound in the background it kind of gives you a feeling that it's like something like super — like something important like oh yeah you are like saving the Fate of the World or something."

The intro music is changing and is getting more intense as I watch the video. Occasionally, what I heard didn't match what I saw on the screen.

As people watched the introductory video, most of the participants, except for Sarah, noticed the music changing as the video played. Typically, the changes they noticed reflect a change in the intensity of the video and sometimes reflected a mismatch between what they saw on the screen and what they heard in the music. Said Donna, "At this point [the music is] kind of neutral. It's a little bit hopeful and it's relaxing. And at the same time I'm looking at cyclones, polar bears dying…" As Austin reflected, at times the music intensified but it didn't always connect with the visuals in the way he expected, "actually I felt like it intensified there…but I wish there were like audio cues to like—I wish it kind of like intensified because it says right here it's like civil unrest is fomenting rapidly here." Andrea also noticed "that it got a lot louder whenever they show that…they switch to the other screen…yeah for the climate summit [towards the end of the video]…like it made us seem like it was more of a…a dire issue because I felt like crescendo."

The music that I heard when I lost didn't strike me as being particularly sad and somewhat neutral. Furthermore, if the background music had gotten more intense before I lost, then it would've told me that I'm about to lose.

Although winning the first mission in FOTW is of course possible, it is also exceedingly difficult. As such, everyone who played in this study saw the lose screen at the end of their play and heard the music that accompanied that screen. With the exception of Leah and Andrea, participants thought that the music they heard at that screen sounded neutral. Said Sarah, "I did think that it was kind of strange that…there was no music associated with loss, right, it's the same ambient sound…as other parts of the game." For Gabriel, "all the visuals really convey a mood of what's going on…the blood splattered…totally defeated monkey…but like…I thought the music…was starting to get like a little bit grim…then just sitting kind of like…[it] just kind of went back, picked up and moved [on]…I felt a little bit defeated at the end but not too much." In particular, Austin also felt that "[had] the ambient music got more intense as I was losing then it would like bring attention that well, I'm really about to lose." Similarly, Donna thought that there should be "different sound effect[s] for [things like] insufficient funds than you selecting this card." Although Donna did not agree with Austin, Gabriel and Sarah about the neutrality of the lose music; she thought that adding sound effects to forecast losing would have provided her with feedback that she was making potentially bad decisions when choosing her cards.

The music I heard when I lost was sad and made me feel as if I failed.

Like Leah and Andrea, Donna felt that the music she heard at the end was sad. According to Donna, "It's perfect. It's just perfect. It's a sad situation." Similarly, for Leah, the music "at the end where I lost…it made me really sad. Like showed like I failed at something. So that was kind of harsh…" Andrea was the only participant to come close to beating the game. However, the music didn't communicate how close she came to her goal: "this part was just…oh you failed like it goes into like minors…whenever I looked at the actual results and like…I wouldn't have noticed…that [I] was so close to beating it with this music…I wouldn't have guessed that I…was that close."

This game is very modal. The background music tells me when the game changes and occasionally it told me whether I was doing badly.

As Donna, Austin, Gabriel and Leah played FOTW, they noticed that the background music in the game shifted as they played different parts of the game. As

Gabriel described, “the music in the background was really good.…You could tell the [surrounding] change between different like movements and moods…just as you’re playing the game…” Donna, arguably the most experienced gameplayer and the only game designer in the group remarked, “If it’s a mode, this is your choose cards mode. It helps me to have a geography [Donna mimes creating a border using her hands] that when I’m in this component I get this music, and when I’m this component I get this other music. Sometimes that’s helpful. And this is a game that’s very modal.” Austin described these modes as he described hearing the music “intensif[ying] at the five years, like after you click five years…” Notably, Austin, *thought* he heard the music intensify when “I realize it’s kind of like, ‘I’m doing something bad.’” Similarly for Leah, the music “was effective in telling me if my actions were going into the right direction or the wrong direction and it kept it from being boring.” Interestingly, the background music in FOTW remains consistent whether players are winning or losing, or whether they are going in the right or wrong direction. Leah and Austin both describe the music changing in FOTW and they both thought the music adapted to their play, when in reality changes in music reflected changes in the game.

I would change the sound effects so that players could hear sound that would tell them they are doing something wrong. I also think it would be neat if they heard sounds when they lost or gained a heart.

With the exception of Donna and Sarah, participants expressed how sound could help communicate when they are making choices in the game that would prevent them from achieving a win. According to Gabriel, “…the news I was reading was bad news…it would've also been cool like if those graphs as they animated, would've like made a little bit of a noise or like, you know, your star rating as you know, uh, increase or decrease. If it was like, if there's some sort of like aural queue...you did well; you did something. Or like, 'Hey, you know, you're really messing up.'" Similarly, Leah remarked, "And I feel like there is someone's doing something wrong like maybe make a negative re-enforcement? So you don't keep doing it." Austin and Andrea went a step further and described wanting the same feedback for approval ratings. Said Austin, "negative feedback for when you lost the heart…Then it would be more apparent that I was going to lose."

There are times in FOTW when the visuals could have had been paired with different sounds. These include changing the music during the intro video, giving me audible cues to direct me to different locations as I play and changing the sound in the news section to reflect that I'm reading bad news.

All participants in this study gave critical feedback about the use of sound in FOTW. For this constituent, all participants described wanting to hear a change in sound while referencing specific visuals in the game. For Sarah, changing the music more frequently in the game to match more of the games "modes" was important: "you know okay when you have your space view of the world you know that's a very different place than when you're playing your cards at the table, right?...I might change the music in each one of those modes." Gabriel noticed a different mismatch of sound and visual while reading the news in FOTW: "…and over here…the picture was very…descriptive because it was like…you know war in the Middle East and then like…blood splatter here in one of them…So, I thought now — I thought it would've been nice if like the music, kind of…conveyed more of what was going on like it was just like… It was kind of just like run-of-the-mill, like ho-hum like here's your update type of music." Donna expressed a nearly identical concern in the same section saying, "where there was bad news, it was a little incongruous." Austin described several instances where he "was just taking visual cues and then I translated them to audio cues that didn't happen." Likewise Leah thought the music in the introductory video could have been more dramatic and for Andrea, pairing visual and aural cues was important. As Andrea reflected, "I feel like if they're like — if there was like a visual like indication like 'ooh like here's this' and then like along with that visual indication like there was sound with it like, like higher than expected or lower than expected?"

I don't think the animations of people talking in the news section actually need narration because I think the vocals would distract me from reading

About half of the participants thought that the animations they saw in the news section of FOTW didn't need narration, despite viewing an animated on-screen character that was moving its lips and not making sound. "Overall," thought Gabriel, "without the narration it was fine." Similarly, Andrea also thought narration wasn't needed, "because you, you already have like the text at the bottom. I think if you added more sound to like a guy talking or something it probably was—I don't know, I feel for me personally it would distract me from reading." Interestingly, Donna also believed that hearing narration would distract her from reading because "I would be focusing on what's the caption below that person. …I would be looking at that area of the screen like it says, you know, unrest in north, northern Africa as opposed to over the other parts." That said, Donna and Gabriel also described wanting to hear more sound in the narration section, and thus gave a description that was more aligned with Sarah's perspective on narration.

What I saw and heard in the news area didn't match. There were animations of people of people moving their mouths but not speaking. I'm also reading bad news but what I'm hearing doesn't sound like anything that should concern me.

According to Donna, "Hmm, the people are talking and I was expecting to hear some kind of voice when you see a little faux newscaster." For Sarah, it was jarring to see animations of news characters talking but not hear sound because "I was listening for something. I thought maybe it was going to be like telling me something or that there was a person talking to me or trying to tell me something…Um, but just having lips moving…that was just strange. Like okay, these lips are moving but he's on mute." Gabriel didn't want to hear narration; however he described the mismatch between what he heard and what he saw in the news section as "like I'm reading really a bad news but it doesn't feel like too much of a surprise…Or anything that I should be worried about, based on what I'm hearing."

At times, usually when I didn't hear sound, I wanted to skip the intro video entirely

Half of the participants described a desire to skip the introductory video of FOTW. As Sarah was about to start her play, she looked up from the computer screen and indicated to me if she should continue the video. When Austin discussed his experiences in viewing the introductory video without sound, he shrugged his shoulders, saying, "Please let me skip through it," while laughing and miming a mouse motion with his hand. Austin also described wanting to "kinda just want to get into the game as well." However, Austin also described that if he "were to skip, I would probably definitely skip if there was like no music playing." Andrea also described, "I don't think I would have taken it like as seriously and I probably wouldn't have like seen anyway because I was like really okay skip," her hands covering her face, while she laughed and appeared to be somewhat embarrassed as she said this.

Music is part of my experience and helps to draw me into the game. It helps me to be immersed as I play and it helps make a 2D game more of a 3D game. Playing without music would probably be awkward.

Everyone except for Gabriel described in some way that music contributed to the sense of immersion in FOTW. Even Sarah, who originally wanted to skip the introductory video altogether, said, "I think it needs some kind of music though right? It's going to take you into it and makes you — well I like you know, having some kind of [music] otherwise I mean, it's visually pretty but it doesn't take you into the game as much." Furthermore, for Sarah, "When talking about you know, focus and being able to be a part of the — engage in the story, music is part of the experience." When I asked Andrea about hypothetically playing with sound effects but not music, she primarily described her experience as "I can't think of a word like other than 'awkward' because… [Laughs] I don't know…even though there would be that sound [effects]…it's just something about the music that helps you feel like I guess comfortable in playing [the game]." For Leah, the music "really added on to what I was doing the whole time. And it just added a different element like it if it was like a 2D thing it made it 3D and it definitely added…” Like Andrea, Leah also felt that playing without music would have been “really awkward…when I see games they’re just like sounds in the background cause it kind of re-enforces where you’re at and what’s going on.”

The sound effects that I hear help to keep me engaged as I play. Sound helps me to feel more a part of the game and makes it more interactive. Playing without sound would probably be boring.

All participants described ways that sound helped to keep them engaged as they play. According to Leah, playing without sound can be less engaging and distracting, “Yeah. I just feel like you’re less engaged, like if you hear a different sound elsewhere, you are going to look of there and you are going to lose your attention a lot faster than if you…if you had your headphones on and you were just looking at the screen and you feel…like you just feel a lot more part of the game.” Sound was important for Austin in the beginning of the game in part because “I don’t know necessarily if that’s where I’m supposed to be clicking [when I start playing] but I was like so if it had no sound or like feedback I would probably click that, click ok then click on the other things to like read about every single one.” For Sarah, sound effects “just makes it more believable in some way…‘cuz in real life…there’s definitely a noise associated with everything.” For Donna, her experience in areas like the news section FOTW could have changed because “this is hard for me to say, [but] I think I’d be less likely to read [the news].” Andrea explained why sound was important to her: “with the sound in the background it kind of gives you a feeling that it’s like something like super — like something important like oh yeah you are like saving the Fate of the World or something, but um if I did without that like sound…you are kind of like still in like your own world here rather than like in that [game].”

Without sound this game doesn’t feel the same anymore. It’s awkward, cheesy and boring because nothing’s going on and you’re not engaged.

I asked everyone in the study to watch a video of himself or herself playing FOTW without sound. In some cases, I asked participants to replay portions of the game without sound. Typically I took this step if the participant either hadn’t clicked on certain areas in the game, or if I sensed they needed to explore an area that they had visited in more depth. After I asked these participants to describe their opinions about playing or watching the play of their game without sound, they described their experience without sound in a variety of ways, but centered their thoughts on their overall experience without sound. Said Donna, “It [gameplay] would take longer. I would feel it was slower. It would just feel — a time perception would probably feel slower to me.” For Leah, the background music “drew me in, it was engaging, um it was effective in telling me if my actions were going into the right direction or the wrong direction and it kept it from being boring.” Similarly, Donna also described the background music as “very much a communication from the game to me. And I would feel as unsympathetic, cold [without it].” Without sound, Leah described her experience of play as “It’s like you’re pausing it,…Yeah like nothing’s going that’s how it feels like.” Austin described playing without sound as “[playing the game] would seem kind of cheesy because this kind of reminds of like the Star Wars like a long, long time ago.” Although he didn’t describe the game as cheesy, Gabriel felt, “like you know without the sound,…[FOTW is a] very boring action consequence driven game.”

Without sound I would have been less engaged. I might get distracted by things around me, and I just want to read and dismiss what’s on the screen.

With the exception of Donna and Sarah, the participants felt that a lack of sound in the game would be less engaging. As Andrea put it, “I’m soo bored,” her hands covering face while she laughed, and as she watched her gameplay without sound, “yeah if I didn’t have the sound, I wouldn’t have been like as into it, ah just because I’ll be like I guess influenced by like with a lot of this of going on…I don’t think I would have played as well.” Gabriel described a disconnection from the game, beyond the on-screen text: “I mean right now my, right now my main focus really is on just reading the text on the screen. Like, I felt like before I was looking at other stuff and I was noticing like a little icon there, but right now it’s just my primary focus really seems to be just on reading it because there’s nothing else going on in my mind.” Furthermore, the visuals alone weren’t enough to keep him engaged: “I mean the visual effects are really impressive but, you know, I don’t know. Without the music I just I don’t feel so inclined to like really sit and read through it so much.” Similarly Leah thought that without sound, play in FOTW would be “Boring…Because it’s not engaging and if — there's like another sound somewhere else I’ll look somewhere else and then I’ll lose interest in this very fast.”

Sound in FOTW is not distracting me as I play

Half of the participants described how the sound in FOTW was not distracting to them as they played. According to Sarah, " [in games in general]..when there is some sort of noise associated with an action I just like it, I mean those can definitely be an overload I think…" but she didn't think that FOTW overloaded her with sound. As Gabriel put it, the sound in FOTW "wasn't something that I'd get tired of. There are some games that like…You know, if you have to jump a lot and it makes, like a little bouncing noise every time you jump. After a while, you want to kill yourself." Similarly, Donna was attempting to learn the interface in FOTW and thought, "I'm overwhelmed trying to absorb the interface…It's buttons with icons and no instruction so at this point I'm a little overwhelmed and tuning most of the music out. So, it's good the music is not distracting me."

The background music added a lot. It was engaging and served as fuel for my thoughts as I played.

All of the participants commented on how the background music added to their play. Andrea thought that the music "does a lot to keep you engaged." As Sarah described, "I think the music definitely adds a lot…this is very mellow, flowy music, definitely keeps you very calm and in a place where you want to think." She went on to describe the music as "not provoking a big emotional response but at the same time this was definitely trying to figure out what's going on, trying to figure out how this game works, trying to figure out what I can and can't do on the screen." Gabriel similarly described the music as "It was so kind of like picking-your-brain type of music…" while Austin described the music as "music going on with my clicking to help I guess inspire thought…" For Donna, the background music was "fuel for my thoughts…" and explained that the reason for it is that "the sounds I hear while I'm working to some extent are the beads from which I'm putting together the other things, and they don't necessarily need to be directly related, but it helps if they do. It helps if the music is relevant. It helps if the mood is harmonious."

The background music doesn't provoke much emotion, nor does it give me details that help me to play the game.

All of the participants except for Donna described how the background music was ambient and emotionally neutral. Sarah thought, "this is just very ambient sort of calm music that — it's not provoking a big emotional response…" Gabriel went on to compare his experiences of music in FOTW with other games such as Grand Theft Auto, saying, "It's a little bit too much, like it's laid on too thick. Um, so I mean like there's good and bad ways of using it…I just…I think music plays a much bigger role." For Gabriel, music in FOTW had a self-described, "subliminal" effect. "There['s] subconscious thing where it's like you, sort of are hearing the sound but it's just like that music. It's, it's that kinda music that's just like picking you like that, picking-your-brain, type of the music like…" For Austin, he didn't get the "nitty gritty details [of the game from] the music, but I can get like a general overview." In this instance, Austin is primarily describing his experience of music in the introductory video, but he also describes his experience with background music as changing and as giving him feedback in the game: "I wouldn't know how bad I was doing or how good I was doing without the music. [The music] intensifies I realize it's kind of like, 'I'm doing something bad.'"

The music I hear is much like a communication from the game to me. It helps me feel comfortable with what I'm doing, like when I make choices in the game.

Donna, Andrea and Austin described the music in FOTW either as having communicated something to them during play or as having made them feel comfortable playing the game. As I reported in an earlier constituent, Donna described the music as a "communication from the game to [her]." In particular, for Donna, playing without music "would be like I'd had a dialogue with this situation and now I was getting silence." Austin described the music as "the kind of music you will hear in The Sims a lot and like Sims is like, a game where you just make choices about these people." Donna took this one step farther and described how the music helped her to identify with her role in the game. Said Donna, "the music tells me who I am." Although Andrea didn't articulate what specifically the music communicated to her, she described that there's "something about the music that helps you feel like I guess comfortable in playing [the game]."

I really noticed when the background music suddenly stopped playing. It seemed like a really long pause and I thought that either I was too slow or that I now I'm on pause too.

To my surprise, half of the participants noticed a bug in the sound in FOTW while playing the game. The background music for the game abruptly and unexpectedly cut out as they played. As a result, Andrea, Gabriel and Sarah noticed the abrupt absence of the ambient background music. As Sarah described, “I think it’s kind of interesting because you know, there are moments in the game where the music pauses…” Not only did she notice the sound cutting out, Sarah also “wanted to stop [playing the game], [because] it’s kind of like, okay I’m just kind of like I didn’t want to do anything until the music starts again right? I felt that it was just like, okay—now I’m paused too.” Not only did Gabriel notice the sound dropping out as he played, he described the experience as “just like having a blanket pulled out from under you.” As he continued to reflect on this experience, he remarked, “The thing too was that like it’s interesting how you don’t really notice the music…It’s just sort of there and then the moment it cuts out, it just kinda rattles your world.” Andrea also described how she not only noticed that the music stopped but that “the music would like stop for a while, then I just be like, oh I’m really slow! and then it would start up again I’m like oh okay.”

The clicks, whooshes, and dings that I hear tell me that I successfully selected something, that I have something to pay attention to, that I’ve just unlocked a nugget of information, or that I’m progressing in the game.

All of the participants except for Donna described how the sounds they heard while operating the interface in FOTW affected their play. For Sarah, “…the ding to me you know, signals to me that — some kind of action is required on my part that you know either look at this box or click okay, or make your next move or — or that it affected a change, right?” As Gabriel reflected on the ding sound Sarah mentioned, he said, “…each time you hear the little up pitch like little ding sounds that sort of like, uh, oh wow I just unlocked a little nugget of information.” To Gabriel, when he first started playing FOTW, "everything is new so every time I click on a new, you know, part of the interface or it presents a new piece of information…and you just get a little sound…every time I just kind of feel my brain spike a little bit because I'm like, oh something cool just happened. What is it?" To Austin, sounds that he heard "…[are] kinda just like signaling to me that like, you are progressing in the game." Similarly, Andrea and Leah both described the ding at the end of each turn in FOTW as having "signaled like the turn of like another round" of play.

The dings, clicks, and confirmation sounds I hear tell me that my feedback has been acknowledged, that I've affected some kind of change, and that the interface is working.

When I asked people about the dings and clicks they heard when they operated the game interface in FOTW, they described how those sounds helped them to know that their mouse clicks were working and that their action was acknowledged. As Sarah described, "I do like the auditory feedback when I make a move or when I make a selection, I like those things." As Donna reflected, "[It's] good to know that the puck is working. Good to know that the mouse interface is working, but that's, that's pretty much what it should do." Gabriel provided a specific example of the usefulness of auditory feedback when he described his experience of clicking on pop-ups at the beginning of FOTW and hearing the resulting ding sound. "I think each time you hear the little, when you click it and it makes like the, uh, pitch [audible *'Ding!'* from the game] like that sound right there when it makes that sort of like up pitch sound effect, it sounds like you're unlocking something." Leah described the role of the ding sounds as helpful "reinforcement," while Andrea described it as the "sound of like validation."

The beeps and dings I hear after I click on something tell me I'm doing what I've been asked to do and that I was clicking on the things I should be clicking on.

Everyone except for Donna and Sarah further described the auditory feedback when they worked the game interface as sounds that signaled to them they were clicking on the right things in the game. As Andrea described, the interface sounds she heard at the beginning of playing the game signaled that "like I was just like going in the right direction...[the sound is] like pretty, pretty good…like telling you that you are doing like the right thing." Similarly, Leah also describes that the dings she heard "kind of re-assured me that I was kind of on the right path." For Austin and Leah, the sound they heard as they decided which parts of the game interface to click was a "good sound, it's a good re-enforcement of…that you are doing what you are supposed to do" (Leah) and is what Austin described as a "positive feedback kind-of when you click."

The bleeps, bloops, and dings are like someone trying to give you hints, but they don't tell me where to look on the screen or how to put things together.

Half of the participants elaborated on the interface sounds they heard in the game. According to Sarah, Leah and Austin, although these sounds provide helpful feedback, they do not tell you where to look on the screen or how to piece together the relevant bits of information needed to make decisions in the game. As Sarah described about the ding sound, "I think that um the ding is not — ding doesn't say to me look in the upper right hand corner, like…[laughing hard]…[it] just alerts me that there was something on the screen I should look for.” As Austin elaborated, “I said before that the sound kinda guided me to like progress...but I don’t think the sound was used like, any like for direction…” The interface sounds for Leah are like “someone trying to help you or give you hints but you still don’t really know where you are at.” Furthermore, she couldn’t rely on the sounds to help her piece together the information needed to beat the game. According to Leah, “Honestly, when they gave me different information, I couldn’t really link them together at first. I think it really comes with clicking more...At least for slow people.”

Imaginative Variation

The following text is the imaginative variation that I wrote for Fate of the World, to place my impressions of the constituents of meaning based on participants’ experience into a broader context.

The world is in trouble. Global temperatures are rising along with emissions of greenhouse gases. Species like the polar bears are becoming extinct. The world has finally reached the precipice of environmental collapse, and only the leader of the GEO—the Global Environmental Organization can save it. These six participants, for a brief time inhabited the role of that leader by playing Fate of the World. They launched the game, watched and listened to the crisis unfold through animation and music. The visuals and music worked together to envelop these participants in the experience of the game. The music evoked the notion that the cause was epic, and that it was up to them to fix the world's problems. As they listened during the cinematic, the music carried them through the unfolding drama, at times making them feel hopeful and helping them to predict what the game was going to be like. What they heard affected how they felt about what they saw.

With the story in place, they worked the controls available to them. What they heard helped them to know they could affect the controls they used, and gave them the feedback they needed to know they were on the right track. The music they heard in the background provided the fuel they needed to think, without leading them in an emotional direction. They played the game and made choices using the cards at their disposal that would decide the fate of the world they were trying to save, and in the process the sound faded into the background of their play. At times, the music stopped and the players who noticed it stopped their play, the experience of the game momentarily stopped; their play momentarily on pause. They continued to play, the audible prompts subtly and incrementally helped to guide their choices. They moved from the game's introduction to the overview screen, to the area whey they chose cards to play, to the section that gave them news about critical events and finally, to the end of the round where they saw the results of their decisions. The sound and music they heard shifted with each area they used in the game, but they were left wondering whether they were winning or losing. They saw animated characters talking—*why were their lips moving yet they didn't make a sound*?

Finally, they reached the last round of play. Were they going to succeed? Were they going to fail? The game was silent and the result a surprise. Did they nearly succeed? Why didn't they? They failed, but why didn't the music always make them feel as if they did? Yet, the music and sound overall kept these players in the game and prevented them from being distracted. The sound effects kept them enmeshed in the experience of play, while the music helped make this two-dimensional game feel more three-dimensional.

Hush

CLUSTERS OF MEANING

I used the same process to organize meaning units for Hush as I did for Fate of the World. I thus took the 615 meaning units that I found for Hush and organized them into 62 initial clusters of meaning. As with the groupings for Fate of the World, I proceeded to further group the clusters into related categories of meaning. Examples of these tentative clusters for Hush include:

- Without sound I didn't feel anxious.
- I thought the mom was me.
- Some of the sounds were horrifying.
- With the story comes the sound.
- Hearing the baby gave me feedback.

As with Fate of the World, meaning unit clusters with less than three participants were grouped with other clusters when possible or otherwise eliminated, and clusters were expanded to provide the right perspective to represent the newly grouped data.

Some clusters were also left intact if they conveyed a clear perspective on a constituent of meaning.

Constituents of Meaning

After I completed the process to group clusters of meaning into constituents of meaning, I derived 22 constituents of meaning from the initial clusters of meaning in Hush. The complete list of constituents can be found in Table 4.

Table 4. Constituents of Meaning in Hush

Number	***Constituent of meaning***
1	Playing Hush while hearing the sounds of everything going on around you was eye-opening, and makes you think of the bigger picture. I think just how scary it would be to be stuck and have to endure that horrible situation, even if I didn't totally identify with the game.
2	In Hush there's no interface. It's all about the story, and with the story comes the sound. I'm hearing the commander on the radio, people begging for their lives. As the sound escalated, I heard voices of the insurgents killing everyone. One time I also thought the mother had a beautiful voice. She seemed heroic to me.

Table 4 (continued)

Number	***Constituent of meaning***
3	Hush really gets its point across through sound. There are powerful, impactful sounds in this game that are mixed with soft piano music. You can't see blood being sprayed on the screen but you hear people getting slaughtered. The sound evokes emotion and helps deliver a powerful message in the game.
4	I can't press the letters at the right time when they appear on the screen because the timing in this game is hard, and I'm wrestling with the interface.
5	The sounds I heard as I played made typing harder to do. It was difficult to concentrate when you hear people yelling and getting killed. I'm responsible for this child and that pressured me to press the right keys.
6	As I play I think that I need to FOCUS and get this child to HUSH. As I type, I think please-stop-crying-now! Please!
7	Hearing the baby cry gave me the feedback that I needed so that I could know how I was doing in the game.
8	I don't quite recall hearing much from the mother as I played. I think I heard her a little but then her voice got lost amongst the other sounds.
9	I remember the mother singing. Her singing is like a lullaby to her baby to stay quiet so that the soldiers don't hear you, but at some point she stopped.

Table 4 (continued)

Number	***Constituent of meaning***
10	Towards the end of the game, I thought I was losing because I heard the baby’s crying get worse. Other times I knew I was losing because I heard crying, the soldiers kept getting closer and then there was gunfire that I knew was meant for me, and I was like, oh crap!
11	As I play, I can hear that the sound escalates as things outside are getting worse. I go from hearing soft piano music and the baby being calm to gunshots that get louder, people being tortured or killed and the baby crying very loudly.
12	As I played, I felt responsible for this child. I know my actions are going to affect this child crying. Regardless of whether I felt like I was playing the mother, I felt like the baby crying was my fault and that I needed to do better because the soldiers are going to come!
13	The mom is in danger.
14	When I played with sound, I felt like I was a lonely mother with a helpless child. When I heard her cry I thought it was me.
15	This game was really heavy and was absolutely an intense experience. There was a lot of chaos around me, with the sounds of blades, and of throats being slashed. The sounds made the game feel sad.

Table 4 (continued)

Number	***Constituent of meaning***
16	This game was a mind trip, and made me feel anxious and sometimes scared. The game was disturbing because some of the sounds I heard were horrifying, brutal and violent. My sense of fear and hiding mostly came from the sound.
17	When I played without sound, this game was totally different. I didn't feel like I was a part of the game, and at times didn't even want to play it. I had no way to know that there was any danger at all in the game. I didn't feel anxious or stressed. Sometimes it was easier for me to get the letters right, but I think not having sound can ruin this game.
18	Without sound, it felt like I was playing a strange typing program or a spelling game for a kindergartner. I was paying more attention to the pictures, and when I missed a letter it was like, oh it's red. Oops.
19	The sound is setting the scene and tells you where you are and what's going on. The sound mostly seemed authentic to me, like it was pulled from that part of the world. At times I felt immersed in the scene and engaged in the game.
20	I was mainly focusing on the sound while I played. I think the visuals were the supporting actors in Hush. They didn't contribute that much and often got buried by the sound.

Table 4 (continued)

Number	***Constituent of meaning***
21	The piano music in Hush really sets the mood of the game. It's pristine, peaceful, innocent and is sometimes reminiscent of a lullaby.
22	When I played Hush and won, I didn't hear music at the end. The end of the game feels empty and unfinished. Why are they leaving me hanging like this?

Textural-Structural Description

I now present a textural-structural description to illustrate each constituent of meaning that I derived from participant descriptions of Hush. As in the previous analysis for FOTW, I have matched each constituent with quotes from the text and descriptions of non-verbal responses taken from the video recordings to highlight and illustrate the meaning of each constituent.

Playing Hush while hearing the sounds of everything going on around you was eye-opening, and makes you think of the bigger picture. I think just how scary it would be to be stuck and have to endure that horrible situation, even if I didn't totally identify with the game.

Every participant in some way reflected on how the experience of playing the game related to the larger perspective embodied by the game. Donna, who described being otherwise detached from the game in other constituents, reflected upon what she remembered learning about the situation in South Africa when she was growing up. As Donna explained, "I think this is a great perspective that many of the people what you had to do was to endure, what you had to do was keep your wits about you." Others like Gabriel and Austin both expressed how the game embodied the situation. Austin remarked, "…I don't know if it's still happening…Probably is…I've heard of like the child, sold…soldiers and what not…But it's just… It's horrible stuff happening over there." As Gabriel reflected after playing Hush, "I think it really it's an eye opening game I think…if you haven't thinking about it or if it's never really crossed your mind it does kind of rattle your world a little bit. It makes you think bigger picture." Sarah echoed Gabriel's point, "I think that that's just a very you know, such tough period of history is very difficult to imagine what it would be like to be stuck in that kind of situation, right. I think that it actually does a decent job of creating that tension um, which I thought was very interesting. so…"

In Hush there's no interface. It's all about the story, and with the story comes the sound. I'm hearing the commander on the radio, people begging for their lives. As the sound escalated, I heard voices of the insurgents killing everyone. One time I also thought the mother had a beautiful voice. She seemed heroic to me.

Everyone described the ways in which Hush communicated a sense of the story that provided the backdrop for their gameplay. As he listened to his game playback and heard the voice on the radio at the beginning of the game, Austin remarked, "The way I like, imagine it in my head, he's like a commander…Commanding his soldiers…like through like the radio, I guess…Yeah, so that's the image I got from that, like that kind of [muffly] sound…" As he continued to listen and watch his game playback he continued, "Those like I guess, uh or what I called them…like insurgent voices. And so, I already know that it and like the gunshot, so right now, I can already assume that they're going around, to I guess everyone's house… Houses and just like killing everyone." For Leah, she also connected with the opening narration and the subsequent crying of the baby: "Like I think when he said that that was when the baby first started crying I don't know but it kind of gave me a sense of what the story was about…" The story Austin and Leah described parallels Andrea's description of the escalation that she heard in the game, "Yeah, because I thought that, I died just because — the fact that, like the sounds kept escalating and escalating?" As Gabriel described when he compared his experience of playing Hush with his earlier experience in FOTW, "[Unlike in FOTW] This there's no interface, nothing. It's just it's all about the story and it, and with the story comes the sound."

Hush really gets its point across through sound. There are powerful, impactful sounds in this game that are mixed with soft piano music. You can't see blood being sprayed on the screen but you hear people getting slaughtered. The sound evokes emotion and helps deliver a powerful message in the game.

Everyone except for Donna vividly described the sounds they heard in Hush. For Sarah, the sounds were a key component of her experience of play. As she described, "these are really um, these are powerful sounds these — that would have been enough to put me there [in the game]." Gabriel also described the sounds in Hush as "just loud, powerful impactful sound. Uh, not in the literal sense of loud, but you know." Austin and Gabriel both enumerated the sounds they heard: "when you hear those footsteps, when you hear the sound of the soldier.…Outside in the distance is the soldier. You hear those footsteps…" (Gabriel). All the while, "you're trying to get your baby… You're singing her – Your baby, him or her, a lullaby to like stay quiet so that the soldiers don't hear you and kill you" (Austin). As Leah pointed out, the visuals don't typically reflect the sounds you hear: "…you can't see blood being like sprayed on to the screen through the window but you can hear like people getting slaughtered, so…" Overall, according to Andrea, "I think if they [the game designers] wanted to get their point across to raise awareness, I think they did it effectively, through the sound..."

I can't press the letters at the right time when they appear on the screen because the timing in this game is hard, and I'm wrestling with the interface.

Hush was not an easy game to play in general, according to feedback from everyone who played the game, and it was difficult for people to adapt to the timing of pressing letters on the keyboard while watching letters on the screen. For Sarah, "it was very difficult for me to wait until the right moment to actually press the letter…I kept getting the, you know, you know *too soon*, and then then would be *too late* and then [Laughs] it was like, I was like I have waited *too loong* and I…[Laughs]." Others shared similar experiences. As Gabriel remarked in the opening tutorial of the game, "It's such a narrow window I swear … and you really want to get this baby to hush! [laughs]" Andrea, Austin and Donna also described feeling frustration or stress when they missed letters: "The typing does like, 'cause it stressed me out when I would miss" (Austin).

The sounds I heard as I played made typing harder to do. It was difficult to concentrate when you hear people yelling and getting killed. I'm responsible for this child and that pressured me to press the right keys.

Interestingly, even as players described having problems wrestling with the game's typing requirement, all of the participants except for Donna also described how the sounds they heard made the typing more difficult. According to Sarah, "Yeah, it is definitely harder to focus with the sound, you know I mean." When I asked why, she quickly retorted, "Obvious, machine guns and people yelling and people getting killed! …[Laughs] you know it's, it definitely, um, uh, it's hard to maintain that sort of flow, the calm flowy way that you have to press the letters." Even as Austin described having problems with the typing in the previous constituent, to him, sound played an important part of his stress: "You're trying to get your baby…You're singing her – Your baby, him or her, a lullaby to like stay quiet so that the soldiers don't hear you and kill you…And then so, that puts a lot of like, I guess, stress on getting correct inputs." Leah felt similarly distracted by the sound, saying, "I feel like it makes typing a little harder because, umm because you start noticing what's going on in the background because the sounds are so much more extreme than the pictures, it affects your play." She also mentioned how she felt responsible for the baby in the game as she reflected, "…like there is a sense of danger, um for the mom and the kid and I felt like I was the person that was responsible for keeping that child from crying and…not getting caught by the people that are trying to harm them."

As I play I think that I need to FOCUS and get this child to HUSH. As I type, I think please-stop-crying-now! Please!

Andrea, Gabriel and Sarah described their sense of urgency to focus more closely in the game. This was an important point in particular for Gabriel and Sarah. As Sarah described, “I need to stop paying attention to these sounds and start paying attention to these letters so that I can make this calm down…” and “okay I just gotta…I just gotta focus…just okay nothing is going on just these letters like [Laughs]…” Like Sarah, Gabriel made the connection between getting the letter timings correct and the crying of the baby, and like Sarah he felt a need to get the child to stop crying. As he put it, “Yeah. I was like I was — I felt like each time I went H-U-S-H it’s like Please-Stop-Crying-Now [said as if mimicking the slow rhythm of the letters as they faded in and out of the screen in the game].”

Hearing the baby cry gave me the feedback that I needed so that I could know how I was doing in the game.

All of the participants, save for Donna, described how hearing the baby cry provided them with feedback that communicated how well they were doing in the game. As Sarah reviewed her gameplay, she noticed that the intensity of the baby’s cries changed even in the tutorial. As Sarah pointed out, “Now it is a little bit quieter because [I] got that one right.” The baby crying also provided feedback for Austin who remarked that he thought to himself, “Um, the crying baby, like…It kinda made noise and when it did noise, I was kinda thinking to myself that ‘oh, I’m doing really… I need to like do better.'" Andrea remarked on the crying baby, saying that she thought she needed to "do better…cause they're going to come! [laughing]". Leah again explained her connection to the character of the baby, saying, "Um, since I was the person playing and clicking the keys, I felt like the baby crying was my fault if I didn't correctly press the keys, I kind of felt burdened."

I don't quite recall hearing much from the mother as I played. I think I heard her a little but then her voice got lost amongst the other sounds.

Although most of the participants remembered hearing the baby as they played, and used the baby's cries as feedback during play, Andrea, Gabriel and Sarah didn't remember hearing the voice of the mother. Sarah remarked, "I don't recall hearing anything from the mother to tell you the truth." Furthermore, Sarah also confused hearing singing in the game with what she took to be background music: "So is the singing supposed to be coming from the mother? I thought that it was just like a sound track kind of like a song playing, was it changing?" Likewise, when I explained to Gabriel that the voice singing in the game came from the mother, Gabriel responded, "Oh wow… Oh so that singing is sort of like at the foreground because it's using the baby…I feel like at times I remember hearing it but just you just, uh — you're — you kind of mute everything out in anticipation of hearing that soldier's next yelling of commands." Thus, as Andrea pointed out, "Because I felt like there was one point like I heard her and then it kind of got, lost in all the other songs." Thus, the mother's singing was buried amidst the other sounds in the game.

I remember the mother singing. Her singing is like a lullaby to her baby to stay quiet so that the soldiers don't hear you, but at some point she stopped.

In contrast, Austin, Donna and Leah all remember hearing the mother singing. In fact, for Donna the mother and her singing were salient components of her play. For Donna, “The best moment for me is that, the — the woman is singing. She is the hero of it, whether I’m identifying with her or not, I do like her. And hearing her singing was one of my favorite things.” Donna also noticed that the mother’s singing stopped: “…[the point of the game] it’s about her singing, and she stopped singing.” She continued to reflect on the character of the mother saying, “what surprises me about this is how little anger there is in this person that I’m observing. I’m outside of here but amazed that what’s, what’s on her mind is ‘stay the course’ and ‘keep singing’ you know just keep swimming…” Leah also noticed that the mother was at one point singing but stopped. Austin, like Donna, also equated the mother’s singing to a lullaby, which served as important part of the game experience. As Austin explained, “so I assumed the point is you’re… You’re trying to get your baby… You’ll singing her – Your baby, him or her, a lullaby to like stay quiet so that the soldiers don’t hear you and kill you.” Furthermore, Austin also equated the piano music in the game to a lullaby, saying, “Just, I think, ‘cause the piano of the game, kind of correlate to a lullaby and so, her singing is kinda like… It is the mother singing to the child.”

Towards the end of the game, I thought I was losing because I heard the baby's crying get worse. Other times I knew I was losing because I heard crying, the soldiers kept getting closer and then there was gunfire that I knew was meant for me, and I was like, oh crap!

Everyone except for Donna described how the sounds they heard made them think that they were losing in the game towards the end of game—whether or not they actually won or lost. As Sarah explained, "I was not sure if I had won though because the baby was crying, I thought that it seemed like a very loud cry to me, you know like—I would have heard that!" Gabriel, who also won the game said:

> The more you're messing up the more you're causing harm and it's all through that sound because the baby is going crazy…the baby is screaming is, you know, kind of like it correlates to how badly you're doing so you're causing the baby unrest. And then you're putting both of them at risk of dying and then, then, you know, the baby just gets worse and worse…And then a guy comes in and then you just hear that loud gunfire and you know that gun fire was meant not for those other people in the background. It's meant for you and that's it.

What Gabriel described is the sequence of events that unfold as Hush plays. Even though Gabriel was winning, the sounds that he heard while he played, such as the sound of gun fire, conveyed to him that he was losing the game, when in reality he was winning. Andrea also described sounds that she thought "…sounded like super close to your ear and so I thought I was losing I was like Crap! like that wasn't me like I just died [laughing] but then like you kept going…" Conversely, Austin, who did actually lose the game, described hearing "Actually that um, I only heard the gunshot in my left ear at that time and right before it, like I think I heard the mom gasp," — sounds which are a precursor to losing the game. For Austin, the mother's gasp was memorable: "that gasp was really like noticeable and like, it really adds on to like… I don't know. That 'Oh no' kind of feel."

As I play, I can hear that the sound escalates as things outside are getting worse. I go from hearing soft piano music and the baby being calm to gunshots that get louder, people being tortured or killed and the baby crying very loudly.

It was clear to all of the participants that the sounds they heard conveyed a sense of the environment outside and that the sounds changed over time. Sarah reflected on the quieter moments in the game, saying, "So the quiet definitely, you know, let's you know that you are in a different phase of the game, that you—and so now it's setting the scene like where are you, what is going on." Gabriel took this description a step farther, first by describing the piano music and baby crying at the beginning of the game, followed by the "sound of the soldiers and you're like okay this is getting bad. I don't know that it could get much worse. And then just the sound of blades and throats being slashed, like oh wow." Andrea and Donna both described these changes as an escalation. According to Andrea, "Yeah, because I thought that, I died just because — the fact that, like the sounds kept escalating and escalating? I felt like I was doing bad. Like the closer I got, I felt like that's — its alike an indication that I wasn't doing well." Similarly, Donna reflected, "The story — the sound is communicating some, I can hear an escalation, I hear things outside are getting worse."

As I played, I felt responsible for this child. I know my actions are going to affect this child crying. Regardless of whether I felt like I was playing the mother, I felt like the baby crying was my fault and that I needed to do better because the soldiers are going to come!

Except for Donna, all of the participants discussed how they felt that the baby crying was their fault. As Sarah described it, "it becomes pretty clear at that point that you are responsible for this child." Gabriel elaborated on this notion, saying, "And you feel responsible for the killing and you feel like you're going to be responsible for the death of you and your child. You know what I mean?" Likewise, when I asked Andrea whether she felt as if she were a part of the game, she responded emphatically, "Ohh, yeah! I felt like I was a lady like umh with a child." Like Andrea, Leah also shared the sentiment that she was responsible for the child in the game and explained it as, "Um, like there is a sense of danger, um for the mom and the kid and I felt like I was the person that was responsible for keeping that child from crying and…not getting caught by the people that are trying to harm them."

The mom is in danger.

Hush presents players with an environment in which it asks players to play the role of a mother who is protecting her child. Not every participant identified as the mother; however most of the participants (save for Austin and Sarah) explicitly described that they thought the mother was in danger in the game. Interestingly, although Donna described in vivid detail how she did not identify as the mother while playing the game, she still described empathy for the character's situation. As Donna mentioned, she had, "an intuitive sense that she's got to keep going. She can't stop, she can't let up." Leah also described a "sense of danger, um for the mom and the kid" that pressured her as she played. Andrea took this a step farther and described how she thought this sense of danger extended to her family saying, "I was like, my family was dying or something…I wasn't in there like, like I was in like…some house or whatever like, with a bunch of my family I guess and then like I died and they are like killing everyone else and I was like oh."

When I played with sound, I felt like I was a lonely mother with a helpless child. When I heard her cry I thought it was me.

As with the previous two constituents, people reflected on their identification with the mother and child in Hush. Andrea, Austin, Gabriel and Leah all elaborated on how they identified as the mother in the game. As Gabriel described, Hush "is a game where I'm just trying to get the baby to shut up…I'm trying to like get it to be quiet. [like] shh, hey like we don't want to die!" When I asked Austin whether he was playing as the mother or just playing the character, he responded, "I was the mother, the first time through." For Andrea, she felt, "I was a lady like umh with a child." And she described in detail how she identified as the mother. Andrea elaborated by saying, "You know, almost like they are cry-ing. Like I thought that was *mee*, but I guess it wasn't," to which I responded, “you mean the crying of the baby” and to which she responded, “No, like the crying of the woman.”

This game was really heavy and was absolutely an intense experience. There was a lot of chaos around me, with the sounds of blades, and of throats being slashed. The sounds made the game feel sad.

Everyone except for Donna described the ways in which Hush was an intense experience of play. As Sarah put it after winning the game, “That’s intense! [laughing emphatically]… this definitely puts you more into the moment of like okay, I need to be very, very quiet and calm, while this, you know very, aggressive and stressful event is taking place around me.” Gabriel described what he heard as sounds became more intense: “Sound of the soldiers and you’re like okay this is getting bad. I don’t know that it could get much worse. And then just the sound of blades and throats being slashed, like oh wow.” After Austin won the game, he remarked in a subdued tone, “Like the game was like really heavy, like…” He also shared that what he took away from his experience was “Just the feeling of like sadness and that’s what I’m taking away from it. Just sadness…” For Andrea, the voice acting added to her experience and it “…just made you feel it was more personal I guess and more and more emotional.” Leah described the sound as “disturbing” saying, “it was just chaos…Ah there was a lot of killing and then I imagine[d] there will be a lot of blood.”

This game was a mind trip, and made me feel anxious and sometimes scared. The game was disturbing because some of the sounds I heard were horrifying, brutal and violent. My sense of fear and hiding mostly came from the sound.

Not only did people describe their experiences of playing Hush as something intense, everyone except for Donna described that the game made them feel anxious or scared. Furthermore, the sounds they heard created this anxiety. By far, this constituent represented the largest number of participant descriptions than any other constituent, and comprised a cluster of 54 meaning units. I have thus elaborated the descriptions in this section to provide greater detail.

At the beginning of the game, when I turned on the sound for her to listen to her play of the game, Sarah pursed her lips immediately as she heard the sounds of soldiers killing and slicing. When I asked Sarah about whether the narration she heard in the game amped up her play, she elaborated, "Absolutely, because it just like…it adds pressure, you know, absolutely, that was definitely a pressure of like, okay if I don't stay calm something bad is gonna happen." To Sarah, the sounds seemed like "emotionally jarring noises. It was a little hard to stay in that calm place of like allowing that flow." Gabriel annotated his experience of the game as he played. Because he is the only person who voiced his experience as he was having it, I have included a condensed transcript of his play to illustrate the structure of his experience of feeling anxious while playing the game.

> Good God. [Gabriel smiles and raises his eyebrows as he says this with feeling and emphasis as he completes the tutorial in Hush] [Pause for 15

> seconds.] This is unbelievable. [Laughs] Aw crap. [Gabriel cringes throughout the game as he plays] [missing letters in the game and pausing for 20 seconds…] This baby needs to shut up or we're in trouble. [Pause for 31 seconds.] Damn it. [muttering, leans his head back, closes eyes momentarily [Pause for 35 seconds.] Aw fuck. [his voice dipping, he cringes again, abruptly laughing and shaking his head] How's the baby supposed to be calm if there's gunfire? [Laughs] [Pause for 1 minute 34 seconds.] Oh you gotta be shitting me. [exasperated]

Immediately following his play, Gabriel censored himself as he described his experience, "All right. Censoring myself—that was a mind trip, alright? I, I want to say something else but like…"

Although Austin remained quiet as he played, he was also moved by the experience. As he reflected afterward, "Because I'm just like scared because I feel like I don't know how many notes I can miss and so… Uh, I'm afraid that like… That… That they'll like just find me. Is there an option like can they actually find you and like…Kill you?...Um, it was just… I got really like…scared playing, playing through it." Similarly, Andrea also remained quiet as she played, however she was also moved by the experience, saying, "It made me feel more like ner-vous I guess because it was like oh! like I don't know it just made me feel like — like that was the sound that got to me the most is that I was like, I was like oh…" Leah described feeling disturbed by the game, "Because it's like very brutal and violent. Um it was more difficult [with sound], because I hate those sounds; I don't think they should ever be heard."

When I played without sound, this game was totally different. I didn't feel like I was a part of the game, and at times didn't even want to play it. I had no way to know that there was any danger at all in the game. I didn't feel anxious or stressed. Sometimes it was easier for me to get the letters right, but I think not having sound can ruin this game.

I asked every participant to play Hush without sound immediately after playing it with sound. One reason that I did this was that the game took only about five minutes to play. However, I also knew that Hush's core mechanic relied on typing letters with a specific timing. Because this mechanic relied on physical dexterity, I felt it necessary for people to attempt to play the game without sound, instead of either listening to the game without sound, or imagining their play without sound. As a result, there was unanimous agreement among participants that without sound, playing Hush was a markedly different experience. Even Donna, who had previously described a lack of connection to the game, noted that there was a lack of peril in the game when she played without sound. Playing without sound was also not as distracting. Although Sarah had previously described having difficulty in maintaining her concentration with the sound, when I asked her about playing Hush without sound, she remarked, "I wasn't distracted like by I mean, it's very quiet. I just focus on the actual… and I noticed the visual intensity of the letters more." Likewise, Leah also found herself focusing on the letters, saying, "So without the sound there is like no factor that made me stress, so I was just focusing on the letters." Austin also elaborated on his experience, saying, "[the] second time through [without sound], like I wouldn't even know…that… My life was…In danger, I wouldn't even know."

Andrea also described a lack of anxiety, saying, "…I guess I didn't feel that rush that I needed, like I didn't really feel like as — I don't know like I was really like yeah like I was like trying to get the letters and stuff, but I wasn't really like I didn't feel nervous or anxious or anything."

Without sound, it felt like I was playing a strange typing program or a spelling game for a kindergartner. I was paying more attention to the pictures, and when I missed a letter it was like, oh it's red. Oops.

When people described playing the game without sound, all of the participants except for Sarah characterized their experience of playing the game as more of a typing oriented program or a program in which they placed more emphasis on the visuals. As Donna put it, "What a strange typing program." Austin actually asked whether he could stop playing the game without sound. When I asked why, he explained, "It's just so… I feel like I'm playing a… A spelling game for a…for like a Kindergartener, [laughs]." For Austin, when he missed letters as he played without sound, he noticed that "Oh it's red, oops." Austin also explained, "as soon as you take away like the sound element, the game is completely ruined."

Andrea also described her play without sound saying, "Yeah, because I guess like at this point, I was just more like — it just seemed more like a typing game rather than a game like in-context." Leah and Andrea also described focusing more on the visuals when they played without sound. As Andrea explained, "I definitely noticed some visuals stuff that I didn't really notice before like there were some, it was like a picture of like kids hugging or something? like I noticed that was like oh, that wasn't there the first time."

The sound is setting the scene and tells you where you are and what's going on. The sound mostly seemed authentic to me, like it was pulled from that part of the world. At times I felt immersed in the scene and engaged in the game.

All of the participants except for Donna described the ways in which Hush provided a sense of the environment for the game. For some people, the sounds they heard seemed to be authentic. As Sarah described it, "…it's setting the scene like where are you, what is going on." As Gabriel described, he understood what the game was about when "you know, when you hear those footsteps, when you hear the sound of the soldier outside it's like, you know. It's kind of like that multi playing sort of sound where it's like you know the sound closest to you is like your baby is right here. Outside in the distance is the soldier. You hear those footsteps. Every time you hear the sound of like, you know, footsteps in, you know, in rhythm, heavy footsteps you know that's you know kind of synonymous with marching and soldiers." Similarly, Leah also recalled hearing "…there are people screaming…Probably when they were being killed." As Austin reflected on the game, he described how making the game 3-D could make it more immersive. However, he was able to maintain a sense of the game's environment without a 3-D interface. According to Austin, "I can easily just imagine one from… From, from the visual. You… Just from the visual, I'm imagining myself in a corner of a ca… A wooden cabin." Andrea also explained this experience similarly, saying, "'cuz you kind of feel like, like those like sound effects you feel like you are in – in…like the house or wherever in that area."

I was mainly focusing on the sound while I played. I think the visuals were the supporting actors in Hush. They didn't contribute that much and often got buried by the sound.

All of the participants except for Donna described the ways in which the visuals seemed to get lost in the experience of play. Sarah explained that the visuals to her seemed "really subtle," but that the image of the woman on the screen helped to support her play and "kind of you know it reinforces that, okay—I must stay calm, I must stay calm." According to Austin, he "barely noticed" visuals and Leah thought they "registered" even if they didn't "[make] a big impact" to her play. She explained this as the visuals "kind of got buried by the sound." Gabriel summed up this idea when he reflected on the game as a whole, saying, "I feel like the pictures were sort of the supporting actors in this and it was really the sound. And you look at, you look at this picture for a brief moment but really the sound was doing everything. So you want to give — put all your attention into the sound and then also the letters because the letters were impacting the sound which was driving the whole story."

The piano music in Hush really sets the mood of the game. It's pristine, peaceful, innocent and is sometimes reminiscent of a lullaby.

All of the participants except for Donna commented on the piano music present in Hush. Austin, a self-described piano player, described the music as, "It's just kind of beautiful music. That's like peaceful…[you] would enjoy every note, but then at this point, it's like, just sad, like kinda…'Remember those who've fallen', kind of deal." For Gabriel, the piano music was "You know that piano music is like classic you know 'new life is born' type music. The kind of innocent piano music." He also felt that the music "might have been one of the few things keeping me sane in the frustrating timing and the baby crying." Leah felt that the music "really draws sympathy," while Austin described in detail how the music to him was reminiscent of a lullaby, saying, "…the piano of the game, kind of correlate to a lullaby and so, her singing is kinda like… It is the mother singing to the child…The piano is like kinda like a lullaby…For the baby."

When I played Hush and won, I didn't hear music at the end. The end of the game feels empty and unfinished. Why are they leaving me hanging like this?

During the process of conducting the interviews for Hush, I learned that there was a bug that periodically occurred in the game. The bug prevented people who won the game from hearing the piano music at the end of the game. The piano music was the same music that played during the introduction to the game. Andrea, Gabriel and Sarah noticed that music didn't play at the end of the game. As Sarah, who discovered the bug, reflected, "Well it just stops, right. So there is definitely that moment of hesitation, like—is the game over? I was not sure if I had won though because the baby was crying…" Gabriel also felt that there was a lack of closure. As he pointed out, "So I feel like the entire time it's just loud, powerful impactful sound…And I feel like right there it's just it's dead quiet. It's just feels like, it feels like a gap. It feels like it's unfinished." Similarly, although Andrea eventually figured out that she had won the game, she noticed the absence of the music, saying, "I was kind of confused. I was like, I was like um… it felt…at this point I thought it was like before the description came up, I felt like — it was kind of, they are just going to leave me hanging like this?"

Imaginative Variation

As was the case for FOTW, the following text is the imaginative variation that I wrote for Hush, to contextualize my impressions of the constituents of meaning.

The screen fades to black, and a pristine lullaby begins to play on a piano. A baby softly chatters. New life has, indeed, been born. Letters fade up on the screen introducing the participants to Lilliane. For some people, themselves as player and Lilliane as character are one in the same. The baby crying is often their own child. Instructions fade in, telling them what to do. It may take a moment for them to figure out what to do. *Typing? Did they want me to type? Why is it so hard to type?* They can almost press the letter at the right time, *when it shines bright*…but no. They all have trouble with this. The tutorial is timed and can't be skipped. Everyone who plays thinks this game is hard. What no one knows when they play the tutorial is just *how much more difficult* this experience is going to be. The piano repeats its melody. Finally they get the timing of the letters right and they see *Hush. Child. Hush. Everything will be fine,* fade in on a black screen. The letters then start to fall in calm, slow lines and a voice, presumably that of a military commander abruptly comes on screen tells them that the extermination is about to begin, *sweep them out of the country…because there is no refuge, no refuge then*.

The players all get through this introduction, some needing more practice to get used to the interface. They listen to the disturbing narration and hear themselves being immersed in a war torn environment. *Were there visuals on the screen? What were they?*

Were those soldiers? It was hard to tell since the visuals were swallowed by the sound. The scene and the story then began to unfold, and with the story, comes the sound. *The mother is singing, or did she sing at all? Was the mother even in the game or was she just a shape on the screen?* It's memorable for some but to others her lilting voice fades, overcome by the scene. The footsteps of soldiers and their nondescript chatter creep closer to Lilliane and her child. Still the players type to an uncertain rhythm; the sounds making it difficult to concentrate. *Aw Fuck…you gotta be shitting me…*echoes of frustration as the baby is no longer talking, no longer calm. She is crying. The footsteps are getting closer, and for some louder. There are gunshots. The baby is wailing, and these people know with a near certainty that their baby is about to die. One last burst of gunfire and many of them finally *do* die. Those gunshots were meant for them.

For the lucky few who figure out how to work the timing of the letters, despite the cacophony of the scene, they are treated to a brutal scene. People around them are getting sliced, by the sound of it. They hear the impact made by the blade, the screams of the dying; and still the baby wails. *Did they miss the letter? That white letter on the white background is very hard to see.* They win the game but that was *heavy*, and for most everyone, an intense experience that made them feel anxious. They were, after all trying to save the mother and the child—and for many, themselves and their child. For those that made it to the end, what happened to the music, *why did they leave people hanging like this*, *with no music to give an end to this story? Why didn't that melancholy lullaby play again?* Regardless this was a powerful game, thanks to the sound. Hush screams a powerful message with *powerful, impactful sound*. Even if they were among the few who didn't feel the emotion it evoked, the sound places them in the scene and makes them think of the larger picture; of the tragedy of genocide that framed their experience.

Salamander Rescue

CLUSTERS OF MEANING

As with Fate of the World and Hush, I organized meaning units into related clusters. By doing so, I took the 612 meaning units that I found for SR and organized them into 98 initial clusters of meaning. These grouped clusters represented related categories of meaning. Examples of the clusters for *SR* include:

- Playing without sound is doable but less fun
- if you're gonna do like a contrast between spaces maybe change up the sound
- the characters in SR should have sound
- More objects in SR need to have sound
- I'm noticing that sound in SR is directional, and that is sometimes useful to me

As with Fate of the World and Hush, meaning unit clusters with less than three participants were grouped with other clusters when possible, or were otherwise eliminated. Clusters were also expanded if needed to provide perspective on the data. As was the case for the other games in this study, clusters were left intact if they conveyed a clear perspective on a constituent of meaning.

CONSTITUENTS OF MEANING

After I grouped clusters of meaning into constituents of meaning, I derived 27 constituents of meaning from the initial clusters of meaning in SR. The complete list of constituents can be found in Table 5.

Table 5. Constituents of Meaning in Salamander Rescue

Number	***Constituent of meaning***
1	Different sounds in different locations in the game stood out to me, and included things like walking on the bridge, hearing a Doppler effect and bubbling in the lab and hearing footsteps, bird sounds, and the sounds of the bridge outside.
2	There was very little difference between what I heard in the lab and what I heard when I went outside. I wish I heard something like a door sound to convey that I exited a building.
3	The sounds I hear let me know that there’s an environment around me and typically immerses me in that environment. I get to move around outside, walk on different surfaces and go Swish! when I jump in the water. All of this gives me an experience that isn’t artificial and makes it more imaginable that you’re walking on an island.
4	I'm noticing that sound in SR is directional, and that is sometimes useful to me, and other times it’s pretty cool. I’m also sometimes looking for what is making the sound and what direction the sound is pointing me in.

Table 5 (continued)

Number	***Constituent of meaning***
5	The interface sounds that I heard when I clicked on things like the iPad or when I picked things up or interacted with characters were helpful and provided me with reinforcement as I played.
6	Sounds like the gurgling of the tank, the whirring of the computer or the sounds in the iPad were neutral and are fine, but I don't think they did much for me. That said, I think that some things can be better with sound just because you have something there.
7	I liked the background music that I heard while playing SR. I thought it was cool and was just right for this game. It also added to the overall enjoyment of the game. It also somewhat helped me think as I played.
8	The music that I heard when I played SR is just kind of there. It's ambient, in the background, and is also calming.
9	Music makes playing SR more engrossing. Music helps me to slow me down and be immersed as I play the game. The music is inquisitive and sounds like it's picking your brain. It helps to keep me going.
10	The sounds that I hear are doing what I expect them to do. When I'm walking I've got footsteps. When I see a fish tank I hear bubbles, when I used an interface it went flop and click.

Table 5 (continued)

Number	***Constituent of meaning***
11	The sound that I hear when I pick up objects like coconuts is somewhat ambiguous. It doesn't actually tell me that I'm picking something up. Although it sounds like rustling or like I'm putting something in a bag, it also sounds grass-like or even like munching.
12	The sounds and visuals need to match, even if they don't match up in SR now. Some examples include giving me a jump sound when I jump and making the snakes hiss. But I liked having bubbly water sounds for the tank and creaking when I walked across the bridge.
13	You don't really notice sound sometimes because it's either faint or you're puttering around. But I sometimes noticed when part of the sound cut out on me as I played.
14	Sound makes me feel like I'm actually doing something because I'm interacting with, bumping into, walking on, or clicking on things.
15	When I'm outside exploring, I want to see how interactive and engaging is the game. Sometimes this means walking on the path so that I can hear it crunch or jumping in the water to see if I splash. In fact, if I can interact with it, I like for it to have sound.
16	More objects in SR, like the well and the iPad need to have sound. Generally, these include things that I might be able to interact with in the environment.
17	It would have been good to have actual dialogue.

Table 5 (continued)

Number	***Constituent of meaning***
18	The characters I meet in SR should have sound. This goes for all the scientists and is somewhat true for the salamanders as well. Furthermore, if you have different spaces for the characters, then you should for the most part have different sounds to identify each one.
19	The music that I heard in the introduction of SR was more relaxing that I expected it to be for a rescue game. Furthermore the narrator who spoke to me in the intro about the salamanders dying had a neutral tone of voice and not very enthusiastic. The music and the narration both lacked a sense of urgency about the seriousness of the game.
20	The music I heard at the end when I lost made me feel like I messed up and failed.
21	The music I heard when I lost doesn't make me feel like I failed. It didn't sound that different from the background music and it sounded a little like music that could be used to give a hint at an answer.
22	The music that I hear puts me into the environment of SR. The music has a natural, tropical and even aquatic feel that matched the island that I'm on.

Table 5 (continued)

Number	***Constituent of meaning***
23	I would have wanted sound to provide me with more cues and prompts as I played. Music could have helped me to find things, the iPad could've had notification sounds, different sounds might have helped me know how to work the water tank and different prompts might have helped with dialogue and keeping track of the salamander count.
24	Playing without sound in SR is doable but is less fun. Sounds like clicks for the iPad, splashing in the water or music at the end make the game seem more fun.
25	As I play without sound, SR feels less real and dry to me. At times, it seems like the silence is deafening when I can't hear things like the iPad, water tank, or music when I win.
26	Playing without sound is less engaging and at times, boring. In fact, sometimes I just want to read, do what they want, and blow through the experience.
27	When you play without sound, you don't know if what you do will have an effect. I wouldn't be as sure that I had done something or if I what I did was effective.

Textural-Structural Description

Following the format for the analysis in FOTW and Hush, I present a textural-structural description to illustrate each constituent of meaning derived from participant descriptions of Salamander Rescue. As in the previous analysis for FOTW and Hush, I have matched each constituent with quotes from the text and descriptions of non-verbal responses taken from the video recordings to highlight and illustrate the meaning of each constituent.

Different sounds in different locations in the game stood out to me, and included things like walking on the bridge, hearing a Doppler effect, and bubbling in the lab and hearing footsteps, bird sounds, and the sounds of the bridge outside.

All of the participants described hearing sounds in the outdoor environment of SR that stood out to them. Gabriel described what he vividly recalled about the environmental sound in SR, saying, "yeah, I was like, would there be a plane on this island? And I was like, no it's just the sound of wind blowing by and I remember it blowing by a little bit more then I never heard it after that…I just remember like between that like you walk around, you got the Doppler effect which is cool and you are walking through the water, you are walking on the bridge." Donna was also descriptive of the ways that the sound both stood out and the ways in which she was using it to navigate, saying, "I… I use [sound I hear] as a pneumonic like when I'm walking over the bridge. Planks on ground plus walking on wood. I'm using as a mnemonic for—where is the trail? That seals in my mind where the trail is." Other participants remarked on noticing sounds like walking on planks, hearing bird sounds, walking on the bridge, or the sounds of the water. Leah and Sarah also remarked that they remembered the background music of the game.

There was very little difference between what I heard in the lab and what I heard when I went outside. I wish I heard something like a door sound to convey that I exited a building.

Even as all participants remembered hearing sounds in the environment of SR, Austin, Donna, and Leah remarked on hearing less of a distinction between the indoor environment of either the lab environment or the hunter's house and the outdoor space. All three of these people remarked that what was missing was a transition between the indoor and outdoor space. As Donna explained she needed to hear "Um, um, uh something to identify the place I had come from. If… If there had been a bell…Hanging outside the door and every time you enter or leave that location,…" Likewise, when Austin reflected on the sound at the hunter's house, he said, "…maybe there could have been a door that you can open and it creaks open… it doesn't feel like a house because it doesn't have I guess a door." Similarly Leah mentioned, "Umm, I felt the transition is really like, the transition is very subtle so you couldn't really tell…maybe like when you — or you could have like a door when you actually exit the door is like a different sound."

The sounds I hear let me know that there's an environment around me and typically immerses me in that environment. I get to move around outside, walk on different surfaces and go Swish! when I jump in the water. All of this gives me an experience that isn't artificial and makes it more imaginable that you're walking on an island.

All of the participants described the ways in which the sounds they heard provided a sense of the environment that they inhabited. As Sarah described about the sound in the lab, "it wasn't like overwhelming or whatever, it was just kind of like okay, that's just the environment I'm in." After she moved outside of the lab to talk with the scientists, she elaborated, while moving both hands around her head, "just gets you more into the game, you know, you have all the little sounds, the environment, rustling around you…" Gabriel described explained that hearing the sounds around him "…makes the difference it makes that much more genuine so it doesn't feel like just an artificial experience…that you just kind of forced to interact with because you know you have a job to do…like the sound of the draw bridge as you're walking over and you hear all the creaking sounds." As Austin put it, "Okay so with sound, it — you get the feeling of immersion in the environment." Andrea echoed a similar sentiment: "overall like it was really good like you really had a good feel of the environment and just like interacting with things...like the water and the bridge and stuff …little things like tell you made a difference like it—kind of let you know that you are in a different environment."

I'm noticing that sound in SR is directional, and that is sometimes useful to me, and other times it's pretty cool. I'm also sometimes looking for what is making the sound and what direction the sound is pointing me in.

All of the participants, except for Leah and Austin, mentioned that they thought the sound conveyed a sense of direction to them as they played, even if the sound was not expressly designed to do that. Sarah briefly believed that the music she heard provided her with a way to orient herself on the island. Sarah reflected, as she laughed loudly, "I actually was thinking for a brief moment when I was looking for the last mushroom that the music would help guide me where the mushroom was and it did not!" Sarah thought this feature might be helpful, saying, "I mean if the music got louder as I was getting closer to something that I was supposed to interact with or supposed to be collecting that would be awesome…" Gabriel thought that this sense of direction was present through the sound in the lab environment. He explained this as a Doppler effect as he was turning around the lab space, saying, "I think it helps kind of with the positioning like when you move around then and it's like sounds here, so something over here's making sound and something over there is…so it's just its like that spatial awareness." Donna also described that sound was directional when she was in the lab, and spent some time searching for the source of a sound that she heard. When she described the sound in the environment, she also described using sound in ways that helped her to navigate. According to Donna, "I… I use [sound] as a mnemonic like when I'm walking over the bridge…Planks on ground plus walking on wood. I'm using as a mnemonic for—where is the trail? That seals in my mind where the trail is."

The interface sounds that I heard when I clicked on things like the iPad or when I picked things up or interacted with characters were helpful and provided me with reinforcement as I played.

Everyone who played SR commented on the sounds they heard when they used the iPad or clicked the dialogue boxes when interacting with the characters in the game. As was the case with the constituents used to describe the interface in FOTW, participants like Sarah also described how the interface sounds were helpful, saying, "I mean… like I mentioned before in other interviews that I like it when you know, when I click on something I'm getting the feedback that I did register my click and…Yeah, so I definitely noticed that. Like Leah, Gabriel also thought the interface sound was "…like positive reinforcement like yeah you know 'keep clicking it's—keep clicking because you have to get feedback each time so it encourages the feedback through the popping and clicking and all that." As Donna explained, "They're just what that I expect….And click and it goes flop, click…"

Sounds like the gurgling of the tank, the whirring of the computer, or the sounds in the iPad were neutral and are fine, but I don't think they did much for me. That said, I think that some things can be better with sound just because you have something there.

Even as everyone described how the interface sounds were helpful to them, people like Austin described many of the sounds as "pleasant neutral sounds..." As Austin explained, "They're just kind of there to make the game feel more like the game….Versus just it being a task…" As Andrea mentioned when she was asked about the sound, “Like it’s actually better I think ‘cuz it’s kind of like what I was saying about the dialogue boxes just kind of having just something there.” Gabriel explained that when he used the water tester in the lab, “I mean, this thing here is like you know, you don’t really notice so much when the sound is on…” He went on to describe the difference in his play in moving the slider on the water tester to the right number, with and without sound saying, “…And if you miss even a little bit [moving the slider without sound], it’s almost like an annoyance, like I goofed up and I went too far up on the slider. [Whereas] before [when I heard sound] and it’s like, oh, I goofed up, but they got this sweet sound, it was like — so yeah, personally I like — I like a lot of sound and feedback when I’m doing something…”

I liked the background music that I heard while playing SR. I thought it was cool and was just right for this game. It also added to the overall enjoyment of the game. It also somewhat helped me think as I played.

All of the participants except for Leah and Andrea remarked on the music that they heard in the background as they played the game. Donna thought the music she heard fit what the game she was playing, saying that it was “just calming music…I thought it was just right.” When Sarah reflected on whether or not having music would have affected her play, she said, “I would definitely…[without music] I would not be as engaged in the game. I think that the music brings a lot to just how you are — you know um — your — just overall enjoyment of what you’re doing…I still think that the music is definitely kind of the, you know cherry on top, [Laughing] you know.” Specifically, Sarah mentioned that the music heard in the background helped to provide her with something to "listen to while you're travelling from point A to point B" between different parts of the game, like "travelling music, you know." Gabriel went a step farther and described how the music engaged him as he played the game saying, "I think the music was really good because it was like it paced me and it was also kind of like inquisitive music, it's smart music. Um, so you know, it makes you stop and think and read everything."

The music that I heard when I played SR is just kind of there. It's ambient, in the background, and is also calming.

Nearly everyone (except for Leah) mentioned that the music they heard in SR was in background as they played. According to Austin, at the beginning of the game, "I noticed it the like title screen I noticed that music's more…but the music in game, it was just kind of ambient so I was more focused on the objective." For Sarah, the music that she heard did not stand out to her, saying, "…I mean [it's] just kind of background music, you know." Like Andrea pointed out, "it's just kind of there…it's actually like it's actually pretty like soothing I guess just to have something there."

Music makes playing SR more engrossing. Music helps me to slow me down and be immersed as I play the game. The music is inquisitive and sounds like it's picking your brain. It helps to keep me going.

Gabriel and Sarah reflected on the background music of SR and described how the music affected their play of the game. Even though only two people provided feedback about how the music affected their play, I have chosen to include them in this constituent because the idea that the background music could affect the way these people thought about the game is compelling. According to Sarah, “the music is, you know, it sets the mood I think for the game…having music there kind of you know, keeps you going and kind of, you know keeps the action moving forward.” Furthermore, playing the game without music was “not as fun…[as]…when there is, you know as when there is music to accompany [the game].” Gabriel described the music as “picking your brain music” and thus was similar to the background in FOTW in supporting his ability to think. According to Gabriel, he felt that “the ambient music for me made me really slow down in this game. And it made me want to sit and read more of how I was doing…”

The sounds that I hear are doing what I expect them to do. When I’m walking I’ve got footsteps. When I see a fish tank I hear bubbles, when I used an interface it went flop and click.

Everyone except for Sarah expressed how the game in some way met their expectations for how things were supposed to sound. In describing the sounds made by the fish tank, I asked Donna if the bubbling sound made by the tank matched what she expected to hear and she responded, “Yeah…Uh, I’d like looking at the 3-D salamander in the tank, little knowing…That I would soon be called upon to torture them! [laughs hard].” When I continued to ask her about the sounds at the tank, which included using the buttons and lever to operate the machine, she remarked, “Oh, that was… I was admiring that. I thought that was beautiful…Totally, this is totally working for me.” As Austin reflected, “Oh clicky. [Laughter] I guess the clicks can help you like if you can’t visually see it, you can hear that you are going up by a step each sound with each click. It actually kind of helps um but other than that it’s a neutral sound.” Similarly, when Leah described the beeps of the interface sounds in SR, she mentioned that those sounds were similar in function to the interface sounds in FOTW, saying, “It reminds me of FOTW. It’s like a lot of games are like that…Like when you clicked on something, it led you to something else…It was good because it gave you more data and info of what you’re supposed to do.”

The sound that I hear when I pick up objects like coconuts is somewhat ambiguous. It doesn’t actually tell me that I’m picking something up. Although it sounds like rustling or like I’m putting something in a bag, it also sounds grass-like or even like munching.

All of the participants, except for Sarah and Leah, gave feedback about the sound they heard when they picked up objects in the game. Gabriel thought the sound was “…like putting it in your bag which that’s what it sounds like,” while Donna thought, “It was ambiguous…I was thinking the first thing was mushroom…[Donna mimes putting a mushroom in her mouth].” Yet, Donna also thought, “…You could have been putting it in the bag but I thought there was a munching sound.” Andrea also could not directly place the sound, saying, “I don’t know, it sound like some like rustling or something…” while Austin thought the pick-up sound was a little like “grass.” He also thought that the heard different pick-up sounds for different objects. Actually, the game only had one pick-up sound for all objects.

The sounds and visuals need to match, even if they don't match up in SR now. Some examples include giving me a jump sound when I jump and making the snakes hiss. But I liked having bubbly water sounds for the tank and creaking when I walked across the bridge.

All the participants, except for Sarah and Andrea, described different ways that SR could have chosen different sounds to match with what they saw on the screen. When Gabriel described the lack of sound in the room occupied by the character of the hunter, he remarked, "if you are a hunter and you're standing there like...if there is nothing in the room there is no reason to make any sounds…" When she described different sounds that could have been made while performing tests on the salamanders at the tank in the lab, Donna described wanting some type of visual and auditory cue that the salamanders were actually dying, saying, "And if [it] started doing that [the tank visually changing], and I started hearing salamanders going [ahk-ahk-ahk-ahk-ahk!]. I would definitely have known…[something was wrong]…Maybe a little faint, [meep-meep-meep-meep] of…Something endangering them." Furthermore, as Austin reflected on the sound that he heard at the screen where he learned he lost the game, he mentioned, "Well I noticed the green first and it kind of threw me off and then I was paying attention say— is this the same music and I noticed it wasn't the same music. And so…Well maybe because I won and I saw green and so I associate that winning with green…Then I hear the sound."

You don't really notice sound sometimes because it's either faint or you're puttering around. But I sometimes noticed when part of the sound cut out on me as I played.

All of the participants, except for Sarah, described that they didn't notice some sounds in SR. Sometimes this occurred because the noises were faint, sometimes they were engrossed in play, while at other times, the sound cut out when they played. Gabriel explained that he heard sound all the time when he played, but "…you don't notice it as much when you're just kind of puttering around." Similarly, when I asked Andrea about the sound of the tank in the lab, she responded, "…I don't know well…I'm not sure. I don't think it really made a difference because the sound is like light enough as it is or wasn't as loud. So I didn't really notice anything." Notably, Leah did notice sound associated with the narration and engaging with the dialogue text boxes when she began her play. However, her experience changed the more she continued to play: "it's just different when you go from the first like narration to the first person you talk to…it's like sound to no sound, but after a while you talk to like the third person. Or like fourth, like third person for the second time you kinda forget about that because you're thinking about finding the — awkwardly cuts out if you — Walk back on the land —As the sound is playing." Leah also noticed when sound cut out on her in the lab, saying, "I liked the sound, and then it stopped somewhere in between for a bit, and I noticed…"

Sound makes me feel like I'm actually doing something because I'm either interacting with, bumping into, walking on, or clicking on things.

All of the participants mentioned different ways in which sound affected their experience of interacting with the game. When I asked Sarah what play would be like without sound effects, she responded, “I still like sound effects though; I like to know that I’m actually affecting things in my environment.” Gabriel described an example of this interaction, saying, “If you click on stuff do you hear like pops and clicks and sound effects that coincide, and it’s cool cause like the iPad, like each time you click or press a button or do something on there you like, a little whish! or a little—clock!…a when you’re clicking through the prompts to talk to the different professors…you kind of get that same little sound it’s because you know sort of like confirmation of what you’re doing.”

Andrea described a similar experience, saying, “whenever you like have the little sound effects there and like you play with the amounts, it kind of makes you feel like you’re actually like doing something, actually like as opposed to like if nothing’s there and you don’t really know if what you're doing is like, I guess like effective.” When I asked Leah to use the water tank testing machine in the lab without sound and describe what was happening with her, she responded, “Lack of reinforcement…” whereas with the sound, operating the machine became a different experience, “like you hear the um the sounds change as you go from like different intervals, and I thought that was good, because if there was no sound it would just like be moving it…like for example, forward like you can hear a little click.”

When I'm outside exploring, I want to see how interactive and engaging the game is. Sometimes this means walking on the path so that I can hear it crunch or jumping in the water to see if I splash. In fact, if I can interact with it, I like for it to have sound.

As Gabriel pointed out, when he first starts to play a game, he pays attention to the degree of interactivity the game provides him, saying, "you want to see like how sensitive are the controls, how interactive is everything like is everything a sprite or is it an actual interactive element and with the sound you want to see like, is it just like some flat track that plays in the background?" Austin and Donna also mentioned testing the environment. When I asked Donna if she liked playing the game, she reflected, "It's really cute. [Laughs] Yeah, [I enjoyed playing it] uh I had to run out into the water and jump up and down to see if it would splash." Austin reflected on the sound as he played SR without sound and compared it to his experience in playing with sound. Said Austin, "When I'm just exploring the environment, with sound on, I'm really focused on the sound, but when the sound's off. I'm just kind of focused on like tryin' to jump on stuff." Donna explained her experience with interacting in the game with sound, saying, "For… For me, sound — Interacting to get sound, for me is something that I'll go out of my way to do deliberately like walking over…To the water and splashing. Or I see some kind of swamp…And I wanna walk on it to get the swamp, squishy noise." As I asked her to describe her experience as she moved around SR, she pointed out, "I'm mostly thinking about what can I interact with, like there's a well…."

More objects in SR, like the well and the iPad need to have sound. Generally, these include things that I might be able to interact with in the environment.

All of the participants, except for Sarah and Gabriel, indicated that more objects in SR needed to have more sound. Said Donna as she reflected on her first experiences wandering outside of the lab, "I'm mostly thinking about what can I interact with, like there's a well….And I didn't find anything to do with it. What? I was curious. Here, I'm walking up and…the first time I came up [to] this person, [noting the biologist] I didn't hear the walking on the boards." Austin had similar feedback about the well outside of the lab, saying, "Yeah, I think it would be actually pretty cool if I like walked out…even if it didn't have any purpose to the objective. If it say rolled the barrel up or rolled the bucket up with some water…If you know that sound it…like [would have been] pretty neat to hear that, and see that." When I asked him why, he said, "Just so I know I can interact with my environment."

Interestingly, even though Leah didn't mention anything about the well during the interview, as she was playing SR she clicked on the well, and after she didn't hear a response, she pursed her lips. Inside the lab, as Donna interacted with the water tank, she noted that the lack of an audible cue to let her know the salamanders were dying. As she put it, "Maybe a little faint, [meep-meep-meep-meep]" might have helped. Similarly, Austin had substantial feedback about different sounds that the iPad could have made, indicating that "Like maybe iPad could have been more digital….yeah, shuffle sounds." He also suggested having the iPad make the sound of "like fifty six kilobyte internet. Kilobit internet like 56 K it makes …Yeah like the phone line kind of sound."

It would have been good to have actual dialogue.

Half of the participants, Andrea, Austin, and Leah, thought the scientists in the game should have spoken to the player, instead of communicating through text prompts. Austin explained the need for the scientists to have voices, saying, "Um, I think if you were to like talk to the lab assistants you would have to go through voice acting. Um, but I guess if there was voice acting; it would make the voice in the beginning more normal, because that's the only voice throughout the whole game." Leah echoed this exact point, saying that the scientists should "Like actually say things…Because you already have your na — narration at the beginning so it's kind of like not equal. Because if you already have one, why not have everything like that." Andrea shared Austin and Leah's desire to have voice acting, but did not explain why.

The characters I meet in SR should have sound. This goes for all the scientists and is somewhat true for the salamanders as well. Furthermore, if you have different spaces for the characters, then you should for the most part have different sounds to identify each one.

Except for Sarah and Andrea, all of the participants felt that the scientist characters in the game should have had more sounds associated with them. Gabriel was very descriptive about this point and suggested that there should have been more sound in the house with the hunter scientist saying:

> Yeah, like you know, it's a small house like you know if there was like…assume if he's a hunter you would have like some birds in a bird

> cage, and the sound of them kind of chirping off in the distance…because I'm like…I'm thinking like when I go talk to him, he's not talking to me. And uh… like because none of the characters have a voice or anything and then it's like, okay we'll, what other sounds are there? There are no other sounds. Why are there no sounds in here, but there are sounds in the lab?

Donna also thought the hunter character needed more sound and gave extremely similar feedback as Gabriel about the need for bird noises playing near the hunter. Said Donna, "If there had been ambient sound with the characters, like you go to the hunter and the blue jays and… And sparrow noises are present, then I would associate, Oh, he's the man with the bird noises." Donna also wanted to hear sounds for the female environmentalist character: "Imagine that we have another character here, who's the hula girl. And when you walk up to her, you start hearing some Hawaiian music. Even though what she says might be something about salamanders. Right away, you have an identity for her." Leah described something similar but from the perspective of space. She thought that different spaces should have different sounds, such as "Like a Biologist should have a different sound, than like, a hunters place." Furthermore, she thought, "Like if you're gonna do like a contrast between spaces maybe change up the music [so] you will notice a difference?"

The music that I heard in the introduction of SR was more relaxing than I expected it to be for a rescue game. Furthermore the narrator who spoke to me in the intro about the salamanders dying had a neutral tone of voice and not very enthusiastic. The music and the narration both lacked a sense of urgency about the seriousness of the game.

Andrea, Austin, and Leah thought that the music that they heard in the introduction of SR lacked a sense of urgency about the seriousness of the game. The narration that explained the objective of the game was also delivered in a way that was monotone and thus incongruent with what they thought a rescue game should sound like. As Andrea pointed out about the narrator, "he's just kind of like *the salamanders are dying* [with a monotone to her voice] and then it's like, oh, okay like it didn't really seem like, it just seem like he was reading from a paper. So I just remember like from the beginning thinking that I was just kind of weird 'cuz he doesn't really sound like that into it?" Leah correctly guessed that I provided the voice of the narrator in SR. As Leah remarked during our discussion, "You should, like, use your emotions and feelings." According to Austin, the narration "…was neutral because I can't remember what you said and if it were impactful I would probably remember." Leah also thought the sound should convey more of a sense of urgency: "Not to — not an urgency to like play the game, but like more of an urgency to find stuff. And find the answers."

Andrea and Austin observed that the music during the opening of the game didn't match what they expected to hear. Said Andrea, "Umm, it just seemed like, I don't know it's just like 'happyish' music kind of not really like. It didn't really seem like I was, had to like rescue anything; because I kind of felt like the music made light of it." When he first heard the music, Austin remarked, “Its really relaxing music for a rescue game…” Later, during our interview, he elaborated on his thoughts saying that, “in the first game [FOTW] like during the cinematics, [it] intensified and it so it set the, the stage I guess. In this one [SR] there was some relaxing music, there still — I expected it to be kind of like an action kind of rescue.”

The music I heard at the end when I lost made me feel like I messed up and failed.

The participants were split on whether the music that they heard at the end of SR, after they submitted their solution and lost the game, made them feel as if they had failed. Andrea, Austin, and Gabriel thought the music did make them feel as if they had failed. According to Gabriel, “Its kind, it’s sort of like that same end of the world type of music like that [Fate of the World game] oh no! You know… you're kind of like — kind of that whole like where our world just fell apart and we’re in a crisis depressing type music.” Similarly, Austin thought, “Yeah it’s like, [the music] works for the screen like you, you killed the salamander, or, you didn’t kill it, you rescued no salamanders. And so it’s like oh I failed.” Andrea also mentioned that she thought the music sounded “…like you failed…” and explained it as “I don’t know, it made me feel like I did something that was really bad because it’s kind of like a minor key and I think oh I really messed up now! [laughing hard].”

The music I heard when I lost doesn't make me feel like I failed. It didn't sound that different from the background music and it sounded a little like music that could be used to give a hint at an answer.

Donna, Leah, and Sarah all thought that the music they heard at the end of playing SR did not make them feel as if they had failed. Sarah thought, "I think it was pretty neutral actually I mean." She explained that her own expectation for what the music should sound like was important, saying, "you know I guess that's more of a conditioning kind of thing you know that you get used to playing a game and when you win the game there's a certain you know happy song or whatever or when you lose the game there's kind of a sad song." Donna also remarked, "I…I would have made it sadder…[laughs]". Furthermore, she also said, "I think this music is out of place for me. I would have wanted this music to be the hint." By "the hint," Donna is referring to the potential role for the music to forecast whether a player is about to make a successful attempt at submitting a solution. The music that she heard when she lost sounded more like music that should accompany a hint. She also thought that the music also failed to match the number of salamanders saved. That is, the game allows for partial successes, by indicating that a changing number of salamanders are saved, depending on the solution presented. According to Donna, "I still think of this as a win-lose, as opposed to a partial success. Zero is not a… Uh, zero is not an extremely small amount of success." Leah provided similar feedback, saying while smiling a lot, "I think you should have a different sound if somebody doesn't save more than zero." She also explained that music that she heard when she lost "[was] very similar to the music throughout the thing. I noticed that there was a difference but the difference isn't big enough to make a person feel bad." When I asked if she thought people should feel bad if they lost, she emphatically said, "Yeah! [instead of]…it was still happy like, yay!, you didn't save any salamanders, like…"

The music that I hear puts me into the environment of SR. The music has a natural, tropical and even aquatic feel that matched the island that I'm on.

All of the participants commented on the ways that the music they heard in the background matched the environment of the game. Sarah described the music by saying, "I think that comes across…kind of the natural sort of you know feel to it though…Which definitely kind of a nature sort of." Donna described a similar natural feel with the music following her playing the game as "It's some xylophones playing from nowhere…And there's nothing wrong with that. It's just fine. I'm on a… I'm on a fantasy island and…There's things… There's things happening here." Austin also described "an aquatic kind of feel" to the music that allowed him to make "the correlation between salamanders and the aquatic feel." For Andrea, the music "kind of I guess puts you…like into their environment, like by having like I guess some music it kind of like just surrounds you kind of…you are kind of in a different world I guess." The music conveyed to Leah that "You have like a mission to complete…But..." Leah described how the music and the environment worked together, saying, "…like it's green outside, there is a lot of water, it's like it goes with the music. Like it goes with the background."

I would have wanted sound to provide me with more cues and prompts as I played. Music could have helped me to find things, the iPad could've had notification sounds, different sounds might have helped me know how to work the water tank and different prompts might have helped with dialogue and keeping track of the salamander count.

All of the participants, except for Leah, described wanting to hear more cues and prompts as they played. Notably, sound could have helped people to use the water tank differently and people generally wanted the iPad to make more sounds. As described in a previous constituent, Donna wanted to hear audio feedback, "Maybe a little faint, [meep-meep-meep-meep]" to indicate that the salamanders in the water tank were being negatively affected by the water tank tester in the lab. She also suggested a change in the volume level of the machine once the machine actually became available for use: "If it did had a sound, and then the next time you come in…[When it] becomes available, the sound is louder." As described for a prior constituent, Austin wanted the iPad to make more digital sounds. He also thought the iPad should make more "notices" (meaning audible notifications), because "Oh yeah it would also make the iPad more like, useful." Andrea also thought the iPad could have used more sounds, saying that, "So if you added more like I guess people could become more like aware of it or something." Austin also thought more digital sounds would have made the fish tank easier to use by conveying that "Um, I would have realized that was an on/off faster."

Playing without sound in SR is doable but is less fun. Sounds like clicks for the iPad, splashing in the water or music at the end make the game seem more fun.

All of the participants except for Andrea and Leah described the ways in which it is possible to play SR without sound, but that doing so would not be fun. Sound in some way contributed to making SR a fun experience. Austin, for instance thought, “I would be able to do everything I did without the sound because I think this is a really text driven game.” However, he also thought, “without sound, It’ll be kinda of…sad without sound.” Sarah echoed this sentiment, “I mean I can — I can play without it. It’s just more fun [with sound].” Gabriel also felt that he could play the game without sound, because “…I feel like I’m engaged quite a bit visually.” Gabriel elaborated, saying, “So you know I’m sort of okay if the sound, like I’m not super okay but like I’ll be fine if there is not sound with the, with the environment but like, I don’t really have any desire to go with the iPad without the sound.” Interestingly, Gabriel also felt that the music at the end of the game contributed to his play, saying, “I guess without the music I feel, with the music I feel guilty that the salamanders died and I was responsible for it, without the music I feel annoyed that I lost the game.” Donna also thought the music at the end of the game was important to her play, and conveyed that “for me, the end game melody is a reward.” She also thought that without sound it would have been “harder for me to learn what buttons mean what…[and that] I would not be as sure that I had done something or not.” At the same time she felt that she would have “probably” stuck with the game,” but she said, “…I wouldn’t to have enjoyed it as much.”

As I play without sound, SR feels less real and dry to me. At times, it seems like the silence is deafening when I can't hear things like the iPad, water tank, or music when I win.

Donna, Gabriel, Leah and Sarah all described in some way that playing without sound was less real and "dry." For Donna, "dry" meant "something missing…[because] I'm in a virtual reality." When I asked Donna what SR would have been like without music, she also replied, "it would feel dry. It would have been a dryness without some [music]." When I asked her to elaborate, she remarked, "it just would have…And that's funny, because real life doesn't have a music soundtrack." Leah explained that she expected to hear sound in the game, because "like in daily life, when you step on something, there's the sound. So if, if they're trying to make it 3-D and more realistic…" However, taking sound away from a game according to Leah is "like subtracting and detracting from it…[because]… It makes the game more 2-D." In an earlier constituent, Gabriel described how sound helped make the iPad "more fun to use, otherwise I don't, without the sound I just…I don't feel like using it, you know what I mean?" Furthermore, he thought that although there were some sounds that "you barely hear it but it make the silence is deafening when you don't have it."

Playing without sound is less engaging and at times, boring. In fact, sometimes I just want to read, do what they want, and blow through the experience.

All of the participants, except for Donna, thought that playing without sound was less engaging. Sarah played SR without sound and described the experience saying, "well

I mean, it did change the experience though and I think that it, I was, I mean less engaged in the, in the game." Despite having previously described in another constituent that he could have beat the game without sound, Austin felt that with sound he could be "immersed in that environment but, without sound's like, okay I'm just gonna, read, do what they want and…" As Gabriel put it, playing without sound made him more inclined to "…just want to blow through the experience because it's just reading and getting the details." Andrea explained this lack of engagement in playing without sound simply as, "I don't know, kind of makes it seem boring kind of.

When you play without sound, you don't know if what you do will have an effect. I wouldn't be as sure that I had done something or if I what I did was effective.

Andrea, Donna, Gabriel, and Leah discussed how playing without sound might result in uncertainty about knowing whether what they did would affect their gameplay. Andrea explained that without sound, "you don't really know if what you're doing is like, if like doing anything like if it's going to have like an effect." By example, she explained, "whenever you like have the little sound effects there and like you play with the amounts, it kind of makes you feel like you're actually like doing something…" As mentioned in an earlier constituent, Donna thought that the buttons in the interface would have been harder to learn. Gabriel described the experience of interacting in the outdoor environment by walking into water without sound saying, "you walk in the water if you don't hear, if you don't hear any feedback in terms of the sound changing then it's a farce. The water is just, it's there but it doesn't do anything." Leah described the experience of using the water tester in the lab without sound as consisting of a "lack of reinforcement." Leah explained using the water tester with sound, saying, "you hear the um the sounds change as you go from like different intervals, and I thought that was good, because if there was no sound it would just like be moving it."

Imaginative Variation

The following text is the imaginative variation that I wrote for SR, to present the aggregated participant experiences of sound in this game. As is the case for the previous games, this passage is based on my impressions of the constituents of meaning.

The web browser window opens and the sound of a thumb piano plays, plinking out a soft melody while the players start the game. The click of the mouse button is echoed with a sound in game and the game loads. The music is very soothing—*isn't this a rescue game? Isn't the music too soothing for this game?* There's no cinematic, just an opening narration by a guy who sounds just like the interviewer, who is saying that the *salamanders are dy-ing*. He is very monotonous and isn't really giving the players much information, except to talk to the assistant in the lab. Some people wander around the lab; they hear that the sound seems to be coming from all around them, although it's hard to tell *what's making the sound they hear?* They talk to the lab assistant, but he only responds with word balloons, his arms outstretched. They wander outside—*why is it that the outdoor area sounds so much like the lab*, they wonder. *Right*—it's because there's no door that opens. But, they're outside, on an island. The music is just right, it's plinky and plunky island music, and it sets them in the scene. There are birds all around them, a path for them to walk on, and the ground *crunches*. They have footsteps, and the boards creak when they walk on them. The water goes *swish!* when they walk into it; everything sounds like it should for an environment like this. When they use the iPad, it makes noise. When they see the fish tank, it makes a bubbling sound. They know, from the sound, that they're affecting this space.

They talk to the environmentalist, the biologist, the hunter—*why don't these characters make more sound*? *Just how interactive is this environment?* They jump in the water; they try to use the well. *What's wrong with the well? Why doesn't it work or make a noise?* They start collecting the stuff the scientists want them to collect. *Wait, is the music trying to direct them somewhere?* No, never mind but it's a nice thought. They pick up the items on the ground—*was that the sound of an item going into a bag? Or is it going into a mouth?* No matter, the game is fun and the sounds are fun and they're still playing. They start to wonder though—they're not getting much out of their interaction with the scientists, in terms of the sound. The game should give players a way to identify the characters through sound. Take the hunter, for instance. He's a scared little guy in a little, empty house. He makes no sound, but he's a hunter. *Shouldn't he at least have birds in a cage? Animals? Something around him?*

The iPad is useful, but it should make more sound too—at the very least it should make a sound when it notifies them that something new is coming on screen. And, it should sound more digital. As for the tank in the lab, they know that they need to use it to test the readings they get from the lake but…*is this thing on? How do you turn it on?* The tanks gurgles and makes bubbling sounds, and that the slider works—it makes a *clicky* noise and that's useful when positioning the slider. Wait…*did the sound in the lab cut* *out?* They're ready to submit a solution…and no they didn't automatically get it right. *Was that music supposed to make them feel as if they lost? Because it isn't clear.* It's sort of sad but somehow, also not. *Why was it that some salamanders were rescued but the games still says they failed?* While it's true that this game needs more sound, and the characters need more sound to be actual characters, this game is still fun. The sound effects, even though they sound somewhat neutral, make this less like a task they have to complete and connect the players to their environment. The music they hear picks at their brain and supports them as they think and solve this fun problem.

CHAPTER FIVE: ESSENTIAL MEANINGS

OVERVIEW

Following Dahlberg, Dahlberg and Nystrom (2008), I present the essential meanings of the experiences of sound, as represented by the six study participants, and in each of the three educational games selected for this investigation. As these researchers suggest, the essential meanings are described in the present tense, since that approach "describes how the phenomenon *is*, i.e. not what the informants said about it" (p. 255). Furthermore, as these researchers suggest, the essential meanings are presented in ways that are abstracted from the constituents that have been previously described in Chapter 4 of this dissertation. However, instead of following the suggestion of these researchers by presenting the constituents of meaning together with the essential meanings derived from them, due to convention of this dissertation format, I present the constituents of meaning and their imaginative variations as the results of this study in Chapter 4. I then describe the essential meanings as the findings interpreted from these constituents in Chapter 5. In my description of the essential meanings, I connect the findings to supporting research.

In addition, I present the essential meanings as aggregated across all three games in this study, and I include an analysis of the similarities and differences in the responses of individual participants across the games they played.

FATE OF THE WORLD

Game sound in this game provides an important component to player experiences of gameplay, and is a salient element of play. Sound provides players with information about the interface they are using (Jorgensen, 2008) and feedback about the events conveyed (Gaver, 1993) as they make choices in tools throughout the game. Fate of the World uses auditory "icons" in the form of clickable interface icons to trigger and convey events heard in the game's interface. It is also an example of what Collins (2008) describes as non-dynamic audio, since most of the non-interface game audio (e.g., background music, notification sounds, such as the dings*!* and rollover sounds) play regardless of the choices that players make. Players may not always notice all of these sounds in the game, and may tune out sound as they play. However, the presence of sound is still beneficial even if tuned out.

Conversely, players notice if sound is absent from the game when they click on the game interface and hear silence. The absence of interface sounds prevents players from getting the feedback they need from game interfaces to know that their choices have been registered as they use the mouse (Gaver, 1991). Sounds that are heard when players click to use complex interfaces in the game can provide them with important feedback that the game is responding to their input, and that they are continuing to progress through the game. In-game audible prompts can be used to provide hints and to prompt players as they play. As Jorgensen (2008) points out, audible prompts can signal to players whether they are winning or losing. Playing without these and other sounds increases the chance that players will become confused as they play and can remove their ability to receive information about their progress and decision-making in the game (Jorgensen, 2008). Playing without sound can also make a game less engaging and might increase the likelihood for players to become distracted by the environment around them.

Sound helps games to be seen as being interactive, reduces the chances for players to become bored, and helps to draw them into the game environment. It is critical however, that sounds for visual elements such as animated characters in the game or an in-game display of graphics and text information be appropriately paired with what people hear. Mismatches between the messages conveyed by visual images, such as seeing bad news from a game character and hearing only ambient background music, can be confusing and cause players to interpret the visual information differently than intended by the image. As Marshall and Cohen (1988) and Lipscomb and Kendall (1994) have shown for film music and visuals, music and game sound can affect the way people view visual images in games. This effect is explained by Chion's (1994) notion of synchresis, in which sound and visual work together to create a unified perceptual experience.

Sound can help to situate players in playing a game while music can help add dimensionality, drawing players into a game and keeping them engaged. Music that is heard during the introduction or conclusion of Fate of the World can carry emotional messages that are critical to establishing story and ascribing a sense of failure and success. In the opening cinematic of FOTW, music situates players on a game quest while foreshadowing what the game will be like (Tan, Spackman & Bezdek, 2007).

After the cinematic ends, game music can be applied in ways that are neutral and that provoke minimal emotion as players play. Background music can be designed to provide fuel for thought as players work, as long as the music continues to play. However, disrupting the music may also disrupt player flow and momentarily take players out of the game (Csikszentmihalyi, 1990). Game music can also be used to reinforce changes in game's story and, with the right synchretic pairing, changes that mark different phases of the game, such as the start and end of each round of play. During the opening cinematic, players notice whether the music they hear matches what they see on the screen. At the end of a game, when players are viewing win or lose screens, music has the capacity to make players feel as if they have succeeded or failed, assuming the music clearly conveys those emotional messages (Marshall & Cohen, 1988). Fate of the World contains phases of the game in which players read new information, choose cards, and end the turn. Through appropriate pairing, music can, as Collins (2008) suggests, "be used to enhance the overall structure of the game" (Kindle location 1839 of 2796) and provide the game with continuity. Sound and music can thus be used to pair what the player hears and sees in a way that clearly conveys the emotion and sense of urgency of the initial quest, while providing milestones that mark each of the distinct phases within the game.

HUSH

Sound can be used as a tool to create a rich environment to situate play, communicate a game's back-story, and help people to appreciate the point of the game. As was the case with Fate of the World, the sound in Hush can be used as a mechanism to immerse players in gameplay by providing feedback (Gaver, 1991) and motivating players to focus on critical tasks in the game. Hush provides players with a rich auditory soundscape that is intended to clearly convey the game's environment (Schafer, 1993) and supports what Collins (2008) describes as "immersion and the construction of the real" (Kindle edition, location 1879 of 2796). In doing so, game audio can support and extend the subtly-drawn game visuals presented. The game also provides a challenging game mechanic by which players must press letters on a keyboard and time the press to coincide with an increase in brightness of the display of the same letters on the screen. Although this mechanic alone is difficult, strategic use of what Schafer (1993) describes as sound signals (e.g., soldier footsteps and gun fire, or the sounds of people being slashed and mutilated) increases the game's overall difficulty. How well players are able to correctly time the press of the keys affects the extent to which the baby character in the game cries. If players successfully time their key presses, the baby remains relatively quiet, and the mother and child thus remain hidden from the approaching soldiers. However, if players are unable to successfully time key presses, the baby's crying intensifies and, over time, places the lives of the mother and child—and thus the player's chances of winning—in jeopardy.

As these players experienced, Hush thus uses the sounds made by the baby to indicate changes in the game, and thus directly adapts to the players performance (Collins, 2008). Hush accomplishes this by using sound to communicate changes in game state (e.g., the baby cries when a player is starting to lose) and events that occur in game's storyline (e.g., when the soldiers are getting very close). One mechanism by which critical events in Hush are communicated is by foreshadowing whether players are about to win or lose. In Hush, players hear the baby in the game begin to wail, followed by a burst of loud machine gun fire, which signifies that the game characters are about to die and the players are about to lose. This foreshadowing is related to Tan, Spackman, and Bezdek's (2007) notion that music can help to affectively prime audience perception of characters they see. However, the auditory imagery in Hush takes this notion one step farther. Hush communicates most of its storyline through sound, since, as Gabriel pointed out, the visuals serve as "supporting actors" in the game. In this case, the sound effects—not the music—foreshadowed to the players their impending demise. Hush does, however, make use of game music in the form of a solo piano playing a pristine, innocent lullaby at the start of the game. This music serves as the emotional weathervane to set the "mood" of the game during the beginning game tutorial. The music stops after the tutorial and is not designed to return until the end of the game. Players expect the game music to return at the end, and when it fails to do so, the experience of the game lacks closure and seems incomplete.

Game sound can play a critical role in helping players to adopt a role as characters in the game while ascribing key game states (e.g., danger) to in-game characters. As Collins (2008) illustrates, music can be used to signal that characters are in danger. Hush provokes a similar sense of danger through the design of its soundscape and considered use of sound signals (e.g., sounds of mutilation) to accomplish a similar goal. However, when sounds that are associated with game characters are ambiguous or become buried by other sounds, the reason for players to relate with those characters is also ambiguous. The character of Lilliane, the mother in Hush, is visually represented by an on-screen, cartoon silhouette of a woman, her hair worn tall. The game implies that she is the mother and provides information to players that it is her singing that will console the child and prevent it from crying (Figure 18). However, players receive mixed messages from this character. At one moment, it sounds like she is singing, at the next her voice is swallowed by the cacophony of the environment's soundscape. In this case, the inconstancy of the character's actions in singing her child to safety results in a diminishing of the character's role to game players.

Figure 18. Hush: mother singing

The sounds players hear in Hush create an intense, immersive experience of play. The game accomplishes this by layering key sound signals together to create a rich soundscape. Players hear the military commander, who speaks at the beginning of the game, *"Exterminate them. Sweep them out of the country,"* the soldiers firing weapons, the sounds of brutality and of people dying around them. These sounds evoke visual imagery not clearly present on screen and, as Chen and Spence (2010) point out, convey semantic meaning to the sounds heard. The silhouettes of soldiers combined with sound of yelling and gunfire convey danger. The sounds of slashing, followed by cries of men and women, convey the brutality of a genocide that is happening around the player. Even though there is no blood on the screen to reinforce the static images of the soldiers, the semantic meaning of the scene is clear: people are dying at the hands of the soldiers. Lilliane and her child are clearly in trouble. The sound in Hush clearly conveys actions taken by in-game characters. When these in-game actions are clearly represented through sound, even in the absence of strong game visuals, game sound can be used to immerse players in intense and emotionally engaging experiences of play. For these players in Hush, game audio enhances, and arguably provides, what Collins (2008) describes an "imaginative, immersive quality" for play (Kindle edition, location 1890 of 2796). In this design, the absence of game sound removes the contextual story and the connection to feedback and reward mechanisms that are critical to gameplay (Salen & Zimmerman, 2003).

SALAMANDER RESCUE

Sound effects convey a sense of the environment in Salamander Rescue by providing audible indications of an island setting, while providing context for the events that occur around the player. SR provides a rich tapestry of sound to convey that players are playing in an environment complete with bubbling water, blowing wind, and singing birds; are walking upon different types of surfaces (wood, gravel, or grass); are splashing in the water; or are otherwise picking up objects. The blowing wind and singing birds comprise what Schafer (1993) describes as the keynote of the game's sound. It is, according to Schafer, "the anchor or fundamental tone [of the environment]…[and is] often obscure[ed] [in] importance]" (Kindle location 247 of 6308). Keynote sounds do not have to be heard consciously to be present and are those sounds that typically comprise the "geography" of an environment. Other sounds players describe, including their footsteps on different surfaces, the bubbling of the tank, the splashing of the water, or the sounds they hear when picking up objects, are examples of what Schafer (1993) calls sound signals. Sound signals imbue objects with identity and auditory semantic meaning and are sounds that appear in the foreground as people play.

Sound can also convey a sense of direction by providing players with what Schafer (1993) describe as *soundmarks*, or "sound[s] which [are] unique or possesses qualities which make it specifically…noticed by the people in [a] community" (Kindle location 247 of 6308). The community in this case is the community comprising the scientists on the island, the lab assistant in the lab, and the players who acts as scientists to rescue the salamanders. Players identified as soundmarks the sounds of the bubbling tank in the lab, the sounds of the creaking bridges, the sounds made by walking on wood, and (accidentally), the background music of the game. These sounds help some players to navigate in the space. However, when the sounds are inconsistently applied, as when players mistakenly use music for direction, this navigational advantage disappears. Together the keynote sounds, sound signals, and soundmarks in Salamander Rescue work to provide players with a sonically rich, realistic game environment.

Players may also recognize when certain sounds they hear appear to change as they move. The most recognizable example is the Doppler effect that occurs in the lab within SR. As the player turns around in the space, they hear the localization of the sound in the room change, and thus notice a slight shift in sound. As Farnell (2010) explains, a Doppler effect occurs when "a moving object causes the apparent frequencies of any sound it emits to be shifted up or down…relative to a stationary listener" (p. 67). In the lab, this effect (albeit slight) can be heard when listening to the drone of the computer and turning around.

In the outdoor environment, players describe a rich array of sound effects that make up the auditory environment around them. However, they are unaware of the ways in which the sound they hear is localized. Auditory localization, according to Farnell (2010), occurs when players process different sounds in each ear, and is what enables us to experience an auditory depth of field. This localization effect is a key feature in the design of the sound in Salamander Rescue, and can be heard with the computer fan and bubbling tank in the lab, and through the position of the bird and the wind sounds outside. For instance, the birds the player hears appear to first sing in one ear, and as the player turns, appear to sing in the other ear. However, players remain completely unaware this localization is happening.

When properly matched with what the player sees, music can support sense of the environment in which the player is situated. The music in Salamander Rescue conveys they are on a tropical island and conveys much of what Schafer (1993) describes as the environment's keynote track. The natural sounds in SR's music are comprised of natural instrument timbres and evoke descriptions that are congruent with the descriptions for the rest of the environmental sounds in SR. Music that is ambient and in the background adds to the enjoyment of the playing the game, and helps to make the game more engrossing.

Players expect that the sounds they hear match what they see on the screen in what Chion (1994) describes as a “plausible synchronization” (p. 97). When players hear sounds that match what they are seeing in game, their expectations for the game environment and interacting in the environment are met. As Collins (2008) points out, designing game audio is necessarily influenced by both “genre and audience expectations,” in addition to other factors such as space and story (Kindle location 128 of 2796). Mismatches are possible between sound and visuals if they are ambiguously paired, or if the sound abruptly cuts out during play. In instances when the background sound accidentally stops, the audiovisual contract between players and what they see and hear is disrupted, and can momentarily interrupt a player’s ability to focus on the game.

Sounds support players as they interact in the environment. This notion is similar to Gaver’s (1991) research in human interaction with computer interfaces. However, the virtual environment creates a space to simulate virtual interaction (Kwon, Jee-Hoon, Bae & Suh, 2006). Unlike the simulator in Kwon et al.’s study, Salamander Rescue offers multiple ways in which players can interact with the game. SR provides sound to support interacting with objects such as the tank in the lab, walking on different surfaces in the game, using the in-game iPad, and splashing in the water. Each step the player takes marks an interaction with the physical environment of the game. Players test their ability to interact in this three-dimensional space because, as Collins (2008) alludes, they have expectations for how sound should work in a game. The sounds players hear as they interact in the space represent what Collins (2008) describes as an interactive function of game audio, in which the sound players hear happens as a direct result of their actions. Players recognize that pressing buttons on the iPad makes sound, walking on different surfaces makes different sounds, jumping in the water makes a splash, and using the slider on the tank in the lab makes clicking noises.

Some interactive sounds, such as the sound made by the button on the tank when pressed, go unnoticed. Other sounds that provide feedback that buttons have been pressed and dialogue pop-ups clicked are noticed, but are otherwise unremarkable. Although the presence of neutral sounds does not cause problems with play in SR, the absence of sounds that can otherwise be used to notify or guide players is noticeable. The iPad fails to provide an audible notification of new emails, thus defying people's expectations for how a mobile device should work. The iPad is also silent when it is used to test the water, and the water tank in the lab provides no audible indication as to whether certain tests increase or decrease the survivability of the salamanders.

Other areas of SR also noticeably lack sound. The scientists on the island communicate information to players in the form of text pop-up dialogue boxes. Although there is a sound that indicates the use of the pop-up windows, there are no sounds that otherwise accompany these characters. Thus, there are no sounds in SR that help players to identify with the characters in the game. One obvious solution is to add narration to enable these characters to "talk" to players. However, this is not always desirable and indeed, is insufficient. Players instead need what Collins (2008) describe as "symbols and leitmotifs [i.e., musical passages]…to assist [them] in identifying…characters, moods, environments, and objects, to help the game become more comprehensible and to decrease the learning curve for new players" (Kindle location 1827 of 2796). Collins's (2008) use of the term "symbols" is synonymous with Schafer's (1993) use of the term "sound signals" and implies that judicious application of sound can help to convey the presence of characters and help to support in-game narrative. Examples of sounds that can help connect players with characters in-game include sounds that are unique to each scientist, such as animal sounds that play when players are near the hunter, or musical themes that are unique for each character.

It is critical that the music clearly conveys a sense of the game's mission and communicates to players whether they either win or lose the game. The absence of a cinematic in SR is noticeable, as is the lack of urgency communicated through the music at the start of play. From a synchretic perspective, SR lacks a plausible synchronization between the visual presentation of the game (e.g., the Salamander Rescue title screen) and the calm musical leitmotif that serves to background the game's opening. At the end of the game, the music that players hear when they lose does not clearly communicate that they lost. Thus, an incongruity is possible between what they see on the screen (i.e., that they saved few or no salamanders) and the music they hear (Chion, 1994). In contrast, the music that plays when people win *does* clearly communicate they won. However, given the game's complex problem, not every player wins unless given sufficient time to solve the problem, and thus will not hear this music.

As Collins (2008) points out, music has the capacity to serve as adaptive sound in games. If designed appropriately, it can reflect that players are losing, or are about to lose a game. Salamander Rescue does not use either music or sound in this way. However, sound and music can be used to provide players with cues and prompts as they play (Jorgensen, 2008). Music can help players to navigate the island by adapting to the player's position, relative to where they need to move to complete a task. Likewise, sound can be used to make what Liu, Yuen, Horton, Lee, Toprac and Bogard (2013) describe as cognitive tools and in-game mechanics easier to understand (Collins, 2008). Conversely, playing the game without sound is less engaging. The absence of sound separates the player from the game environment, and separates their actions from the effects they otherwise see in game. Without sound, the audiovisual contract between the player and what they see and hear never forms and the game's environment fails to fully immerse people in the experience of gameplay. It is certainly possible to play and the beat the game without sound. However, gameplay is a lot less fun and seems more like a task that players must complete.

Shared Meanings

In this investigation, I asked six participants to play three different games and discuss their experiences of sound for each game played. Their descriptions formed the basis of a rigorous phenomenological analysis, which resulted in a total of 76 constituents of meaning between the three games. From these constituents, I situated each of the sets of constituents with an imaginative variation to provide the context for the participants' play, and I explained the essential meanings within each of these games that I derived from my analysis. From the essential meanings described in this chapter, I now present the eight essential meanings of sound in educational games that are commonly shared across the three games studied.

Sound Conveys Interface and Directionality

In Salamander Rescue and Fate of the World, the game provides a complex interface through which players must interact with the game environment (Gaver, 1993). Players make choices in the game by using the visual controls provided to click buttons, operate game menus, advance dialogue boxes, and navigate resources and references that are sometimes embedded in game objects (e.g., the iPad in SR or selecting cards in FOTW). Players expect that the sounds they hear when they make these choices to give them feedback that their input has been acknowledged, and that the interface is responding appropriately. Games like SR and FOTW sometimes use these sounds to help guide and provide direction to players (e.g., the ding sound in FOTW). However there is unrealized potential for these otherwise neutral sounds to provide players with prompts and cues they need to know how well they are playing, and to make the game easier to understand (Collins, 2008). SR critically lacks sound that could otherwise help players not only to operate the iPad but also to have a more realistic experience when conducting important tests in the game.

Sound Conveys Environment

In Salamander Rescue and Hush, sound provides players with a rich environment in which to situate their play. Hush presents players with a rich palette of sound signals that together comprise the soundscape of the game (Schafer, 1993). SR uses sound to augment an already visually rich 3-D game environment. In Hush, sound evokes intense auditory imagery, even in the absence of corresponding visuals, and uses sound to breathe life into underwhelming, barely moving on-screen silhouette images. Although there is no direct interaction between the presses of keys in Hush and its soundscape, players in SR hear auditory feedback as they interact with the environment. Because SR is designed in a 3-D environment and is very obviously a game, people test the environment to see just how much they are able to interact with their surroundings.

Sound Can Support The Presentation of Game Characters

In Hush and Salamander Rescue, game audio is used to establish a connection with the characters in the game. In SR, this connection can potentially form between the player and the scientists in the game. However, SR in its current design lacks the ability for players to associate the identity of in-game characters with sound and could use sounds that provide an identity to the visuals of the scientists in the game. Ironically, Hush with its single image of a mother and baby uses sound to elicit a stronger (although not perfect) connection between these simple visuals and their identity as game characters. Although the auditory connection with the singing by the mother character, Lillianne, is somewhat tenuous, the sound made by the baby is critical to player success. Hush uses the intensity of the baby's cries to provide player with feedback in the form of adaptive audio to signal how well they are performing in the game (Collins, 2008). More research needs to be done to help guide designers of educational games to use sound in ways that support the design of game characters. In what ways should characters express their identity through sound, and in what ways should players be asked to interact with and relate to those characters through sound?

SOUND COMMUNICATES NARRATIVE

Sound provides players with a connection to the back-story in both Hush and Fate of the World, and it can potentially provide such a narrative in SR. FOTW provides players with an animated opening cinematic to situate the players on an epic quest to save the world. Visuals and sound are carefully timed and synchretically paired to produce a coherent back-story to situate play. The story in Hush is communicated through a series of auditory events that signal an increasingly hostile environment in which they must continue to shield a crying baby. Salamander Rescue, by contrast, offers little in the way of story. Indeed, the basic story and problem statement is communicated by the narrator when the game opens. However, most of the story present in the game is communicated through text dialogue or in-game emails or references that the player reads. An opening cinematic could help to provide a narrative and the opening music could be designed to communicate more of a sense of urgency about the problem.

SOUND SUPPORTS ENGAGEMENT, WHILE ITS ABSENCE REMOVES IT

For all three games in this study, players are more likely to be engaged and immersed in their play with sound than without sound. The absence of sound separates players from what Collins (2008) calls a "living environment" (p. 205). According to Collins, this absence reduces the "immersive quality" of games and removes what she describes as the "imagined real of the sound" (p. 136). For these players, this lack of immersion made playing the game seem more like a task. Playing without sound in Hush turns the game into a strange typing game, while playing FOTW without sound makes players more likely to skip through the game's introduction and prevent players from feeling as if they are a part of the experience of playing the game. This lack of engagement experienced by players without sound reflects a lack of intrinsic motivation on the part of people to play the game. This disengagement is the reverse of the effect in studies like Tüzün, Yilmaz-Soylu, Karakus, Inal, and Kizilkaya (2009), which saw an increase in intrinsic motivation as a result of gameplay.

Similarly, in SR, playing without sound is doable but less fun, and makes people more inclined to "blow through" the experience of play. Based on participant descriptions, sound in these games support what Malone and Lepper (1980) describe as "what makes an activity fun or rewarding for its own sake" (p. 162). Malone & Lepper (1987) offer an amended taxonomy of intrinsic motivation for games to explain that games motivate students by addressing a combination of fantasy, curiosity, challenge, and control. Participants' descriptions of the sound making gameplay in SR more fun are also similar to qualitative findings by Liu, Rosenblum, Horton, and Kang (2014). In their study, sixth grade students mentioned having fun as one of the four most important reasons why they liked playing Alien Rescue, as compared with doing other science activities.

In Hush, sound contributed to a sense of fantasy by immersing the player in a hostile environment. The difficulty in playing Hush modulated the level of the players' challenge in the game and subsequently threatened their control over winning or losing. Through this immersion, the sound in Hush offered players the opportunity to experience what Habgood (2005) and Habgood (2011) describe as “endogenous fantasy.” According to Habgood, this type of fantasy occurs when a game’s visual representation is connected with its core mechanics. Notably, the findings from this study extend Habgood’s notions of endogenous fantasy beyond use of visuals to use of sound. The mechanic of the crying baby in Hush is clearly connected to success or failure in the game, and thus provides the endogenous fantasy of the player needing to save the crying baby in the game. This use of sound to create endogenous fantasy is also an example of what Habgood (2005) describes as "rid[ing] on the back of the flow experience” (p. 494). Habgood refers to Csikszentimihalyi’s (1988) notion of flow in which the right balance of challenge to the player combined with a player’s skill level results in a focused, deep immersion within a task. Although this study is not designed to specifically study flow, this example of player engagement through endogenous fantasy is a compelling example of a flow experience in games.

In FOTW and SR, sound helps to support the fantasy embedded in the game. In FOTW, this fantasy is established in the opening cinematic of play through the use of sound and visuals. In SR, the interactive sounds embedded throughout the game’s soundscape provide a sense of realism and establish the fantasy of playing a scientist on an island who is charged with saving salamanders.

MUSIC PROVOKES THOUGHT AND IS NOT ALWAYS NOTICEABLE

The background music in FOTW and SR, what Collins (2008) categorizes as non-diegetic music that plays in such a way that it cannot be heard within the context of the game’s environment or narrative, provide players with an ambient backdrop to their play.

Background music in these games is not noticeable, and instead is simply "just there." This type of game music is not designed to be emotionally moving, but works to give players something to listen to as they play, to make players feel comfortable, and to keep the pace of the game moving forward. This ambient music, in both games, provokes minimal emotion, yet can serve as fuel for thought as people play. Background music can inspire people to think and to connect people with their experiences of gameplay. Prematurely disrupting the playback of background music, either by improper design or by accident, can disrupt player concentration during play. Interestingly, the disruption caused by the music stopping in the game induces a loss of concentration on the part of the player. Concentration, according to Kiili and Lainema (2008) one of several "flow antecedents" (p. 482) that indicate whether players are immersed in what Csikszentimihalyi (1988) describes as a flow experience. The implication here is that according to these players, the background music they heard otherwise helped to keep them within the flow of the game. There is insufficient evidence to indicate (a) whether the majority of the players experienced flow and (b) the extent to which sound defined this state. However, these results are nonetheless compelling and thus point to a direction for a future line of inquiry.

It is critical, however, to note that additional research also needs to be done with background music to address questions raised by Hallam (2012), which lead me to inquire: How exactly is background music defined, and what is the distinction between music that is in the "foreground" versus the "background" of what we hear? Moreover, based on answers to these questions, how can one form a theory of how background music is best applied to support immersion and play in educational games?

MUSIC CAN CONVEY EMOTION

The music in FOTW and Hush provoke emotional reactions during play. The music in FOTW is epic and conveys a range of emotion at the beginning of the game, including giving the players hope that the world can, in fact be saved. The music in Hush offers an innocent, if slightly sad, lullaby to set the mood for playing the game. For FOTW, music helps to foreshadow what the game is like. In SR, the music that players hear when they win conveys success; however, the music heard when players lose is emotionally ambiguous. Music could be used in SR to clearly communicate emotion, particularly in the beginning of the game. This is a critically under-researched area in the design of educational games. The notion that music in games may be able to foreshadow aspects of gameplay is notably related to research in affective priming of film characters by Tan, Spackman and Bezdeck (2007). The results of this research indicate that music can help to play a role in shaping how players perceive the emotional motivation indicated by the music for the game. In what ways might music thus modulate player emotion to in turn shape their view of game narrative, or of their interpretation of the emotional importance of play?

THE GAME VISUALS PRESENTED NEED TO MATCH THE SOUND THAT PEOPLE HEAR. WHEN MISMATCHES OCCUR, THEY ARE NOTICEABLE.

Mismatches between what players hear and see throughout all three games are noticeable and are examples of loss of what Chion (1994) describes as synchresis. In *FOTW*, inconsistencies can be found between the visuals in the cinematic and the music heard at different points in the sequence. Likewise, when players see the visuals in the news area of FOTW that describe dire environmental conditions, what they hear does not match the information given. The only mismatch present in Hush between visual and sound occurs as the result of a bug that prevents the piano lullaby music from the beginning of the game to play at the end when players successfully finish and win the game. Salamander Rescue, on the other hand, offers several opportunities for synchretic problems in the game. The calming music at the beginning of the game does not match the opening title screen when the game first loads. The music players hear when they see that they have lost does not consistently communicate failure, the figures on the island lack the sound needed to identify them as game characters, and multiple objects that they would expect to work and make noise are noticeably silent.

Similarities and Differences

This dissertation study centers on the question: *What is it like to experience sound while playing educational gam*es*?* To answer this question, I have taken a descriptive and interpretive phenomenological approach to study the essential meanings of the experiences of six people as they played three educational games. I conducted this analysis by examining patterns of meaning shared by these participants for each of the games studied and discussed the broad meanings shared across all three games. As I consider possible avenues for future research, one interesting question that has emerged from this analysis is: *What's it like for* ***someone*** *to experience sound while playing educational games?* To answer this question, a phenomenological analysis must also consider case study perspectives to examine the experiences of the individuals as they play and reflect upon sound in games. Although a complete analysis is beyond the scope of this current investigation, a preliminary analysis of shared essential meanings in this study is compelling and offers insight into how people articulate their experiences across different games.

Sound Conveys Interface and Directionality

All of the participants consistently described the ways in which sounds they heard when operating the game interface in Fate of the World and Salamander Rescue provided helpful feedback. Often, participants used similar language to describe this feedback. Sarah described how interface sounds helped to "register" her tap and thus provide feedback about the actions she took in-game. Gabriel similarly described the "positive reinforcement" he received through sound as he played each game. Austin described these sounds as "neutral" and "just standard," while Donna remarked that these sounds reminded her that her mouse was working. Additional research in the ways that sound can convey interface to a player can help us to better understand how the design of interfaces in different games can best provide audible feedback to game players.

Sound Conveys Environment

Nearly everyone had different ways of describing the environments conveyed by sound in Hush and Salamander Rescue. People's descriptions of Hush tended to convey the ways in which they, as players, were part of the game's environment. Sarah mentioned "imagining what it would be like…" to be in the environment in Hush. Gabriel felt that he was "hiding from people outside…" while Andrea and Donna "hear[d] an escalation" outside. Austin "imagined" people getting killed around him and Leah heard "people getting slaughtered." Conversely, their descriptions of the environment in Salamander Rescue tended to illustrate how sound helped to make the environment more real. Conversely, in SR, Sarah remarked that what she heard reflected "just the environment," while Donna illustrated the ways in which environment was made more real: "maybe this bridge isn't so sturdy after all." More research is needed to see if there are differences in the ways that sound can prompt people to describe a sense of environment differently, depending on the games played. Participants clearly describe the ways that Hush and SR both use sound to create environment, but there seem to be differences in the degrees to which players describe their immersion in these environments.

Sound Can Support the Presentation of Game Characters

Most of the participants described the ways in which they thought that they were playing the character of the mother in Hush. Descriptions like "Oh…I was the mother," "I need to protect this child," "I thought that was *mee*…" and "you feel responsible" all point to the ways that players inhabited the roles of the character of the mother in in the game. Hush accomplished this by connecting the core mechanic of typing letters to the likelihood of the "player's" baby surviving for the duration of the game. Salamander Rescue had no such mechanic, and the characters presented in the game served as a means to provide information that the players needed to save the salamanders. When people described their interactions with the characters of the biologist, environmentalist, and the hunter in SR, they mentioned different ways that SR could have presented these characters through sound. Statements like "I was thinking that I would be talking to salamanders," "anything that would…[have] given them more identity," and "none of the characters have a voice," all point to a lack of a connection between the player and the presentation of the characters in Hush and SR. More research is needed to explore the ways in which sound can be used to support and present game characters, and the ways in which sound can help players to identify the visual depictions of game characters with the identification of those visuals as game characters. It is clear from participants' descriptions that the mere presentation of 3-D models of characters in SR is not enough for players to assign these visual depictions with identities as scientists in the game.

Sound Communicates Narrative

Participant descriptions of the ways that sound helped to communicate narrative in each of the three games were similar. In particular, participants described the ways that music communicated a sense of the story in the game. Sarah was critical in her descriptions of both SR and FOTW, suggesting that the music in FOTW should change throughout the game and suggesting that the lose music SR was "pretty neutral." Gabriel was also similarly critical about the music in the FOTW cinematic, saying that it needed to “convey more of what’s going on,” but unlike Sarah, he felt responsible for the salamanders dying in SR. Likewise, Andrea also felt “bad” at having failed both games. In contrast, Leah felt this way at having failed FOTW, but felt SR lacked a sense of “urgency,” because there was not enough emphasis on the narrative, as communicated through the music.

These descriptions are compelling because they suggest that music can help to support the narrative embedded in the game. Indeed, all participants described the ways that sound (but not music) supported the story in Hush; however, people’s descriptions of FOTW and SR suggest that more research is needed to learn the ways in which the music presented during opening cinematics or at the end of play can reinforce narrative elements of a game. It is clear from these people’s descriptions that music can help to modulate how people feel about winning or losing, and that the selection of music is important to that process. This selection of music thus has implications for the extent that game designers should *want* players to feel a certain way after failing at a game. That is, should players be made to feel as if they’ve *failed* a game when they lose? If players feel a sense of failure, does that affect their motivation to play the game again?

Sound Supports Engagement While Its Absence Removes It

Interestingly, players consistently described the ways that sound supported engagement while the lack of sound removed it. Sarah mentioned not being taken “into the game” of FOTW as much without sound. She also had “less empathy” for the people in Hush, and was “less engaged” and thought SR was “not as fun” without sound. Similarly, Austin was so disengaged when he played Hush without sound that he asked if he could “intentionally [die].” Likewise, he expressed wanting to skip the intro cinematic in FOTW without sound. Andrea also wanted to skip through FOTW without sound and, like Sarah, described being less “engaged” without it in SR. Gabriel describing focusing on “just reading the text” in FOTW without sound and wanting to “just blow through” the experience of playing SR without sound.

The similarity of these descriptions both among these participants and among the games played by these participants is striking, and implies that playing games with sound can impact the ways in which players engage with games. These findings raise questions about the ways that sound should be designed for different games. Can different applications of sound help to modulate player engagement and make it less likely that they will “blow through” their experiences of play? How can designers find the right balance between using sound to support engagement and making too much noise during play?

Music Provokes Thought and Is Not Always Noticeable

Sarah’s reaction to the music in FOTW and SR indicate that music heard in the background while playing these games “definitely adds a lot” to gameplay. Sarah describes this effect as like a “subconscious…emotional response” from music that keeps her “very calm” and “in a place where you want to think.” Her reaction in SR indicates that music in this game “keeps you going” and keeps the game moving forward. However, like the music in FOTW, the background music in SR is music that “sets the mood” and is “just kind of background music.” Sarah’s descriptions parallel Donna and Gabriel’s descriptions. Gabriel in particular thought the music in both FOTW and SR as provoking thought or as “that picking your brain music.” Interestingly, Sarah, Austin, Donna, and Andrea described the music in FOTW as provoking thought, while they all also described the background music in SR as “ambient,” “calming,” or “just kind of there.” It is interesting that people describe background music as either music that keeps you moving forward in the game or something that supports thinking during play.

Given the paucity of research into the effects of background music in educational games, more research needs to be conducted to help develop a theory for how different applications of background music can work to foster thinking in different game environments. Descriptions by these participants suggest that music that is matched to the game can help players to connect with their experiences of thinking about their actions and choices in games. Furthermore, from these people’s descriptions, this effect can occur even if players do not consciously attend to the music during play.

Music Can Convey Emotion

Most of the participants consistently described the ways that the music they heard in the game conveyed emotions during or prior to gameplay. The music in this case referred to uses of music not designed to be played in the background of play; rather to be played during the opening cinematic, such as in FOTW or in the introduction to Hush. Sarah, Austin, Gabriel, and Leah in fact shared a similar pattern to their descriptions of the music in FOTW and Hush. All four of them described the music in the opening cinematic of FOTW as being “epic,” like going on a “quest,” conveying “bring[ing] hope to the world,” etc. These people described the music in Hush also in ways similar to each other, saying the music was reminiscent of “music boxes” or “remember those who’ve fallen," "innocent piano music," or music that otherwise "draws sympathy." That everyone described the music differently for FOTW and Hush is not surprising, since these games have different stories, and thus different goals.

The goal of the cinematic in FOTW is to provide the player with context for the back-story of the game, while positioning players as heroes who can help to solve the problem. As these people have described, the music in FOTW conveys emotions related to urgency, hope, and heroism. Conversely, the music in Hush is designed to support the story of a mother and child in a seemingly impossible situation. From these people's description, the music thus draws sympathy and does so using an innocent piano lullaby. Sarah expressed that "[the FOTW intro music] definitely has that sort of... 'hey,...we are going on a quest'" versus "well it is definitely...childhood music [in Hush]...music boxes and things like that, that I had as a child." The use of music in these two games to foster emotional responses on the part of players is both noticeable and compelling. First, players are aware of the emotions that music is prompting them to feel. Second, all of these players except Donna remarked upon what Tan, Spackman and Bezdeck (2007) discuss as "affective priming" in positive ways. Only Donna critiqued Hush's use of piano music as "obvious" and manipulative, saying it reminded her of what she heard in "tear-jerker commercials." For Donna, the music asked her to apply an emotional interpretation (Tan et al., 2007) to game characters that she was not willing to accept.

As is evident from participant descriptions, the descriptions of emotion as conveyed by music varies widely between games in both type and intensity. The music in FOTW was designed to elicit feelings of hope, and the feeling that the player is an integral part of a larger “quest.” Conversely, the music in Hush was reminiscent of a lullaby and such supported the narrative of the mother and child in the game. As these participants described for these games, this connection was important to situate themselves on a quest in FOTW and to draw sympathy for the characters in Hush. Notably, participants pointed out a missed opportunity in FOTW to elicit stronger feelings of failure. Similarly, Salamander Rescue used music to convey either success or failure at the end of the game. Unfortunately, based on these participant descriptions, the music did not do a consistently clear job at communicating that people failed. Likewise, because there was no opening cinematic for SR, players were not given music to listen to that elicits any emotions. Indeed, just because music *can* convey emotion in games does not mean this experience always occurs. More research is needed to help develop a theory for how music in games is best applied in ways that modulate player emotional connections to gameplay.

The Game Visuals Presented Need to Match the Sound That People Hear. When Mismatches Occur They Are Noticeable.

The similarities in how people described discrepancies in what they saw and heard is notable. For Austin, the music he heard when he lost FOTW did not “drive the point” that he failed, but the music he heard when he lost SR was confusing, especially since what he saw was the color green, which for him signified winning. Sarah described the same mismatch with the sound and lose screen visual in FOTW, but described a lack of ability to associate the sound of singing with the mother in Hush, and a mismatch in the music that she heard when she lost SR. Gabriel also described an inconsistency in what he saw in FOTW and what he heard when he read the news, and went on to describe the mismatch between sounds that should have been present in SR near the hunter, but were otherwise missing. Donna also described a mismatch between seeing visuals of dire climate change, paired with the music that was "hopeful and…relaxing." Again, that each of these participants does not consistently describe how they perceive mismatches in sound and visual between each game is not surprising.

FOTW, Hush and SR all present different opportunities for sound and visuals to be paired, and they use visuals in different ways. FOTW conveys much of its narrative through animations during the opening cinematic, while Hush uses static images that appear during gameplay to convey a sense of the game's basic environment. By contrast, SR provides players with an immersive, 3-D environment in which to situate play. Given the diversity of the visual environments in each game, it is perhaps not surprising that these players would find different opportunities for mismatches to occur in each game. Still, the fact that mismatches occurred speaks to the synchretic relationship present between sound and visuals (Chion, 1994).

When a lack of a plausible connection between visuals and sound is present in what people experience during gameplay, they notice, and their noticing affects how they interpret and describe their play experience. More research clearly needs to be done to help predict where synchretic problems can occur in games. For these games, the problems stemmed from loose connections during opening cinematics and on the screens displayed while losing the game. However, other problems, such as lack of sounds for the amount of on-screen visuals, were apparent in SR, and the lack of sound to identify the main character of the mother in Hush were also present. It may be that these problems are related to a lack of planning the design of visuals and sound together in the game's design.

CHAPTER SIX: IMPLICATIONS

Sound, Games, and Implications for Design

DESIGNING SOUND FOR EDUCATIONAL GAMES

In the investigation described in this dissertation, I explored the experiences of six people as they played three different games and described their experiences of sound during play. Participant descriptions in this investigation were rich and nuanced. I derived essential meanings from their descriptions, which I present in Chapter 5, viewed from several perspectives by which to highlight the findings from this study: (1) An examination of the essential meanings in each of the three games studied provides an in-depth phenomenological view of shared experiences within each game; (2) I discuss the shared meanings found across all three games, which provide a glimpse into the related meanings found across all of the games in this study; (3) I examine the similarities and differences present in what individuals said about each of these shared essential meanings across the games studied, as a way to illuminate patterns in how people described sound in these games. The findings from these descriptions are perhaps not surprising, given the rich legacy of research in the effects of sound and music in areas such as film studies and in industry practices employed by game designs and film creators.

However, these findings have significant implications for the process used to design educational games. This analysis clearly indicates that sound and music are critical components to the design of games that are to be used for teaching and learning. Even seemingly subtle discrepancies in the pairing of sound with game elements are noticeable, such as when Donna described seeing polar bears dying in the introductory video to FOTW while simultaneously listening to music that was “hopeful and relaxing”. Moreover, as these participants describe, the absence of sound can also be deafening, such as when Sarah noticed the music cutting out when she played FOTW. It is thus within this space of educational game design that I situate my analysis and discussion. Throughout this analysis, I also hint at areas of research to explore in each of the shared meanings presented. In this chapter, I extend this analysis to discuss the implications that the findings from this research have on the process to design educational games.

2-D Strategy Games

As people in the study described, Fate of the World is a strategy game that asks players to tackle solving problems related to climate change. According to these participants, FOTW does a good job at positioning players on an epic quest to save the world, and uses sound in ways that give feedback and support the experience. Music is used to convey urgency in the cinematic and provides fuel for thought as players work. The sound in FOTW, although arguably well done, can stand to be improved. It is this space between how FOTW treats sound well, and how it can improve, that provides take-a-ways for people who would design similar games.

FOTW offers players the opportunity to be engaged in the game’s narrative from the opening cinematic of play. The players in this study adopted this narrative, and accepted the affective priming that led them to think they were on an epic quest. The music heard in the introductory video was critical to this positioning and, arguably, to engagement in the game as a whole. However, FOTW does not always appropriately match the music heard with the intensity of the visual images presented. This happens in the opening cinematic and in other areas of the game. As the essential meanings in this study reveal, sound is a key component to supporting player engagement in FOTW. As such, designers may need to use visuals designed to convey important semantic information in games like FOTW, and may wish to pair those visuals with sound to support this engagement. In this case, it is critical that the visuals in cinematic sequences and presentation of information during different rounds of play be enumerated to reflect not only broad aesthetic needs. In addition, key visual changes should be listed, and corresponding sounds should be selectively paired with those changes, in order to best provide a synchretic match between game sound and in-game visuals. Notably, the interface sounds that people described hearing when they clicked the mouse and operated the game's interface should not be overlooked. Sounds do not necessarily need to draw a player's attention in order to be effective. Sounds like the *ding!* in FOTW can be used to selectively draw player attention, while subtle clicking sounds that play when players use the mouse can provide subtle feedback that the player's physical connection to the game (e.g., a mouse) is working.

Interactive, Experiential Narrative-Driven Games

Players had a harder time describing the type of game that Hush represents, as compared with Fate of the World. I describe it as a social impact game, but participants focused the majority of their descriptions on the aspects of hitting letters with the right timing. That said, they described Hush as a typing game only when the sound was turned off, and they did not unanimously consider it to be a rhythm game. To be sure, Hush is difficult to classify as a game, simply because it does not fall into the common categories of games that people in this study described previously playing. Thus, I classify Hush according to its use of sound to support the historical context of the story of the game as it unfolds, since several of the essential meanings that emerged related to the role that sound played to support the narrative and the presentation of the game characters to the player. Thus I describe the implications of the findings for this game from this perspective. Most of the participants described richly intense experiences when hearing sounds while playing Hush. Hush accomplishes this by providing a detailed soundscape that situates players in a brutally real environment, while linking the core mechanic of the game to sounds made by a key game character (the baby) that is otherwise represented through a simple visual.

Hush uses powerful sounds to make it more difficult for players to comfort the crying baby, and thus to drive home the reality of life during a genocide. According to these participants, the experience of playing Hush hinged on hearing sound. These participants clearly described feeling empathy for the mother and child in the game. However, it is difficult to say from these descriptions how well Hush raised awareness of the specific plight of the people in Rwanda in 1994. People often described feeling empathy for people dying in a region ravaged by war, and to a lesser extent, genocide. However, the connection between their experiences and descriptions of empathy with Rwanda specifically did not emerge from their descriptions. It is plausible that the intense experiences of play as heard through sound may have been a factor. People repeatedly described noticing sound, but the visuals in the game were clearly the “supporting actors” as compared with the sound. Thus, since the connection to the region of Rwanda was only presented through visuals, this information may have been buried by the experience of sound.

At the very least, the lack of pairing of sound with the visuals that present the actual historical context speaks to a synchretic gap that exists in the game in the presentation of the audiovisual content in Hush. Hush has a few additional problems with insufficient pairing of sound and visuals. Participants were split as to whether they recognized and connected with the mother singing throughout the game. The mother's singing actually continues throughout Hush. However, half of the participants clearly described her voice being washed out by the rest of their experience of sound. The mother's singing is also somewhat disconnected from the visual of the mother on-screen. The mother (Figure 18) is represented as a silhouetted picture that appears to slightly move left and right on the screen during play. However, as some participants described, there is no way to make the connection between the woman singing and the mother on-screen. Had this connection been clearer, the role of the mother's singing might have been made clear to study participants.

These findings thus have implications for designers who wish to design games that present an opportunity to experientially engage with historical contexts. Based on these participant experiences, designers would be wise to take advantage of the potential for sound to provide a rich fantasy context for play. Moreover, the game's core mechanic is an example of what Habgood (2005, 2011) describes as endogenous fantasy; that is, fantasy that is embedded in the context of the play experience. In this way, Hush adopts what Collins (2008) describes as adaptive audio, in which game sound provides an indicator of game state. Designers who create interactive historical narratives can combine both sound and visual to present the progression of the game's story while making sound a primary component of the game's core mechanic. As was the case with FOTW, it is critical that the presentation of the on-screen visual be synchretically paired with the presentation of the sound, if players are to notice and incorporate key game characters into their play experiences.

3-D Problem-Based Learning Games

In playing Salamander Rescue, participants were asked to save as many salamanders as they could from dying in the island environment of the game. SR provides players with a visually rich 3-D space in which to situate play and, as people in this study described, uses sound as a way to reinforce the aesthetic realism of the play environment. Players were not always aware of these sounds, yet their play without sound conferred a loss of this realism. Based on player descriptions, SR is evocative of play in other 3-D virtual environments and as such, they often brought their own expectations with them for how the game should use sound.

They consistently made connections between the presence of objects in this space and the lack of sound associated with those objects. The game object of a water well, located outside of the lab, is one example of an object that players repeatedly wanted to interact with and hear but couldn't. In that case, players expected the object to have an audiovisual presence, and the lack of audiovisual synchresis was apparent. Players noted that Salamander Rescue used sound to provide feedback that objects like the iPad were working, and that features like the clicking slider in the water tester in the lab functioned in ways that helped players to use the in-game cognitive tool (Liu, Yuen, Horton, Lee, Toprac and Bogard, 2013).

Players also described ways in which the sound in SR could be designed to support their interaction with the characters on screen. As was the case in their descriptions of the animated characters in Fate of the World (who also did not talk), participants were split as to whether the characters in SR actually speak to the player. Players consistently mentioned a lack of sound with the characters of the three scientists on the island, and provided ideas as to how to make these characters come alive. One shared suggestion among several of these participants was to design sound that could be associated with the characters. For instance, the character of the hunter could be associated with sounds (and visual objects) of animals. Similarly, music could be used to help give these characters a musical identity that replayed when the player was in proximity. Leah described a similar effect, except instead of providing the character with an audible identity, she suggested ascribing unique sound that marked the location that the character was in. The suggestion of using sound to enliven characters is synonymous with using what Schafer (1993) calls sound signals, while the suggestion of using sounds to indicate specific locations is what Schafer describes as designing "soundmarks" to denote a sense of location. Either suggestion would provide players with an indication they are interacting either in unique spaces or with unique people, and in turn help players to see the visual depictions of people on the island as characters with whom they can interact.

At times, players also used spatial changes in the sound to help orient themselves in the space, although at times this effect was imagined, as was the case with Sarah when she thought music could help guide her to complete her objective. This misinterpretation in the use of sound for SR has important implications. First, it is possible that players like Sarah may attempt to assign meaning to coincidences they observe happening between the presentation of visuals and presentation of sounds they hear. In Sarah's case, she heard musical changes that she thought coincided with her changing directions on the island. If designers were able to purposefully design games in ways that use audible cues to indicate progression towards an objective, and do so in ways that integrated with the game's soundtrack or soundscape, players would then have a means by which to scaffold their learning through quests in the game, in ways that are authentic. Also, Sarah's initial misinterpretation of the function of background music in the game tells us that in the absence of clear applications for sound in games, it is possible that players may assign meaning to the sounds they hear, regardless of the original designer's intent. It is worth noting however that Sarah's case is unique, and thus hardly represents a problem with the music in SR. However the possibility of player misinterpretation of sound is nevertheless real.

Players repeatedly described the ways that sound helped the play in SR to be more fun. Even as people described needing more sound in SR, the sounds that were present formed a coherent audiovisual contract (Chion, 1994). This coherence was further maintained by the use of an auditory depth of field in the placement and programming of sound objects in the game, in addition to the composition of the background music in the game. Surprisingly, people described the music they heard as conveying a sense of the island they inhabited. Thus, the music they heard evoked a sense of the island they saw and thus also demonstrated a synchretic pairing between the visuals and sound presented. Thus, it is recommended that designers who work in immersive 3-D environments consider the design of the sound in ways that achieve a similar coherence in the games they design, if they are to preserve the fantasy they seek to evoke through the visual presentation of the virtual environment.

PLAYER INTERACTIVITY AND SOUNDSCAPES

I chose Fate of the World, Hush and Salamander Rescue because they each demonstrated uses of sound that corresponded to the framework proposed by Collins (2008), which I summarize in Table 1 and describe through detailed soundmaps in Appendix E. Moreover, rich participant descriptions further reflect Collins's division of sound by player interactivity.

Fate of the World provided an examples of non-dynamic sound in which players hear sound, but are not able to affect whether it plays. Although Hush contains some non-dynamic elements, its primary use of sound as an interactive element is adaptive. As the six participants in this study described, in Hush the player's actions determine the level of crying by the baby, thereby indicating the game's final outcome. Salamander Rescue also contains non-dynamic elements, but the game's sound does not adapt to player responses. However, SR does contain sound that is, by Collin's description, interactive. As players interacted with objects in the 3-D environment, the objects they touched noticeably made noise and player movement results in sounds that semantically conveyed the type of terrain and consequently, the location upon which the players walked (e.g., splashing in the water versus walking on a rickety bridge). All three games provide what Schafer (1993) describe as elements of a soundscape. As was conveyed in the participants' descriptions for Fate of the World, this soundscape is represented through the keynote ambience provided by different applications of background music. This music is heard as players progress from the menu screen, to the screen in the opening round of play, to the music at end of a turn, and to the music played at the end of the game. FOTW also provides a variety of interface sounds that indicate what Schafer (1993) describes as sound signals. These include sound elements such as the dings, clicks, and shuffling sounds that people described during their interviews.

As people described sound elements in Hush, they overwhelmingly described the ways in which sound helped to situate them within the game's environment of a war torn area, with the sounds of soldiers and of dying happening around them, and, for many people, *to* them. These sound elements convey a range of sound signals in the environment, while the mother's singing and baby's breathing conveyed the keynote ambience of the environment, although players did not always notice these sounds. In SR, players described the soundscape in terms of sound signals such as the sounds made by the iPad, water tester in the lab, and the footsteps in the game. The sounds that comprised the game's ambient keynote track included sounds such as the blowing of the wind, while one of the game's soundmarks was denoted by the hum of the equipment in the lab. These sounds were not as salient in player descriptions; however, they were nevertheless were critical in immersing players in the island environment of the game.

An Applied Phenomenological Framework

This research takes a phenomenological approach to study people's experiences of sound. As described in Chapter 3, I ground this research in descriptive and interpretive phenomenological traditions and I incorporate Don Ihde's (2007) philosophical perspective on sound and silence. I discuss his Focus Field Horizon Structure model (Figure 1), which illustrates a circular space that represents all possible horizons by which to describe sound. A smaller inner circle represents the listener's immediate focus on sound within this field. Notably, the boundary of his model represents silence. I use his model to justify my use of silence as a perceptual tool in this study to help people recall and discriminate their experiences of sound in the games that they played. In this section, I return to this model, and incorporate perspectives by Karen Collins (2008) and R. Murray Schafer (1993) to construct an applied phenomenological framework to describe the impact of sound in the educational games studied (Figure 19).

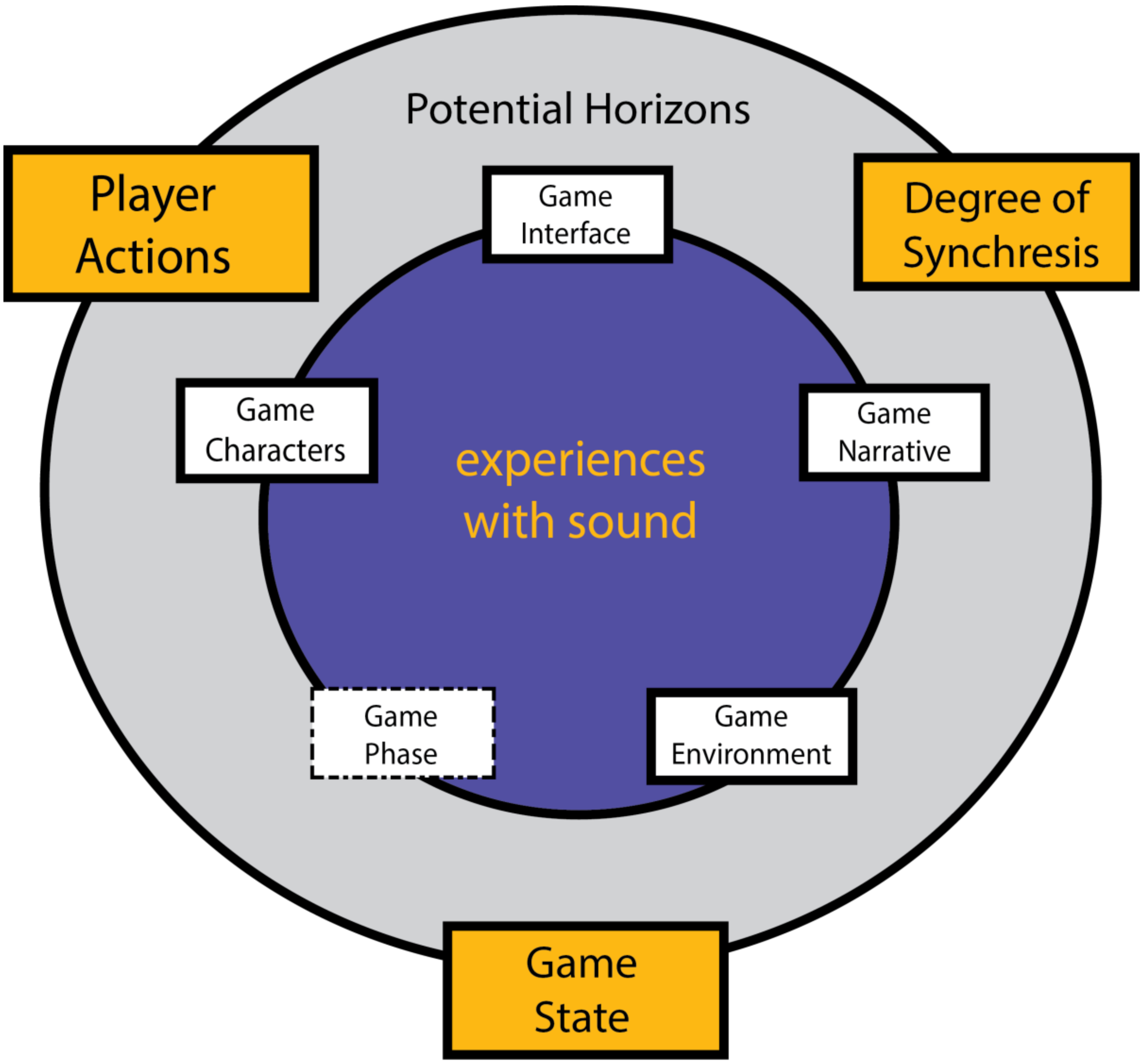

Figure 19. Applied phenomenological framework for sound in educational games

This model contains two concentric circles; the larger circle is titled "Potential Horizons," while the inner circle is titled "experiences with sound." This pattern is analogous to Ihde's (2007) Field Focus Horizon Structure model (Figure 1), except that in this framework, the inner circle represents the participants' experiences of sound in the games they played. The outer circle thus represents a possibility space for all of the potential horizons of meaning that could exist for the player. These potential horizons are dependent on three critical factors, represented in boxes placed on the border of the outer circle: the actions taken by the player in the game ("Player Actions"), the game's state at the time of the experience ("Game State"), and the degree of synchretic pairing of sound and image that is embedded in the game's design ("Degree of Synchresis"). The notion of player actions is analogous to Collins's (2008) discussion of interactive sound that is triggered as a result of the game players' interaction with the game (Table 1). Collins refers to interactions with game objects, such as the water tester in Salamander Rescue (Figure 15). The idea of game state is also taken from Collins's framework, as described in Table 1. Here, Collins refers to game state in the context of the changing conditions that mark different aspects of play, and thus results in what she describes as adaptive audio. Hush makes liberal use of adaptive audio when it uses sound to represent key changes in the win/lose state of the game. Players who continued to succeed in the game heard increasingly brutal sounds, which made the game harder to play and thus reflected play that approached the win state of the game. Player interactions in SR and the use of a dynamic game state in Hush represent key conditions that mediate player experiences of sound in those games. Thus, I use them in this framework to denote two critical but variable factors that determine the potential horizons of meaning that participants described in this study. It is worth noting that while I incorporate two key factors from Collins's (2008) framework for functions of game audio, I do not include her description of non-dynamic audio for sound that is not impacted by player actions, since the experiences from these sounds are included both in the explanation of synchretic pairing and are also reflected in other areas of the framework.

The third factor in the outer circle, Degree of Synchresis, is also included in this area because of the importance that the participants placed on audiovisual pairing across all three games studied. Degree of Synchresis reflects the extent to which there is a plausible pairing of sound and visuals within the game's design. While these participants clearly describe the importance of having sound and visuals connected throughout these games, the way this pairing is interpreted varies. Although participants often agreed upon problems when seeing visuals without sound (e.g., the visual depictions of scientists in SR), this agreement was not always universal (e.g., the lose music on the SR lose screen). The three factors, Player Actions, Game State, and Degree of Synchresis, mediate participant experiences of sound as they play games and are dependent upon the players' actions, their progress through game states, and the degree to which players interpret synchretic pairing of sound and visuals. Although these three factors may vary based on an individual's own experience and perspective, it is important to note that removing the ability for players to hear sounds when they interact with a game, failing to provide sound to denote game state, or having minimal synchresis present in a game can all dramatically reduce the number of potential horizons of meaning can be derived as a result of experiences of sound.

While the outer circle of this framework (Figure 19) represents the potential horizons of meaning that could emerge from play, the inner circle represents components that were presented using embedded sound by the three games studied. These components are represented as boxes placed on the inner circle: Game Interface, Game Characters, Game Narrative, Game Environment, and Game Phase. All of these components, except Game Phase, were extracted from the shared essential meanings found in common across all three games. The fifth component, Game Phase, was added because it was an essential meaning derived specifically from the analysis of Fate of the World. This game in particular contained a game structure that the other games did not. Namely, it organized play through a series of phases within a given round. As was described in the essential meaning related to this component, participants thought that sound and music could be used as milestones to denote key structural points in their play. The game phase component is thus included in this framework since it has the potential to describe other games that have a similarly structured game design. However, because this component did not emerge as a shared essential meaning, I give the box a dotted outline. All five components of gameplay thus reflect the ways in which sound is embedded in each of the games' designs in this study. The inner circle represents actual player experiences with sound as played games, and as such is situated within the overall possibility space of the potential horizons of meaning.

Questions about why sound was important to people's experiences of play in this study rest in the description of the shared essential meanings, and in the implications for the application of sound in these games. Sound in these games clearly supported player engagement in each of the games studied. This framework is designed to visually summarize the relationship of game components and mediating factors that defined the possible horizonal space for this study and which, through play, ultimately led to these participants' thick descriptions of sound in educational games.

Limitations

I derive an applied phenomenological framework for sound in educational games from the essential meanings derived from the findings in this study. Thus, the presentation of this framework itself defines its own limitations. It is not my intention to derive a generally applicable framework to define and illustrate all uses of sound in educational games. Such an endeavor would be impossible, given the depth and scope of current educational game designs. Many such designs incorporate diverse strategies that combine immersive narratives with immersive 3-D environments, while including strategic decision-making on the part of game players. Thus, attempting to build a framework to define the scope of sound experiences all possible educational games is futile, as the definition of what constitutes an educational game is constantly changing. A framework that is based on an attempt to enumerate functions or uses of sound is equally futile, since sound can be designed to support visuals and gameplay in equally infinitely diverse ways. Thus, I do not attempt to catalog all possible functions and uses for sound in educational games in this framework.

I did not research commercial, off-the-shelf entertainment game titles for this study and thus I did not hear player experiences of sound in popular, commercial games that are also used for teaching and learning. I limited the number of educational titles in this study to three, and thus I do not claim that the findings from this study are generalizable to all educational games. It is not only possible but also likely that research with different educational games will result in different descriptions of experiences of sound, which may lead to a refinement of the framework that I present.

I interviewed a total of six participants for this qualitative study. Although this group was diverse in gender, age and profession, it is possible that discussions about sound with different participants may yield even more diverse results. Consequently, I also do not claim that the essential meanings derived from these participant experiences will match those of all people who play educational games. Finally, I was the only researcher to engage with these participants. It is possible that other researchers would have different perspectives on the horizons and essential meanings that emerge from this research.

Concluding Thoughts

Significant research is now needed to test the applicability of this phenomenological framework for sound to design sound for other types of educational games. An analysis of this framework, the essential meanings from each of the games studied, and the shared essential meanings between these games presents ample opportunities to develop theories about the ways in which sound helps learners stay engaged as they play educational games. Furthermore, my study involved learners from diverse backgrounds, such as undergraduate and graduate university students in addition to working adults. However I did not use people's varying degrees of musical backgrounds as an analysis variable. Given the varying degrees in specificity of the comments made by my participants, I am now curious as to whether differences in musical backgrounds of people who play educational games affect their phenomenological responses to sound. Furthermore, there are faint glimmers in these descriptions that indicate the potential for flow experiences. These experiences point to fertile ground for exciting research to extend, broaden, and ultimately deepen the findings derived from this phenomenological investigation. It is my hope that this study will thus inspire future research that explores sound, games, and motivation.

APPENDICES

Appendix A: Pre-Screening Script

The intention of the pre-screening process is to assess the person's willingness to participate in an extended research process and to gauge their interest in the topic. The following script serves as a guide to structure a brief 10 to 15 minute conversation to help inform the person of the research and what will be asked of them if they choose to participate.

> Hi xxxx. Thanks for meeting with me today to discuss the research study. How did you hear about this study? I'm a doing dissertation research in the Learning Technologies program in the College of Education at UT. I'm interested in learning more about how people experience sound as they play educational games. I'd like to talk about the study and answer any questions that you may have before we get started with the interviews. I am doing a study on people's experiences of sound as a result of playing educational games. I'm asking people to play a variety of educational games and describe their experiences of what they hear in the game. I'm asking each person to play three games over three different sessions. I'll be asking you questions as you play and I'll be recording the session. You don't need to be proficient with playing games in order to participate. If you agree to participate, we'll need to meet a total of three times, not including today and each meeting will last about an hour. I'll be asking you questions like, "what are you hearing as you play the game? or "What thoughts about sound used in the game stood out for you as you play?" I might ask you to play an area of the game a couple of times and ask you about what you hear and I may ask about how what you hear is impacting how you play. Do you have any questions for me at this point?
>
> I'm curious—do you like to play either computer games or console games? Do you have a favorite game? What about music—do you enjoy listening to music? What kind of music do you like to listen to?
>
> You should know that I'll be recording each of our gameplay sessions as you play and talk. I'll also be videotaping our session so that I can refer back to our discussion later. What you say will be completely anonymous in my research, and I won't share the recordings with anyone outside of my dissertation committee. Although I'd like for us to have three meetings, there's no obligation on your part to complete the research and you can back out at any time. I'm giving away gift cards for everyone who participates. I'm hoping that these sessions will be fun

and provide you with a chance to play some educational games while they give us a chance to talk about sound. Do you think you might be interested in participating?

[If yes] OK, great! I’m glad to hear that you’re interested. I’m putting together an interview schedule and would like to see how our schedules line up. [Discuss scheduling.] Thanks for letting me know about your schedule.

[If I have doubts as to their fit for the study] Thanks for taking the time to talk with me today about the study. I’ll be in touch once I make a final selection of people to participate in this study.

[If it is clear that the person will be a good fit] Thanks for taking the time to talk with me today about the study. When do you think you might be available to start the study? How frequently would you be able to meet?

[If no] OK. Thanks for taking the time to talk to me today.

Appendix B: Interview Prompts

All interviews were structured as open-ended discussions of sound in educational games. I let participant responses shape the questions asked during the interview. Some examples of questions and prompts that I used include the following:

1. Can you walk me through some of your thoughts about sound used in the game that you just played?
2. Can you tell me more about what you said when you described xxxxx?
3. What thoughts are standing out to you as you play and listen to the sounds here?
4. Earlier you mentioned that you were experiencing xxxx. Are you noticing the same thing here?
5. Some people describe xxxx as they listen to sound here. Are you noticing something similar? Different? In what way?
6. Can you tell me more about the sound that you hear in this area? Do you find that it helps you or interferes with what you're doing?
7. Can you describe any feelings that were generated as you played the game?
8. Did you notice that there wasn't sound here xxxxx? Do you think there should be sound at this point?
9. I am going to observe you while you play the games in this session. Sometimes people who play video games experience physical reactions such as leaning into the screen, facial expressions or laughter. I'll be

observing these reactions and may ask you about them during the interview. During the observation I noticed xxxx; did you realize that you were doing xxxx? Can you help me to understand more about xxxx?

10. Is there anything that you'd like to share about experiences with sound?

Appendix C: Research Matrix

This matrix structure to organize sources of data with data analysis techniques is derived from Hughes (2009). Participant quotations are from a pilot study.

Table 6. Research Matrix

Research Question	**Data Sources**	**Specific data to answer this question**	**Analysis Required**	**What this allows me to say**
What is it like to experience sound while playing educational games?	Participant Interviews	Participant descriptions of their experiences of sound as they play games	Descriptive phenomenological data reduction: identification of meaning units / horizons / invariant constituents	The following meaning units were identified from Everest's interview, e.g., "but this is different. It has emotional [sic] like, I don't know…that just made me nervous." The following horizons were derived from the meaning units in Everest's interview, e.g., "I've never [had] emotion like this in a game" The following invariant constituents were derived from the identified horizons, e.g., "For Everest, sound brought an emotional experience. Everest explains this as a result of becoming aware of what is happening around her in the game"

Research Question	**Data Sources**	**Specific data to answer this question**	**Analysis Required**	**What this allows me to say**
				The following final invariant constituents represent the final, grouped clusters of initial invariant constituents, e.g., “Sound can trigger emotional experiences”
	Gameplay recordings	Examples of participant gameplay interactions as they describe their experiences	Coding to associate recordings with meaning units / horizons / invariant constituents.	The following codes were used to describe Everest’s gameplay with Hush, e.g., “presses keys too late.”
	Video recordings	Participant non-verbal, affective responses that accompany descriptions	Coding nonverbal responses, e.g., laughter, hand gestures, dancing while seated (occurred during a prior study)	The following codes were used to describe Everest’s nonverbal responses during gameplay with Hush, e.g., “hands in lap,” “hand hovers above keyboard.”

Appendix D: Analytical Process

In this Appendix, I provide a sample of the data from this study as an example of the analytic process. This data are taken from the Excel spreadsheets used to organize meaning units that were originally coded in NVivo. These steps illustrate the identification of sound horizons as described through meaning units, the organization of the meaning units into tentative clusters of meaning, and finally, the derivation of the constituents of meaning identified in Fate of the World. These fundamental analytical steps provide the basis for the textural-structural descriptions and imaginative variation for FOTW in Chapter 4, and ultimately ground the discussion of the essential meanings of participant experiences in this game in Chapter 5.

MEANING UNITS

The data in Table 7 represent a fractional sample of the initial set of 534 meaning units that characterize the horizons of experience represented in *Fate of the World*. Data were coded and meaning units were clustered with the original interview protocol to produce 50 initial clusters of meaning. Table 7 thus pairs two sample meaning units with their corresponding tentative meaning unit clusters, in addition to the original interview text that is associated with the meaning units. These tentative clusters were associated with multiple passages of text from the interview protocol. The first meaning unit cluster example in Table 7 represents 13 meaning units, while the second example represents 9 meaning units. Each meaning unit corresponds to either a segment of text in the interview protocol or a portion of the recorded gameplay or interview video footage. Once these tentative clusters were identified, they were then filtered, re-examined, broken apart, and regrouped into constituents of meaning.

Table 7. Example Meaning Unit Clusters

Meaning Unit Cluster	**Meaning Unit**	**Original Interview Protocol**
Overall the intro sound was	I think [the FOTW intro] needs some kind of music though...it's going to take you into [the game]	SARAH: I think it needs some kind of music though right? JASON: Why? SARAH: It’s going to take you into it and makes you — well I like you know, having some kind of [music] otherwise I mean, it’s visually pretty but it doesn’t take you into the game as much.
Lose music didn’t make me feel like I lost	I wouldn't have guessed that...I was that close	ANDREA: Okay [laughing hard] this part was just kind of like oh you failed like it goes into like minors and it’s just kind of like its…gets quieter... JASON: Oh you mean the music switches into minor mode? ANDREA: Yeah and then I just kind of like oh…oh I did bad. I guess like whenever I looked at the actual results and like I didn’t I wouldn’t have noticed that I would have known that was so close to beating it with this music like it’s just kind of like this music just kind of like oh you fail everything but then whenever like I actually look at my result

Meaning Unit Cluster	Meaning Unit	Original Interview Protocol
		like knowing like I wouldn't have guessed that I beat -- I was that close.

CONSTITUENTS OF MEANING

Once meaning unit clusters were identified, I gradually moved away from the original original interview protocol to my interpretation of the meaning units. This step led to the identification of constituents of meaning, as described in Chapter 3, which reflect the thematic categories of participant experiences in the games studied. A sample of the constituents of meaning from Fate of the World is provided in Table 8. For both examples, the tentative clusters were reorganized into different groupings to represent constituents of meaning. In the first example, the meaning unit was organized to support two separate constituents of meaning. The first of these constituents, which describes the intro music in FOTW, is associated with 28 meaning units, while the second constituent, which describes the background music, is associated with 15 related meaning units. In the second example, 9 meaning units are associated with the constituent of meaning of background music and emotion. The final set of constituents for FOTW is provided in

Table 3.

Table 8. Examples of Constituents of Meaning in FOTW

Meaning Unit	Constituents of Meaning
I think [the FOTW intro] needs some kind of music though...it's going to take you into [the game]	The intro music was dramatic and also hopeful. It helped me predict what the game was going to be like and helped to throw me into the game
	The background music added a lot. It was engaging and served as fuel for my thoughts as I played.
I wouldn't have guessed that...I was that close	The background music doesn't provide much emotion, nor does it give me details that help me to play the game.

Appendix E: Soundmaps

FATE OF THE WORLD SOUNDMAP

- Number of total interactive sounds: 0
- Number of adaptive sounds: 3
- Number of non-dynamic sounds: 17

Table 9. FOTW Soundmap

Sound Description	**Sound Event**	**Soundscape Sound Type**	**Player Interactivity**	**Sound Source**
Heroic movie score music conveying drama, danger, epic task to save the planet from environmental collapse	Opening introductory video	Intro music	Non-dynamic (triggered upon starting a new game)	Background
Simple chords that correspond to the melody heard in the opening video, but muted	Background music to the new game menu screen, including character creation	Menu music	Non-dynamic (triggered at main menu screen only)	Background
Smooth, long, sustained chords as music	Background music to the gameplay	Keynote: game music	Adaptive (triggered when starting gameplay and only during first round of play)	Background
Mildly happy, upbeat in-game music	Background music to gameplay	Keynote: game music	Non-dynamic (but triggered only after first round of gameplay ends)	Background
Mildly happy, upbeat in-game music but with	Background music to gameplay	Keynote: game music	Non-dynamic (but triggered only after 1st	Background

Sound Description	Sound Event	Soundscape Sound Type	Player Interactivity	Sound Source
noticeable percussion (wood drums) and soft syncopated rhythms			round of gameplay)	
Affectively neutral, 'thinking and waiting' music with no percussion. Music uses a simple rhythm. Primary instrument is a single mallet with subdued string accompaniment to generate sense of time and pacing.	Used to convey waiting as statistical results of the round are revealed	Keynote: game music	Non-dynamic (but only triggered on results screen). Game music completes during first few seconds of a new round, then crossfades into a new music loop.	Background
Sad, serious game music with sustained, minor chords	Background music to lose screen	Keynote: lose screen	Adaptive: triggered only on lose screen	Background
Simple but heroic chords that develop as an end game theme	Background music to win screen	Keynote: win screen	Adaptive : triggered only on win screen	Background
High-pitched 'ding' tone	Indicates when a new card slot is activated	Sound signal	Non-dynamic menu effect	Bottom of main game interface
	Indicates clicking on 'next' buttons	Sound signal	Non-dynamic menu effect	Throughout the game
2 high-pitched 'ding' tones played in succession	On moving to next screen	Sound signal	Non-dynamic menu effect	Throughout the game
	Indicates a move between rounds of play	Sound signal	Non-dynamic menu effect	Throughout the game

Sound Description	Sound Event	Soundscape Sound Type	Player Interactivity	Sound Source
Single-chord, high-pitched arpeggiated ‘ringing’ chord	On exiting character name screen	Sound signal	Non-dynamic menu effect	Character creation screen
Single, non-arpeggiated ‘ringing’ chord	End of every round of play	Sound signal	Non-dynamic menu effect	Main game interface
Simple muffled click	Selecting agents on deploy screen	Sound signal	Non-dynamic menu effect	Select agents screen
Simple unmuffled click	Closing pop-up windows	Sound signal	Non-dynamic menu effect	All pop-up windows
Two-tap click	Indicates the world icon has been clicked (to jump back to the first level game menu)	Sound signal	Non-dynamic menu effect	Second-level game interface
Paper shuffling sound	Indicates selection of cards on card screen	Sound signal	Non-dynamic menu effect	Choose cards screen
Low pitch ‘whup’ sound of waving paper through air	Indicates mouse hover above a card	Sound signal	Non-dynamic menu effect	Choose cards screen
Barely audible ‘tap’	Indicates when the countries of either northern Africa and southern Africa are selected.	Sound signal	Non-dynamic menu effect	Main game interface

HUSH SOUNDMAP

- Number of total interactive sounds: 0
- Number of adaptive sounds: 8
- Number of non-dynamic sounds: 5
- Number of sounds with non-dynamic and adaptive behavior: 1
- Lose condition applies if player is unsuccessful at typing a word: 5
- Win condition applies if player is successful at typing a word: 12

Table 10. Hush Soundmap

Sound Description	**Sound Event**	**Soundscape Sound Type**	**Player Interactivity**	**Sound Source**
Soft ambient slight drone, baby breathing	Background to all events	Keynote	Non-dynamic (triggered upon game load)	Background
Woman singing	Background to all events	Keynote (music)	Non-dynamic (triggered after tutorial ends)	Foreground picture of mother
Soft piano music	Background piano music playing a lullabyheard upon game opening and during game tutorial and again with string accompaniment at win screen.	Sound signal (music)	Non-dynamic (same music triggered upon game load and upon winning the game) *and* adaptive (triggered on win, not lose)	Background
Happy baby sounds: breathing, squeaking, etc.	Mother is able to comfort her child, child is happy	Sound signal	Adaptive (plays when game state = no letters missed)	Foreground, picture of mother
Child talking, agitated. Voice	Mother is less able to comfort her child, child begins talk/becomes	Sound signal	Adaptive (plays when game state detects	Foreground, picture of mother

Sound Description	Sound Event	Soundscape Sound Type	Player Interactivity	Sound Source
becomes urgent	agitated		multiple letters missed)	
Child crying	Mother is not able to comfort her child	Sound signal	Adaptive (plays when game state = more letters missed)	Foreground, picture of mother
Child screams, wailing.	Mother loses control of her crying child	Sound signal	Adaptive (plays when game state = many letters missed)	Foreground, picture of mother
Mother sings softly	Mother is humming to the baby. Humming becomes less noticeable over time. Trigger 19 s after game tutorial.	Sound signal	Non-dynamic	Foreground, picture of mother
Radio announcer heard on an unseen radio. Voice insistent, cold.	Triggered 19 s after game tutorial	Sound signal	Non-dynamic	Foreground, but acousmatic (radio is unseen)
Soldiers walking around, talking to each other. Footsteps.	Triggered 38 s after game tutorial. Mother/child not seen	Sound signal	Non-dynamic	Foreground, picture of soldiers through windows
Soldiers talking. Distant gunfire.	Triggered 47 s after game tutorial. Mother/child not seen.	Sound signal	Non-dynamic	Foreground, picture of soldiers through windows
Sounds of soldiers talking. Gunfire,	Soldiers are nearby but still haven't detected mother/child	Sound signal	Non-dynamic (triggered 1min. 28 sec after game	Foreground, but acousmatic

Sound Description	Sound Event	Soundscape Sound Type	Player Interactivity	Sound Source
violence is louder.			tutorial)	
Soldiers talking, gunfire, slashing. Mother gasps.	Soldiers have found the mother/child. Mother is surprised when found.	Sound signal	Adaptive (signals end of game)	Foreground, but acousmatic
Shouting, sounds of violence, people dying.	Soldiers are very close and are terrorizing people outside	Sound signal	Adaptive (signals increased intensity of action and signifies start of next level of play at 2 m 15 s after game tutorial)	Foreground, but acousmatic
Shouting, sounds of violence grow louder, shouting, wailing.	Soldier is right outside the mother's location and is killing people	Sound signal	Adaptive (sound of killing people only starts at 2 m 33 s after game tutorial)	Foreground, but acousmatic
Loud gunfire, slashing, sounds of violence	Soldier continues killing rampage with new victims	Sound signal	Adaptive (intensity of action/killing increases with new conversation and killing at 3 m 9 s after game tutorial. Intensity increases until end of game at 4 m 10 s and fades out.)	Foreground, but acousmatic

SALAMANDER RESCUE SOUNDMAP

- Number of interactive sounds: 20
- Number of adaptive sounds: 2
- Number of non-dynamic sounds: 7
- Note: Location is provided in this Soundmap since the player is provided a spatial environment for gameplay.

Table 11. Salamander Rescue Soundmap

Sound Description	Sound Event	Soundscape Sound Type	Player Interactivity	Sound Source	Location
Click	Player activates iPad	Sound signal	Interactive: iPad home button press	On/off button	iPad
Soft drum tap	Player uses a tool	Sound signal	Interactive: button press	Button	iPad / computer
Electronic stuttering	Player closes tool/window/ intro menu selection	Sound signal	Interactive: button press	Button	iPad / computer
Simple click	Player selects email	Sound signal	Interactive: button press	Email	iPad
Electronic bloop (soft)	Character activates dialogue	Sound signal	Interactive: run into character	Game characters	Dialogue bubble
Electronic bloop (loud)	Game tutorial activates	Sound signal	Adaptive: opening player prompts	Pop-up window	Salamander icon dialogue bubble
Paper swipe	Sub-menu selection in iPad	Sound signal	Interactive: window press	Character dialogue	Dialogue window
Non-descript electronic bloop	End screen	Sound signal	Interactive: window press	Character dialogue / collect dialogue	Dialogue window
Electric current: stutter	Player activates a test	Sound signal	Interactive: button press	Button	Water tester
Soft clicks	Player uses a	Sound	Interactive:	Slider	Water

Sound Description	Sound Event	Soundscape Sound Type	Player Interactivity	Sound Source	Location
	slider	signal	changes with number value	moves up and down	tester
Hum, low gurgling	Machine noise	Sound signal	Non-dynamic: heard when in lab	Water tester	Lab
Snick	Machine turns on or off	Sound signal	Interactive: button press	Big red button	Water tester
Clop on wood surface	Walking	Sound signal	Interactive: player walks	Footsteps	Lab
Overall background ambience with breeze, birds	Outdoor environment	Keynote	Non-dynamic: heard throughout the game	General soundscape	Outdoors
Hum of lab equipment, lights, small room ambience	Indoor environment	Soundmark	Non-dynamic: heard in lab	General soundscape	Lab
Outdoor area (tropical): louder birds, buzzing insects	Outdoor environment	Soundmark	Non-dynamic: heard in tropical area	General soundscape	Outdoors: swamp area
Outdoor area (snow): cold wind	Outdoor environment	Soundmark	Non-dynamic: heard in snow area		
Less crunchy grass	Walking	Sound signal	Interactive: player walks	Footsteps	Outdoors: grass (thin)
Soft clop on cobblestone	Walking	Sound signal	Interactive: player walks	Footsteps	Outdoors: cobblestone path

Sound Description	Sound Event	Soundscape Sound Type	Player Interactivity	Sound Source	Location
Soft thud on wood	Walking	Sound signal	Interactive: player walks	Footsteps	Outdoors: smooth wooden bridge
Hollow thud on creaking planks	Walking	Sound signal	Interactive: player walks	Footsteps	Outdoors: rickety wooden bridge
Sloshing through water	Walking	Sound signal	Interactive: player walks	Footsteps	Outdoors: water
Soft crunch through snow	Walking	Sound signal	Interactive: player walks	Footsteps	Outdoors: snow
Soft snap.	Collect hard object	Sound signal	Interactive: player picks up object	Pick up	Outdoors: various areas
Scraping as something is lifted off the ground	Collect soft object	Sound signal	Interactive: player picks up object	pick up	outdoors - various areas
Downtempo music: background ambience, with wood percussion, bamboo and other natural timbres	General game background music	Keynote (music)	Non-dynamic, triggered after game menu loads	Background	n/a
Opening music: calming, simple melody with wood mallet instrument	Opening intro menu screen	Keynote (music)	Non-dynamic, triggered after game starts	Background	n/a

Sound Description	Sound Event	Soundscape Sound Type	Player Interactivity	Sound Source	Location
Win screen music: upbeat electronic music, with major modality, arpeggiated tones	Closing win screen	Sound signal	Adaptive (triggered at end upon win state)	Background	n/a
Lose screen music: downtempo music identical to game background music, but with a minor modality	Closing lose screen	Sound signal	Adaptive (triggered at end upon lose state)	Background	n/a
Intro narration	Intro menu selection	Sound signal	Interactive (triggered upon menu choice after game loads)	Background	

References

Alexomanolaki, M., Loveday, C., & Kennett, C. (2007). Music and Memory in Advertising - Music as a Device of Implicit learning and Recall. *Music Sound and the Moving Image, 1*(1), 22.

Antonisse, Jamie. "Hush." Hush. Jamie Antonisse, n.d. Web. 26 May 2014. <http://www.jamieantonisse.com/hush/about.html>.

Baddeley, A. (1992). Working Memory. *Science, 255*(5044), 4.

Beccue, B., Vila, J., & Whitley, L. K. (2001). The Effects of Adding Audio Instructions to a Multimedia Computer Based Training Environment. *Journal of Educational Multimedia and Hypermedia, 10*(1), 20.

Belinkie, M. (1999). Video game music: not just kid stuff. Retrieved from http://www.vgmusic.com/vgpaper.shtml

Bishop, M. J., & Cates, W. M. (2001). Theoretical Foundations for Sound's Use in Multimedia Instruction to Enhance Learning. *Educational Technology Research & Development, 49*(3), 18.

Bishop, M. J., Amankwatia, T. B., & Cates, W. M. (2008). Sound's use in instructional software to enhance learning: a theory-to-practice content analysis. *Educational Technology Research and Development, 56,* 467-486. doi: 10.1007/s11423-006-9032-3

Bogost, I. (2007). Persuasive Games - The Expressive Power of Videogames [Kindle version]. The MIT Press.

Bogost, Ian (2008, February 12). Persuasive Games: Videogame Vignette [Blog post]. Retrieved from: http://www.gamasutra.com/view/feature/131942/persuasive_games_videogame_.php

Boltz, M. G., Schulkind, M., & Kantra, S. (1991). Effects of background music on the remembering of fimed events. *Memory & Cognition, 19*(6), 593-606.

Burak, A., Byrd, M., Treat, E., Ramos, J., Levine, J., Wei, H. (2012). Games for Change. Retrieved September 11, 2012, from http://www.gamesforchange.org/

Bush, T. W., Gershin, S., Klein, M., Boyd, A., & Shah, S. (2007). *The Importance of Audio in Gaming: Investing in Next Generation Sound*. Paper presented at the annual Game Developers Conference, March 4-9, 2007, San Francisco.

Cage, D. (Writer). (2010). Heavy Rain. In Q. Dream (Producer), *The Making of Heavy Rain: Music*.

Carlsson, S. E. (1994). When Picture and Sound merge. Learning Space dedicated to the Art and Analyses of Film Sound Design. Retrieved March 2, 2013, from http://filmsound.org/when_picture_and_sound_merge/

Chen, Y-C., & Spence, C. (2010). When hearing the bark helps to identify the dog: Semantically-congruent sounds modulate the identification of masked pictures. *Cognition, 114*(3), 15.

Chion, M. (1994). *Sound on Screen* (C. Gorbman, Trans.). New York: Columbia University Press.

Chomsky, N., & Halle, M. (1968). *The Sound Pattern of English*. New York: Harper & Row.

Cilesiz, S. (2009). Educational computer use in leisure contexts: A phenomenological study of adolescents' experiences at Internet cafes. *American Educational Research Journal, 46*(1), 42.

Cilesiz, S. (2010). A phenomenological approach to experiences with technology: current state, promise, and future directions for research. *Education Tech Research Dev, 59*(4), 24. doi: 10.1007/s11423-010-9173-2

Colaizzi, Paul. (1978). Psychological Research as the Phenomenologist Views It. In R. Valle & M. King (Eds.), *Existential Phenomenological Alternatives for Psychology* (pp. 48-71). New York: Oxford Press.

Collins, K. (2008). *Game Sound: An Introduction to the History, Theory, and Practice of Video Game Music and Sound Design*. Cambridge, MA: The MIT Press.

Corbin, J. and A. Strauss (2008). *Basics of Qualitative Research*. New York: Sage Publications.

Cope, D. (2001). *Virtual music computer synthesis of musical style*. Cambridge, Massachusetts: MIT Press.

Cilesiz, S. (2009). Educational computer use in leisure contexts: A phenomenological study of adolescents' experiences at Internet cafes. *American Educational Research Journal, 46*(1), 42.

Corbin, J. and A. Strauss (2008). *Basics of Qualitative Research*. New York: Sage Publications.

Csikszentmihalyi, M. (1990). *Flow, The Psychology of Optimal Experience*. New York: Harper Collins.

Dahlberg, K., Dahlberg, H., & Nystrom, M. (2008). *Reflective Lifeworld Research (2nd ed.)*. Lund, Sweden: Studentlitteratur AB.

Degerman, A., Rinne, T., Pekkola, J., Autti, T., Jääskeläinen, I. P., Sams, M., & Alho, K. (2007). Human brain activity associated with audiovisual perception and attention. *NeuroImage, 34*, 8.

Dourish, P. (2004). *Where the Action Is, The Foundations of Embodied Interaction* [Kindle version]. Cambridge, Massachusetts; London, England: The MIT Press.

Farnell, A. (2010). *Designing Sound* [Kindle Edition version]. Cambridge, Massachusetts: MIT Press.

Gaver, W. (1993). What in the world do we hear? An ecological approach to auditory event perception. *Ecological Psychology, 5*(1), 28.

Gaver, W., Smith, R., & O'Shea, T. (1991). *Effective Sounds in Complex Systems: The ARKOLA Simulation*. Paper presented at the SIGCHI Conference on Human Factors in Computing Systems, New Orleans, LA. doi: 10.1145/108844.108857

German, T., & Barrett, H. C. (2005). Functional Fixedness in a Technologically Sparse Culture. *Psychological Science, 16*(1), 5.

Gibbons, W. (2009). Blip, Bloop, Bach? Some Uses of Classical Music on the Nintendo Entertainment System. *Music and the Moving Image, 2*(1).

Giorgi, A. (1997). The theory, practice, and evaluation of the phenomenological method as a qualitative research procedure. *Journal of Phenomenological Psychology, 28*(2), 26.

Giorgi, A. P., & Giorgi, B. M. (2003). The descriptive phenomenological psychological method. In C. P., J. Rhodes & L. Yardley (Eds.), *Qualitative Research in Psychology*. Washington, DC.: APA.

Grimshaw, M. (2010). Player Relationships as Mediated Through Sound in Immersive Multi-player Computer Games. *Communicar, 34*(17), 7. doi: 10.3916/C34-2010-02-07.

Habgood, M.P.J., Ainsworth, S.E., Benford, S. (2005). Endogenous fantasy and learning in digital games. Simulation & Gaming 36. 483.

Habgood, M.P. J., Ainsworth, S.E. (2011). Motivating children to learn effectively: exploring the value of intrinsic integration in educational games. Journal of the Learning Sciences, 20 (2), 169-206.

Hallam, S. (2012). The Effects of Background Music on Health and Wellbeing In R. MacDonald, G. Kreutz, L. Mitchell (Eds.), *Music, health & wellbeing* (pp. 491-501). New York: Oxford University Press.

Hughes, J. (2009). Research Matrix. Unpublished document.

Hung, K. (2001). Framing Meaning Perceptions with Music: The Case of Teaser Ads. *The Journal of Advertising, 30*(3), 39-49.

Ihde, D. (2007). *Listening and Voice, Phenomenologies of Sound.* Albany, New York: State University of New York.

Jorgensen, K. (2008). Left in the dark: playing computer games with the sound turned off. In K. Collins (Ed.), *From Pac-Man to Pop Music: Interactive Audio in Games and New Media* (pp. 163-176). Burlington, VT: Ashgate Publishing.

Kalyuga, S. (2010). Narration or Visual Text: When does Modality Effect Apply. Paper presented at the World Conference on E-Learning in Corporate, Government, Healthcare and Higher Education (ELEARN), Chesapeake, VA.

Karja, A-V. (2008). Marketing music through computer games: the case of Poets of the Fall and Max Payne 2. In K. Collins (Ed.), *From Pac-Man to Pop Music: Interactive Audio in Games and New Media* (pp. 27-44). Burlington, VT: Ashgate Publishing.

Kiili, K., Lainema, T. (2008). Foundation for Measuring Engagement in Educational Games. Journal of Interactive Learning Research, 19(3), 21.

Kim, K-H., & Iwamiya, S-I. (2008). Formal Congruency Between Telop Patterns and Sound Effects. *Music Perception, 25*(5), 19.

Kirschner, P. (2002). Cognitive load theory. implications of cognitive load theory on the design of learning. *Learning and Instruction, 12*, 1-10.

Koroghlanian, C., & Klein, J. (2004). The effect of audio and animation in multimedia instruction. *Journal of Educational Multimedia and Hypermedia, 13*(1), 23-46.

Kraemer, D. J. M., Macrae, C. N., Green, A. E., & Kelley, W. M. (2005). Sound of silence activates auditory cortex. *Nature, 434*, 1.

Kwon, S-J., Jee-Hoon, C., Bae, J-H., & Suh, M-W. (2006). A Study on the Factors That Improve the Velocity Perception of a Virtual Reality-Based Vehicle Simulator. *International Journal of Human-Computer Interaction, 21*(1), 15.

Leahy, W., Chandler, P., & Sweller, J. (2003). When auditory presentations should and should not be a component of multimedia instruction. *Applied Cognitive Psychology, 17*(4), 401-418. doi: 10.1002/acp.877

Lerdahl, F., & Jackendoff, R. (1996). *A Generative Theory of Tonal Music* (2nd ed.). Cambridge, Massachusetts: MIT Press.

Lim, J. (2003). *Multiple channel redundancy: Guidelines for facilitating learning through the effective presentation of multiple forms of information*. Paper presented at the World Conference on Educational Multimedia, Hypermedia and Telecommunications 2003, Honolulu, Hawaii, USA. Retrieve from http://www.editlib.org/p/14287

Lincoln, Y. S. and E. G. Guba (1985). *Naturalistic Inquiry*. Newbury Park, CA: Sage Publications.

Lipscomb, S. D., & Kendall, R. A. (1994). Perceptual Judgement of the Relationship between Musical and Visual Components in Film. *Psychomusicology, 13*, 60.

Liu, M., Yuen, T. T., Horton, L., Lee, J., Toprac, P., & Bogard, T. (2013). Designing technology-enriched cognitive tools to support young learners' problem solving. *The International Journal of Cognitive Technology*, 18(1), 14-21.

Liu, M., Rosenblum, J., Horton, L., & Kang, J. (2014). Designing Science Learning with Game-Based Approaches. *Computers in the School*, 31(1-2), 84-102.

Magic, I. L. (1993). Ben Burtt: Lightsabers. *Star Wars Trilogy : The Definitive Collection* [Laser Disc Set]. San Francisco, CA: Industrial Light and Magic.

Malone, T. W. (1980). What makes things fun to learn? Heuristics for designing instructional computer games. Proceedings of the 3rd ACM SIGMSMALL symposium, Palo Alto, CA.

Mann, B. (1995). Focusing attention with temporal sound. *Journal of Research on Computing in Education, 27*(4), 22.

Mann, B. (2008). The evolution of multimedia sound. *Computers & Education, 50*(4), 1157-1173.

Marks, A. (2002). *The Complete Guide to Game Audio: For composers, Musicians, Sound Designers, and Game Developers*. Lawrence, Kansas: CMP Books.

Marshall, S. K., & Cohen, A. J. (1988). Effects of musical soundtracks on attitudes toward animated geometric figures. *Music Perception, 6*(1), 95-112.

Mayer, R., & Moreno, R. (2002). Aids to computer-based multimedia learning. *Learning and Instruction, 12,* 107-119.

Mayer, R., & Moreno, R. (1998). A Split-Attention Effect in Multimedia Learning: Evidence for Dual Processing Systems in Working Memory. *Journal of Educational Psychology, 90*(2), 8.

McBride-Charpentier, M. (2011, May 9). Acoustic Ecologies: Half-Life 2's City 17 [Blog post]. Retrieved from: http://www.gamasutra.com/blogs/MichelMcBrideCharpentier/20110509/89464/Acoustic_Ecologies_HalfLife_2s_City_17.php

Merleau-Ponty, M. (2002). *Phenomenology of Perception* [Kindle Edition]. New York: Routledge.

Mihelj, M., Novak, D., Milavec, M., Ziherl, J., Olensek, A., & Munih, M. (2012). Virtual Rehabilitation Environment Using Principles of Intrinsic Motivation and Game Design. *Presence, 21*(1), 15.

Miller, C., Veletsianos, G., & Doering, A. (2008). Curriculum at forty below: a phenomenological inquiry of an educator/explorer's experience with adventure learning in the Arctic. *Distance Education, 29*(3), 14. doi: 10.1080/01587910802395789

Molholm, S., Sehatpour, P., Mehta, A., Shpaner, M., Gomez-Ramirez, M., Ortigue, S., … Foxe, J. J. (2006). Audio-Visual Multisensory Integration in Superior Parietal Lobule Revealed by Human Intracranial Recordings. *Journal of Neurophysiology, 96*, 8. doi: 10.1152/jn. 00285.2006

Moreno, R., & Mayer, R. (1999). Cognitive Principles of Multimedia Learning: The Role of Modality and Contiguity. *Journal of Educational Psychology, 91*(2), 10.

Moreno, R., & Mayer, R. (2000). A Coherence Effect in Multimedia Learning : The Case for Minimizing Irrelevant Sounds in the Design of Multimedia Instructional Messages. *Journal of Educational Psychology, 92*(1).

Moustakas, C. (1994). *Phenomenological Research Methods.* Thousand Oaks, CA: Sage Publications.

Nintendo EAD (1998). The Legend of Zelda: Ocarina of Time [Game software]. Kyoto, Japan: Nintendo.

Nintendo R&D4. (1985). Super Mario Bros. [Game software]. Kyoto, Japan: Nintendo.

Neuhoff, J. G. (2011). Perception, Cognition and Action in Auditory Display. In T. Hermann, A. Hunt & J. G. Neuhoff (Eds.), *The Sonification Handbook.* Berlin, Germany: Logos Publishing House

Paivio, A. (1990). *Mental Representations: A Dual Coding Approach.* (Oxford Psychology Series 9). Oxford, UK: Oxford University Press.

Palmer, C., & Hutchins, S. (2006). What is Musical Prosody? In B. Ross (Ed.), *The Psychology of Learning and Motivation* (pp. 245-278). Amsterdam, The Netherlands: Elsevier Press.

Prosody. (n.d.). In *Oxford Dictionaries* (2010). Oxford University Press. Retrieved from http://www.oxforddictionaries.com/definition/prosody

Razdan, A. (2005, July-August). The Father of Acoustic Ecology. *UTNE Reader*. Retrieved from http://www.utne.com/Arts-Culture/R-Murray-Schafer-Father-Of-Acoustic-Ecology.aspx

Red Redemption. (2013). Fate of the World [Game software]. http://fateoftheworld.net/about.

RedOctane. (2005). Guitar Hero [Game software].

Remedy Entertainment (2001). Max Payne. North America: Gathering.

Robinson, Faith, A. (1994). *An existential-phenomenological investigation of the experience of the experience of self-cutting in subjects with multiple personality disorder.* (Doctoral dissertation). California Institute of Integral Studies. Available from ProQuest Dissertations and theses database (UMI No. 9429049)

Rockstar Games (1993). Grand Theft Auto: Rockstar Games.

Rogers, D. K., Chan, J. S., & Newell, F. N. (2010). The effects of characteristic and spatially congruent sounds on visual search in natural visual scenes. *Journal of Vision, 10*(7), 888. doi: 10.1167/10.7.888

Rosenblum, J. (2013, June). *A Phenomenological Inquiry of Sound Within Educational Games.* Paper presented at Games Learning Society 9.0, Madison, WI.

Salen, K., & Zimmerman, E. (2003). *Rules of play: game design fundamentals*. Cambridge, Mass.: MIT Press.

SanMiguel, I., Widmann, A., Bendixen, A., Trujillo-Barreto, N., & Schroger, E. (2013). Hearing Silences: Human Auditory Processing Relies on Preactivation of Sound-Specific Brain Activity Patterns. *The Journal of Neuroscience, 33*(20), 6. doi: DOI:10.1523/JNEUROSCI.5821-12.2013

Schafer, R. M. (1993). *The Soundscape: Our Sonic Environment and the Tuning of the World* [Kindle version]. Rochester, VT: Inner Traditions • Bear & Company.

Shanahan, L. (2012). Use of Sound with Digital Text: Moving Beyond Sound as an Add-On or Decoration. *Contemporary Issues in Technology and Teacher Education, 12*(3), 21.

Sider, L. (2003). If you wish to see, listen: The role of sound design. *Journal of Media Practice, 4*(1), 5-16.

Sony Computer Entertainment (2010). Heavy Rain [Game software for PlayStation 3].

Spradley, J., P. (1979). *The Ethnographic Interview*. New York: Harcourt, Brace, Jovanovich.

Squire, K. (2006). From content to context: Video games as designed experiences. *Educational Researcher*, *35*(8), 19–29.

Stockburger, A. (2003). *The Game Environment from an Auditory Perspective.* Paper presented at the Level Up: Digital Games Research Conference, Utrecht University.

Sullivan, B., Ware, C., & Plumlee, M. (2006). Linking audio and visual information while navigating in a virtual reality kiosk display. *Journal of Educational Multimedia and Hypermedia, 15*(2), 217-241.

Sweller, J. (1988). Cognitive Load During Problem Solving: Effects on Learning. *Cognitive Science, 12*, 28.

Tabbers, H., Martens, R., & Merrienboer, J. (2004). Multimedia instructions and cognitive load theory: Effects of modality and cueing. *British Journal of Educational Technology, 74*, 10.

Tan, S., Spackman, M. P., & Bezdek, M. A. (2007). Viewers' interpretations of film characters' emotions: Effects of presenting film music before or after a character is shown. *Music Perception, 25*(2), 135-152.

Toprac, P., & Abdel-Meguid, A. (2011). Causing Fear, Suspense, and Anxiety Using Sound Design in Computer Games. In M. Grimshaw (Ed.), *Game Sound Technology and Player Interaction: Concepts and Developments* (pp. 176-191). University of Bolton, UK: Information Science Reference.

Tüzün, H., Yilmaz-Soylu, M., Karakus, T., Inal, Y., & Kizilkaya, G. (2009). The effects of computer games on primary school students' achievement and motivation in geography learning. Computers & Education, 52(1), 68–77.

Vagle, M. (2010). *A post-intentional phenomenological research approach*. Paper presented at the American Educational Research Association, Denver, CO.

Vagle, M. (2011). Post-Intentional Phenomenology and the Egocentric Predicament in Qualitative Research. In M. Vagle (Ed.), *Introduction to Phenomenological Research* (pp. 58-64). Athens, GA: University of Georgia.

Valjamae, A., & Soto-Faraco, S. (2008). Filling-in visual motion with sounds. *Acta Psychologica, 129*(2), 5. doi: 10.1016/j.actpsy.2008.08.004

Valve Corporation (1998). Half-Life [Game software].

Voisin, J., Bidet-Caulet, A. l., Bertrand, O., & Fonlupt, P. (2006). Listening in Silence Activates Auditory Areas: A Functional Magnetic Resonance Imaging Study. *The Journal of Neuroscience, 26*(1), 5. doi: DOI:10.1523/JNEUROSCI.2967-05.2006

Vroomen, J., & de Gelder, B. (2000). Sound Enhances Visual Perception: Cross-Modal Effects of Auditory Organization on Vision. *Journal of Experimental Psychology: Human Perception and Performance, 26*(5), 7. doi: 1O.1037//O096-1523.26.5.1583

Walter, J. L. (2004). *Designed music for multimedia instruction: A study of music as a complementary aspect of instructional design*. (Unpublished doctoral dissertation). Capella University. Available from ProQuest Dissertations and theses database (UMI No. 3132755)

Wennerstrom, A. K. (2001). *The Music of Everyday Speech: Prosody and Discourse Analysis*. Oxford: Oxford University Press.

Wharton, A., & Collins, K. (2011). Subjective Measures of the Influence of Music Customization on the Video Gameplay Experience: A pilot Study. *Game Studies: the international journal of computer game research, 11*(2).

Whalen, Z. (2004). Play Along - An Approach to Videogame Music. *Game Studies: the international journal of computer game research, 4*(1).

Zatorre, R., & Halpern, A. (2005). Mental concerts: Musical imagery and auditory cortex. *Neuron, 47*, 9-12.