THE EFFECT OF INTERACTIVITY WITH A MUSIC VIDEO GAME ON SECOND LANGUAGE VOCABULARY RECALL

Jonathan deHaan, University of Shizuoka
W. Michael Reed, New York University, Radford University
Katsuko Kuwada, Tohoku University

Video games are potential sources of second language input; however, the medium's fundamental characteristic, interactivity, has not been thoroughly examined in terms of its effect on learning outcomes. This experimental study investigated to what degree, if at all, video game interactivity would help or hinder the noticing and recall of second language vocabulary. Eighty randomly-selected Japanese university undergraduates were paired based on similar English language and game proficiencies. One subject played an English-language music video game for 20 minutes while the paired subject watched the game simultaneously on another monitor. Following gameplay, a vocabulary recall test, a cognitive load measure, an experience questionnaire, and a two-week delayed vocabulary recall test were administered. Results were analyzed using paired samples *t*-tests and various analyses of variance. Both the players and the watchers of the video game recalled vocabulary from the game, but the players recalled significantly less vocabulary than the watchers. This seems to be a result of the extraneous cognitive load induced by the interactivity of the game; the players perceived the game and its language to be significantly more difficult than the watchers did. Players also reported difficulty simultaneously attending to gameplay and vocabulary. Both players and watchers forgot significant amounts of vocabulary over the course of the study. We relate these findings to theories and studies of vocabulary acquisition and video game-based language learning, and then suggest implications for language teaching and learning with interactive multimedia.

INTRODUCTION

Video games have been very popular for several decades; the Entertainment Software Association (2008) reported that 65 percent of all Americans play video games. Video and computer games are receiving increasing attention by researchers and practitioners in education; however, most of the theory and pedagogy focus on general education (e.g., Squire, 2006) or language and literacy development of native speakers (e.g., Gee, 2007; Steinkhueler, 2007). With the growing popular and pedagogical focus on games, it is important "to become involved in the design and implementation of new media systems *before* they are institutionalized" (Steuer, 1993, p. 21, emphasis in original). Effective second language teaching and learning with games is more likely to occur if practical conclusions can be drawn from empirical evidence. Investigating the relationship between video games and language acquisition is problematic because of the ever-increasing variations of the media. Numerous genres of commercial games (Prensky, 2001; Wolf, 2001) and "serious" (i.e., educational) games (Sawyer & Smith, 2008) have been identified. Video games can differ in terms of hardware, graphical fidelity, human-computer interface, intended audience, theme, and interaction between players.

Investigations have been made of second language learning in multiplayer games. Piirainen-Marsh and Tainio (2009) studied small groups of players interacting with (i.e., repeating, analyzing, and using language from) a console roleplaying game, Sykes, Oskoz, and Thorne (2008) described meaning-making and pragmatic development among players in massively multiplayer online games, and Zheng, Young, Brewer and Wagner (2009) found that language learners' attitude and self-efficacy towards their second language improved through the use of tools to communicate with native speakers to complete quests in a

game-like virtual world. These studies have high ecological validity and pedagogical and practical significance, but they did not investigate how a second language video game might be played by only one individual. Since many video games can be played by a single player, our study focused on the human-computer interaction of a single-player game.

Second language teachers, students or media designers may not be especially helped by general posits for video games' support of second language acquisition that focus on the benefits of playful learning (Hubbard, 1991; Prensky, 2001), motivation, (Baltra, 1990; Carrier, 1991; deHaan, 2005a; Hubbard, 1991; Li & Topolewski, 2002), rewards (Li & Topolewski, 2002), or positive affect (Garcia-Carbonell, Rising, Montero, & Watts, 2001). Understanding how language learning may happen with video games is "more than just the fact that language is involved in the play" (Hubbard, 1991, p. 221–222). It is easy to "blindly accept something as valuable for language learning simply because it involves language and problem solving and students enjoy it …. [M]edia selection should be done on the basis of … whether it really promotes language learning" (Hubbard, 1991, p. 222).

Language teachers or learners may also not be aided by discussions focusing on game features such as: comprehensible input, self study opportunities, subtitles, repetition, and authentic language (Baltra, 1990; deHaan, 2005a; Hubbard, 1991; Meskill, 1990; Purushotma, 2005); these are features games share with other educational technologies such as DVD movies. Second language research, teaching, and design should focus on what distinguishes games from other multimedia. We agree with Clark (2001) that all instructional media contain both technological affordances and educational communication between the designer and user. Video games incorporate various technological and pedagogical elements to both entertain and train the player. Pedagogical scaffolds may be essential for a user's understanding of many complex games and learning environments (Allen & Otto, 1996; Gee, 2003; Kulikowich & Young, 2001; Um & deHaan, 2005). These scaffolds are worthy of study and hold enormous potential for assisting teaching with, playing and designing games, but they are not found in every game. The starting point for our project was a focus on what constitutes a game rather than what can be added to a game to make it more enjoyable or educational.

Study Framework

Interactivity, "the extent to which users can participate in modifying the form and content of a mediated environment in real time" (Steuer, 1993, p. 84) is a defining characteristic of video games (Murray, 1997; Wolf & Perron, 2003). While many games include animated or video sequences that do not allow or require player interaction, games invariably necessitate some degree of player interaction in order to advance (Tamborini et al., 2001, p. 22). Turkle (1985) suggested that, while television is "something you watch," a video game is "something you do, a world that you enter and, to a certain extent … something you become" (pp. 66–67). While interactivity certainly characterizes video games, it is a challenging construct to frame and to study as it is "overused and underdefined" (Heeter, 2000, p. 75) and perhaps "the most grossly misunderstood and callously misused term associated with computers" (Crawford, 2005, p. 25).

Numerous taxonomies of interactivity in educational media exist (e.g., Sims, 1997). Although classifications help to identify player actions, research has not yet been conducted to demonstrate the effects of these various interactivities on the second language acquisition process. Complex materials can prevent learning (Paas, Renkl, & Sweller; 2003), and it has not yet been determined if or what complexity is added by physical interaction with a second language technology or media. This article reports a study in which the physical interactivity of a second language music video game was manipulated to investigate the effect of interactivity on vocabulary acquisition and cognitive load. Before describing the methods, results and conclusions of the project, an addition to a cognitive theory of language learning with multimedia is suggested.

Plass and Jones (2005) presented an interactionist and cognitivist model of language learning with multimedia by synthesizing Gass' (1997) second language acquisition model and Mayer's (2001) cognitive theory of multimedia. Plass and Jones reviewed examples and studies of second language instructional multimedia that assist language learning: (a) glosses: text and/or images that provide additional information for unknown lexical items (e.g., Chun & Plass, 1996a, 1996b; Laufer & Hill, 2000) and (b) simultaneously-presented aural and video information (e.g., Hernandez, 2004). Plass and Jones (2005) stated that "the level of cognitive load induced by the input enhancement and the role this load may play in the acquisition of vocabulary and construction of meaning needs to be taken into consideration" (p. 483). Their consideration of apprehended input seemed to be concerned only with words or pictures selected (by simple computer mouse movements) and viewed; neither the research studies they review nor their theoretical framework address the physical interactivity required of more complex learning environments such as virtual worlds and video games.

When language students watch a video with subtitles, they are required only to attend to input, and their cognitive resources may not be so taxed as while playing a video game. Players of a video game in their second language must perform additional playful and spontaneous tasks (dependent on the specific game genre, for example, pressing a button in time with music, such as the game used in this study) while simultaneously attending to aural and textual language. Not only the cognitive load of the input enhancement, but also that of the fundamental interactivity with the learning environment (whether simple computer mouse actions, or quick and complex video game controller movements) should be a focus of inquiry. Cognitive load theory (Paas et al., 2003) provides a framework for understanding the effect of interactivity on the language learning process. Since human cognitive architecture consists of a limited short-term (or *working*) memory (Baddeley, 1992; Miller, 1956), and a game's complex elements (e.g., music and subtitles) can create an unalterable high demand on working memory (*intrinsic* cognitive load), it is important to understand whether a media feature, such as interactivity, presents a student with unnecessary *extraneous* cognitive load, which interferes with learning, or *germane* load, which enhances learning.

There is some evidence for interactivity increasing mental activity. Pellouchoud, Smith, McEvoy, and Gevins (1999) compared (using electroencephalograms) the mental effort required of children playing or watching a Super Nintendo puzzle game for 15 minutes. The subjects experienced higher cognitive load (i.e., higher *theta* rhythms and lower *alpha* and *mu* rhythms were recorded) when playing the game. No learning outcomes were measured in their study. Brett (2001) reported a unique study in which language learners were required not only to attend to language in various audio-visual presentations, but also to simultaneously perform an interactive task. He found that students exposed to video and subtitles performed best on written summaries, followed by subjects who used video, subtitles and simultaneous on-screen comprehension tasks. Brett concluded that the complex learning environment of videos, subtitles, and tasks caused cognitive overload. Since neither Pellouchoud et al. nor Brett specify which type of cognitive load was caused by interaction with the media in their studies, further research is required.

Our study was designed to investigate whether the interactivity (and simultaneously presented text, audio and animation) of video games is extraneous cognitive load (thus having a negative effect on learning) or germane load (thus having a positive effect on learning). In addition to cognitive load theory, the impact of attention on language learning outcomes was also of conceptual value to the study. The importance of attention's role in second language acquisition has been established both theoretically and empirically (Leow, 2000; Mackey, Gass, & McDonough, 2000; Robinson, 1995; Rosa & O'Neil, 1999; Schmidt, 2001; Tomlin & Villa, 1994). Not being able to attend to second language input in a media environment (such as a video game) will prevent subsequent analyses, integration, and use of that language (Chapelle, 1998).

Kalyuga, Chandler, and Sweller (1999) described instructional media that cause split attention and extraneous cognitive load as having "several sources of information [that] are difficult or impossible to understand in isolation and must be mentally integrated to achieve understanding" (p. 367-368). Although the audio-visual split attention Kalyuga et al. described can take place in video games (e.g., animations, subtitles, and spoken dialogue), a more primary focus of research on split attention should be of that between the audio-visual elements and the typifying physical interactivity of video games, since video games' physical interface "requires frequent input from the player and the input required can disrupt the player's involvement with the game space" (Taylor, 2002, p. 20). Because games can contain useful linguistic information, it is necessary to determine whether interactivity contributes to or detracts a student from noticing it.

deHaan (2005b) reported one Japanese as a foreign language student's experience of playing a Japanese baseball video game for one month. Although anecdotal positive learning outcomes were documented (Kanji character reading improved 57% on the post-test from the pre-test), the participant reported that his attention was divided between playing the game and listening to and reading the Japanese ("I can hear them talking, but I'm concentrating on hitting the ball … I'm not listening to them" and "I'm trying to listen [to what the announcers are saying] . . . I'm not paying attention to pitching" p. 284) and he could not focus on both at the same time, a result that supports Brett's (2001) findings and Kalyuga et al.'s (1999) suggestions.

Second language acquisition theory delineates the importance of noticing linguistic information in a media environment (Chapelle, 1998; Schmidt, 2001), and video games seem to be a medium with various features that can support the language acquisition process (deHaan, 2005a), yet the particular influence of playful interactivity is not yet well understood. Cognitive load theory (Paas et al., 2003) and research seems to suggest that physical interactivity will increase mental effort (Pellouchoud et al., 1999) and hinder noticing and vocabulary acquisition (Brett, 2001; deHaan, 2005b). However, the question of how interaction with a video game environment may affect second language acquisition has not been adequately investigated.

RESEARCH QUESTIONS

1. What is the effect of the degree of interaction (i.e., watching or playing) with a music video game on immediate written vocabulary recall? Are there additional effects for interaction and language proficiency or video game proficiency on vocabulary recall?
2. What is the effect of the degree of interaction (i.e., watching or playing) with a music video game on delayed written vocabulary recall?
3. What is the effect of the degree of interaction (i.e., watching or playing) with a music video game on cognitive load? Are there additional effects for interaction and language proficiency or video game proficiency on cognitive load?
4. Was there a difference between the attitudes of players versus watchers of the music video game?

Non-directional hypotheses were assumed and null hypotheses of no differences were tested in this study; no expectations were made in regard to vocabulary recall, cognitive load or opinions for any group.

METHOD

Participants and design

This experimental study investigated to what degree, if at all, video game interactivity would help or hinder the noticing and recall of second language vocabulary. Independent variables included interactivity, language proficiency, and video game proficiency. Dependent measures included cognitive

load, vocabulary written recall (immediate and 2-week delayed), and participant opinions of the treatment.

Eighty undergraduates (65 males, 15 females, ages 18-24), from a computer science university in rural Japan participated. The participants spoke Japanese as their first language, had between 6 and 11 years of formal English education, and were taking one or two weekly English for Specific Purposes (Computer Science) classes. Very few participants had taken a standardized English proficiency test and very few students studied English with media (e.g., movies, music, and books) outside of class. The participants rated, on a scale ranging from 1 (*much worse*) to 7 (*much better*), their reading skills as *slightly worse* (*M* = 3.49), their listening skills as *slightly worse* (*M* = 3.32), and their music video game skills as *worse* (*M* = 2.75) than other students in their year at the university. Nine participants had traveled (all for less than a month) in an English-speaking country. Only individuals who had never played *Parappa the Rapper 2* (NanaOn-Sha, 2002) or similar music video games participated. The participants reported many years of video game playing experience (*M* = 11.85), most considered role-playing and action/adventure games to be their favorite video game genres, and 16 had played English-language video games. Fifty-six of the participants liked music video games, and the participants played video games, on average, for 7.16 hours each week (*SD* = 9.16, Mode = 3.0). The participants were randomly selected from the university via flyers and email. The two experimental groups (players and watchers of a video game) did not differ significantly in their: gender, age, level of education, familiarity with music video games, overall language proficiency, overall video game proficiency, or self-reported pre-treatment knowledge of the vocabulary of the video game used in the study (players *M* = 35.7 words, watchers *M* = 35.8 words, $t(39) = .152$, $p = .880$),. The written pre-test required each participant to indicate whether he or she knew a particular vocabulary item. The test was comprised of 41 distinct words from the video game lyrics used as answers on the cloze test (duplicate vocabulary items from the lyrics were not included) and 21 additional distracters. There were 62 items in total on the vocabulary pretest, and these items were arranged randomly. A cloze test of the game's lyrics was not used to gauge prior knowledge in order to avoid priming the subjects for the post-tests.

This study manipulated video game interactivity. Forty pairs of students participated and in each pair, one played the game and the other watched an identical video signal of the partner's game (See Figure 1). For the interactive treatment, participants played Stage One of the game *Parappa the Rapper 2* on a Sony PlayStation 2 connected to a 25" TV. English subtitles were displayed on the screen. Players did not pause the game. Players used stereo headphones and sat in a cubicle. For the non-interactive treatment, participants watched the video of the player's game on a linked identical 25" TV in an adjoining cubicle. The watchers could also see English subtitles on the screen and used stereo headphones. Participants were grouped in order to ensure that each pair was exposed to identical language. The players and watchers could not see each other or interact.

Materials

Parappa the Rapper 2 was used because of its authentic English language (it was designed for the commercial North American video game market), its simultaneously presented aural and textual language (English raps and English subtitles), and its prototypical rhythm game elements ("gameplay requires players to keep time with a musical rhythm"; Wolf, 2001, p. 130).

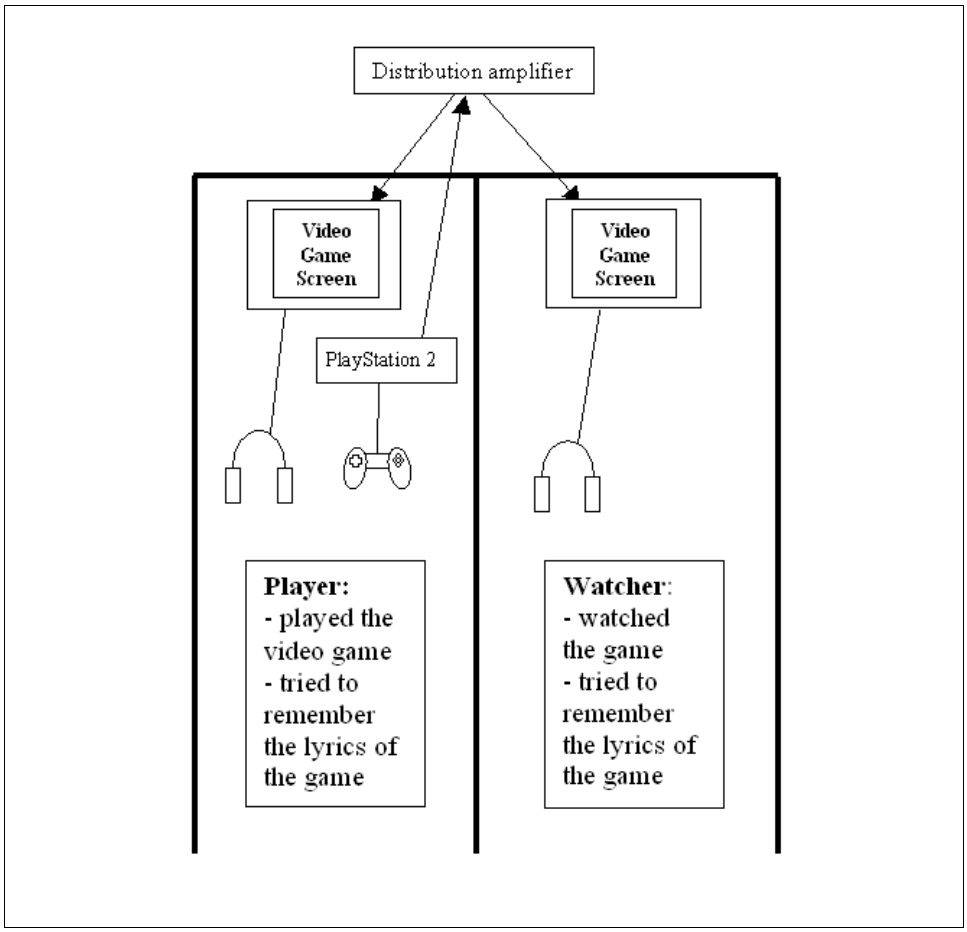

Figure 1. A bird's eye view of the treatment cubicles for the player and watcher of the game.
Note. Arrows indicate the delivery of the game console's audio and video signal to both screens.

Each level of this game is a short rap; the player completes lines of the rap by pressing controller buttons at the correct times. If the player's timing is "off," the line is not completed and if many lines are not completed, the player fails the stage. The rap for the game stage played in this project contains instructions about how to make a burger (e.g., "heat the grill" and "turn the patty over"). Some of the lines of the rap are given by a non-player character (Beard Burger Master). English is not central to gameplay. In other words, a player need not comprehend the game's language to interact successfully with the game. The game's display includes a fast food restaurant (various ingredients and cooking implements can be seen on the screen), a rhythm meter, a score meter, and subtitles of the game's lyrics (Figure 2). *Parappa the Rapper 2*'s elements all relate and interact in complex ways. One button press (cued by a moving icon on the rhythm bar) produces a heard word (e.g., "burger") coupled with an action in the 3D environment (e.g., flipping a burger) that is semantically linked to other words to create a line of the rap and to other actions to create a fast food meal. The correctness of the button press is indicated by an animation on the screen, a change in score, and a sound effect. The game seems to have high interactivity since its elements need to be simultaneously noticed and understood by a player (or watcher).

Physical interactivity can have many forms and functions; the type that most closely approximates the physical interaction the player had with this study's game is object interactivity "in which ... things are activated using ... a device [causing] some form of audio-visual response" (Sims, 1997, p. 162), categorized as "basic stimulus-response" (p. 161). The interactivity of the game in this study is quite simple compared to many of the interactive learning environments used in teaching and research with

technology, for example Nelson and Ketelhut's (2007) virtual inquiry worlds. Still, since any extraneous load can disrupt learning (Sweller, 1994), it is important to examine the effect of the interactivity that this (or any) game has on learning processes and outcomes.

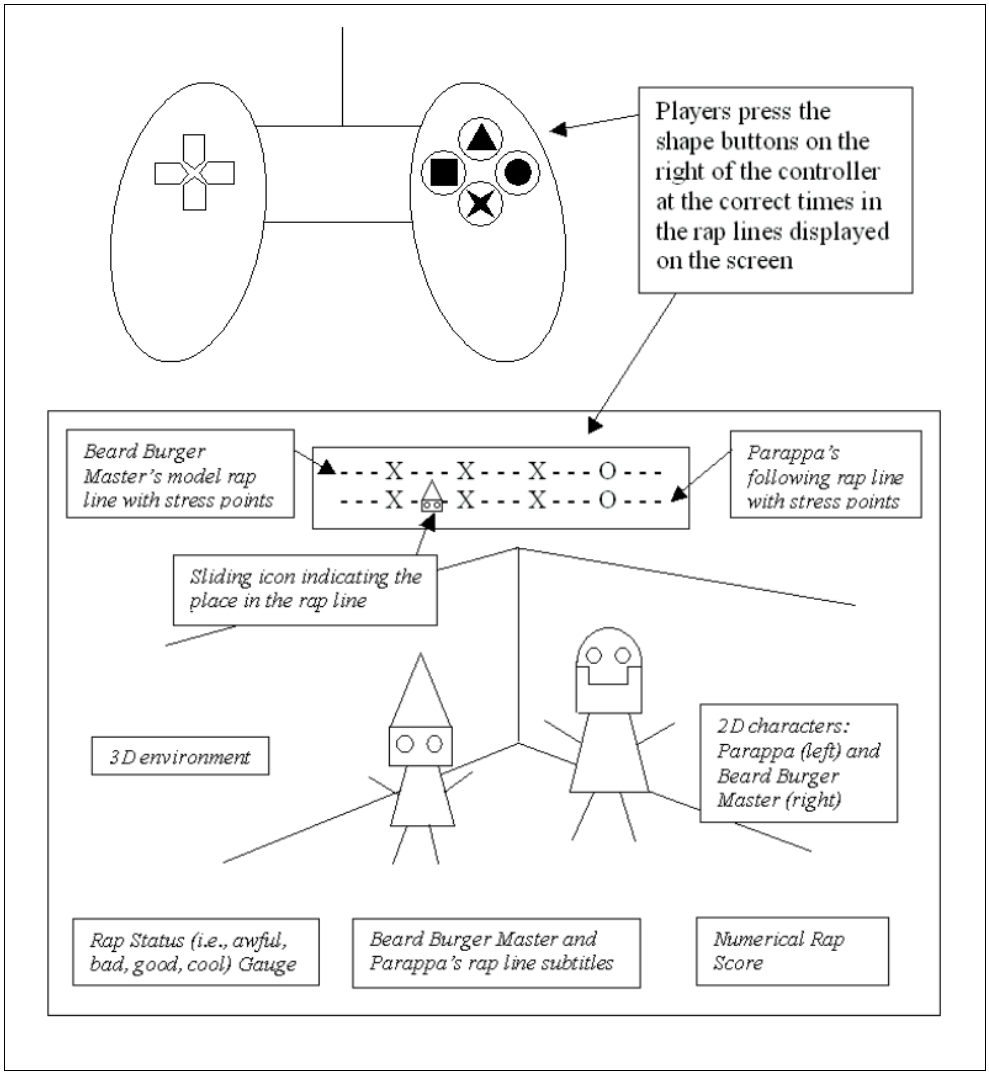

Figure 2. Game controller and wire frame of game screen.

Procedure

This was an experimental study implemented in a laboratory setting. Participants were paired and one participant in each pair was randomly assigned to either play or watch a video game.

In the recruitment phase, the participants were invited to participate and gave consent online. The students understood that participation was voluntary, confidential, and that they would be compensated (1,500 yen each). In the preliminary data collection phase, the participants self-reported (online) information about their: biography (gender, L1, age, and education), familiarity with *Parappa the Rapper 2* and similar video games, language proficiency and study habits, knowledge of 41 vocabulary items extracted from the video game, and video game habits and proficiency.

Participants were then paired based on similar language and video game proficiencies. The English and video game proficiency data were used to holistically categorize equal numbers of pairs of participants

into "high" and "low" language and video game proficiency groups.

Next, participants were randomly assigned to one of the two treatments. The pairs participated for 20 minutes. Each participant was instructed to play (or watch) the game and learn the words of the rap. The video game level was repeated five times by all pairs. This was done to approximate the repetitions of a level, either for fun or because the player failed the stage, which might happen in authentic gameplay with this particular genre. The time and repetitions were decided after a pilot test (six months prior to the experiment) in which students who had participated for 30 minutes doing eight repetitions reported boredom and shifting attention. The participants were not allowed to take notes or use their dictionaries. Following the treatment, the participants each completed (presented in Japanese and English) a cognitive load measurement, a vocabulary written recall test, and an opinion questionnaire. Finally, two weeks following the treatment, the participants completed the same vocabulary written recall test.

Instruments

Cognitive load

The participants completed a Cognitive Load Subjective Experience Questionnaire targeting invested mental effort (based on Paas, 1992; Cronbach's alpha > 0.85 as cited in Paas, Van Merrienboer, & Adam, 1994) and perceptions of material difficulty (based on Kalyuga et al., 1998; Cronbach's alpha = .4583). Mental effort may not be the same as task difficulty (i.e., a particular learner may find the material difficult, but not be willing to invest any mental effort to understand it). Items in the questionnaire distinguished between the cognitive load from playing or watching the game and cognitive load from the game's language. The four questions were:

1. How much mental effort did you invest in playing (watching) the video game? (nine-point Likert scale from *extremely low mental effort* to *extremely high mental effort*)
2. How easy or difficult was the video game to play (watch)? (seven-point Likert scale from *extremely easy* to *extremely difficult*)
3. How much mental effort did you invest in studying the video game's language? (nine-point Likert scale from *extremely low mental effort* to *extremely high mental effort*)
4. How easy or difficult was the video game's language to understand? (seven-point Likert scale from *extremely easy* to *extremely difficult*)

Vocabulary written recall (immediate and 2-week delayed)

The lyrics of the game level were used as a written cloze test (i.e., stressed words from the lyrics were replaced with blanks). There were 41 unique vocabulary words in the cloze test. Participants were required to write the missing words from the game's rap in the test's blanks. Answers were scored using the acceptable scoring method, meaning misspelled but recognizable (e.g., "musterd" instead of "mustard") and answers with the correct stem (e.g., "round" instead of "around") were accepted. Notably, though, answers that matched semantically (e.g., "watch the *fire*" instead of the correct answer "watch the *grill*") were not accepted. Each correct answer was counted as one point. The same vocabulary written recall test was given two weeks following completion of the treatment to measure vocabulary retention. See Appendix A for the test (underlined words appeared as blanks for the participants).

Player and watcher opinions

Each subject reported his/her enjoyment of the game or video, the usefulness of the game or video for studying English, and any questions or comments about his/her experience. These opinions were analyzed: (a) to determine trends in the participants' experiences of the video game and the video and (b) to supplement the measures of vocabulary recall and cognitive load.

RESULTS

The data did not violate assumptions of normality, linearity, homogeneity of regression slopes, equality of variance, or homogeneity of intercorrelations. For the statistical analyses, the alpha level was .05, the power was .80, and the effect size was .46 (medium) based on *G*Power 3* (Faul, Erdfelder, Lang, & Buchner, 2007).

Research question 1. What is the effect of the degree of interaction (i.e., watching or playing) with a music video game on immediate written vocabulary recall? Are there additional effects for interaction and language proficiency or video game proficiency on vocabulary recall?

A paired-samples *t*-test revealed that the watchers of the video game recalled significantly more vocabulary items ($M = 21.70$, $SD = 6.94$) than the players [$M = 7.23$, $SD = 4.76$, $t(39) = 11.63$, $p<.05$]. See Table 1. The eta squared statistic (.78) indicated a large effect size, Cohen's $d = 2.43$ also showed a large effect, and observed power was 0.99. No statistically significant main or interaction effects for language proficiency or video game proficiency on vocabulary recall were found.

Table 1. *Mean Scores on Immediate Post-Procedure Vocabulary Recall Test*

	Recall Test Scores		
Treatment Group	*N*	Mean	*SD*
Players	40	7.23	4.76
Watchers	40	21.7	6.94

Research question 2. What is the effect of the degree of interaction (i.e., watching or playing) with a music video game on delayed written vocabulary recall?

The average immediate (Time 1) and delayed (Time 2) vocabulary recall scores of the players and watchers are presented in Table 2. Missing delayed posttest data required that 14 participants (i.e., 7 pairs of participants) be removed from the data set, leaving 66 participants' (33 pairs') data. A two-factor (interactivity: watching or playing the video game) analysis of variance (ANOVA) with a repeated measure on one factor (time: immediate or delayed posttest) revealed that the main effect for time was significant $F(1,64) = 76.82$, $p < .05$, Eta-squared = .546 (a strong effect), Cohen's $d = 0.91$ (a large effect), observed power = 0.99. The immediate recall scores were much higher than the delayed recall scores. A significant main effect for interactivity was also obtained, $F(1,64) = 129.01$, $p < .05$, Eta-squared = .668 (a strong effect), Cohen's $d = 2.54$ (a large effect), observed power = 1.00. The vocabulary recall scores of the watchers were significantly higher, on average, than the scores of the players.

Table 2. *Mean Scores on Immediate and Delayed Vocabulary Recall Tests*

	Time 1 (immediately post-procedure)			Time 2 (2 weeks after procedure)		
Treatment Group	*N*	Mean	*SD*	*N*	Mean	*SD*
Players	33	7.42	5.07	33	5.15	3.81
Watchers	33	23.27	6.09	33	16.03	5.79

A significant interaction effect (i.e., Time x Interactivity) was also obtained, $F(1,64) = 20.96$, $p < .05$, Eta-squared = .247 (a medium effect), observed power = 0.98. There was a much larger decrease in scores for the watchers (from 23.27 to 16.03) than for the players (from 7.42 to 5.15), although the very low scores of the players on the recall test immediately following the procedure may explain some of the

stability of the players' scores from Time 1 to Time 2.

Research question 3. What is the effect of the degree of interaction (i.e., watching or playing) with a music video game on cognitive load? Are there additional effects for interaction and language proficiency or video game proficiency on cognitive load?

Invested mental effort in the game

A paired-samples *t*-test revealed that the players' (M = 6.33, SD = 1.75) and watchers' (M = 5.50, SD = 2.17) reported mental effort in the game was not significantly different [$t(39) = 1.78$, $p = .082$]. The eta squared statistic (.08) indicated a moderate effect size; observed power was 0.08.

Perception of the game's difficulty

The players reported higher scores regarding game difficulty (M = 3.72, SD = 1.13) than the watchers did (M = 2.45, SD = 1.26); furthermore, a paired-samples *t*-test revealed that this difference was statistically significant [$t(39) = 5.25$, $p = <.05$]. The eta squared statistic (.41) indicated a large effect size, Cohen's d = 1.06 (a large effect), observed power was 0.71.

Invested mental effort in the game's language

A paired-samples *t*-test revealed that the players' (M = 5.08, SD = 1.65) and watchers' (M = 5.88, SD = 2.09) reported mental effort in the game's language was not significantly different [$t(39) = -1.80$, $p = .080$]. The eta squared statistic (.08) indicated a moderate effect size; observed power was 0.08.

Perception of the game's language difficulty

The players reported higher scores regarding the game's language difficulty (M = 4.13, SD = 0.97) than the watchers did (M = 3.65, SD = 1.10); furthermore, a paired-samples *t*-test revealed that this difference was statistically significant [$t(39) = 2.38$, $p = .022$]. The eta squared statistic (.10) indicated a moderate effect size, Cohen's d = 0.46 (a moderate effect), observed power was 0.09.

No statistically significant main or interaction effects for language proficiency or video game proficiency on any aspect of cognitive load were found.

Research question 4. Was there a difference between the attitudes of players versus watchers of the music video game?

On average, players enjoyed the game more than watchers (M = 8.00, SD = 1.33 and M = 7.47, SD = 1.54, respectively, on a 9-point scale); this difference is not statistically significant. However, more watchers (19) than players (7) reported that they would buy the game to learn English, and watchers (38) thought that the game was useful listening and reading practice for them (30 players agreed). The watchers, in general, seemed more likely to use the game to study English. Some players may have responded negatively due to their poor performance on the vocabulary test (several were unable to recall any vocabulary).

The open-ended responses were translated and coded. The more important themes included:

Repetition

Many of the watchers reported feeling a little bored watching the same level of the game five times, while many of the players wanted to continue playing the game to be able to raise their score further, and to learn more of the language in the game.

Watcher's concentration

It seemed that the watchers had more time than the players to consider the game; some of the watchers' comments included details about the environment (none of the players' comments involved the environment of the game). A few of the watchers commented that the combination of the objects in the

game level (foods, cooking tools) and the sentences describing the pictures made it "easy to learn" the vocabulary.

Player's concentration

Many players commented that it was very difficult for them to pay attention to both the game and the language simultaneously. They stated difficulty in pressing the buttons accurately when they focused on the language and that they could not listen to or read the English when they concentrated on the gameplay. A few of the players commented that they "wanted to be a watcher to learn the English." One player commented that other video game genres would be better reading practice.

In summary, both the players and the watchers of the video game recalled vocabulary from the game, but the players recalled significantly less vocabulary than the watchers. This seems to be a result of the extraneous cognitive load induced by the interactivity of the game; the players perceived the game and its language to be significantly more difficult than the watchers did. Both players and watchers forgot significant amounts of vocabulary over the course of the study. Players reported difficulty simultaneously attending to gameplay and vocabulary.

DISCUSSION

The players of the video game did recall some of its language, confirming various posits (Baltra, 1990; deHaan, 2005a; Hubbard, 1991; Meskill, 1990) that video games are potential sources of linguistic information for language learners. However, the watchers of the game recalled more vocabulary items than the players. It is important to note that the difference between the players' and watchers' mental effort in the game's language was not statistically significant. The players and watchers invested comparable mental effort on media and language they perceived to be of different difficulties; the players' poorer recall of vocabulary seems to be attributable to the interactivity of the video game.

It is also important to note that the players and watchers did not differ significantly in their pre-treatment knowledge of the video game vocabulary. If their knowledge had differed, the difference in vocabulary recall scores could be attributable to prior knowledge. Additionally, although both players and watchers reported knowing many of the game's words prior to the study (players $M = 35.7$ words, watchers $M = 35.8$ words), the players recalled only 7.2 words and the watchers recalled only 21.7 words. The participants were not able to notice or recall many known words in either the video and video game environments.

It can be concluded that the physical interactivity of this particular game was extraneous cognitive load, that is, the interactivity was not conducive to learning and seems to have unnecessarily diverted the players' attention from the vocabulary and hindered recall. The interactivity of this video game was not germane cognitive load; it did not contribute to schema development. The watchers of the game were not exposed to the additional extraneous load of the physical interactivity and were able to devote more cognitive resources to the intrinsic load of the game and its language. This finding extends the research conducted by Pellouchoud et al. (1999); their participants also experienced higher cognitive load when playing a video game than when watching a video game.

Previous research (Brett, 2001; deHaan, 2005b) illustrated that interactivity with foreign language multimedia learning environments can hinder language acquisition. Our study reinforces those findings; the players recalled fewer vocabulary items than the watchers. With continued research on other interactivities (such as those mentioned by Sims, 1997), learning environments (like the multiplayer games studied by Sykes et al., 2008, and Zheng et al., 2009) and language elements, it may be possible to broaden Plass and Jones' (2005) discussion of apprehended input in second language multimedia environments to include a consideration of the user's physical manipulation of the media's interface.

As Hubbard (1991) suggested, it is important to be critical about the potential of video games to support second language acquisition. This study demonstrated that even though a video game can be enjoyable and contain foreign language vocabulary, its interactivity hindered the language acquisition process; players were unable to recall the game's vocabulary as well as watchers could recall them.

The reason for the lack of more positive learning outcomes for the players in this study may be framed by Murray's (1997) discussion of interactivity and agency:

> Activity alone is not agency. Some games, like chess, can have relatively few or infrequent actions but a high degree of agency, since the actions are highly autonomous, selected from a large range of possible choices, and wholly determine the course of the game. (p. 128)

This study's video game did not in any way allow the players to navigate through the rap, or to make meaningful choices about the game's language. The "object interactivity" (Sims, 1997, p. 161) of the video game lacked user agency, and the controlled experimental research design seemed to have prevented the learners from "select[ing] and organiz[ing] their own learning resources" (Schwienhorst, 2002, p. 197) or focusing the learners on the "meaning and purpose" (Culley, Mulford, & Milbury-Steen, 1986, p. 70) of language. More agentive (i.e., "immersive virtual"; Sims, 1997, p. 167) interactivities (e.g., video games with more controllable in-game tasks that foster deeper consideration of language) may support better incidental second language vocabulary recall outcomes than the "basic stimulus-response" (Sims, 1997, p. 161) interactivity of this study's video game. Also, English was not crucial for gameplay; this may have contributed to the results. Games that integrate language use and play may be better for language acquisition.

The players' inability to simultaneously attend to the game and its language support the theoretical and empirical work on noticing and second language acquisition (e.g., Schmidt, 2001) and split attention effects (Kalyuga et al., 1999). The players of the video game were asked to play the game and attend to the vocabulary simultaneously and these multiple foci of attention prevented them from noticing and recalling more vocabulary items than the watchers.

As Gass (1997) has delineated, before language can be truly acquired, it must be comprehended, integrated with prior knowledge, and used purposefully. Our results do not suggest that vocabulary can be acquired more effectively through non-interactive environments than interactive environments, only that the initial exposure to the vocabulary of this game, for these players, was made more difficult by their simultaneous interaction with the video game. As in previous studies involving incidental vocabulary acquisition (Knight, 1994; Rott, 1999), both the watchers and the players of the game forgot vocabulary over time.

This study did not capture casual gameplay; neither the players nor the watchers were permitted to pause or take a break from the game to reflect. Long (1991) explicated the need for language learners to self-initiate momentary transfers of attention to elements of language; if the player and watcher had had more agency with their media (i.e., been allowed to pause the game, or control how they interacted with the game), the results may have differed. This study was conducted in a laboratory setting, and since context is important to cognition and learning processes, results may differ if this game were used at home or in a classroom setting.

Limitations

The results of this study must be considered in light of its limitations. An important limitation is the low number of female participants (15 out of 80, although there were no between-group gender differences). Another limitation is that the instrument used to measure cognitive load was a self-report questionnaire that did not have strong internal consistency (the mental effort scale had an alpha coefficient of .551, and the material difficulty scale had an alpha coefficient of .565). The vocabulary-based cloze test should also not be taken as an ultimate measure or predictor of learning with games, and the production task may not

have captured the players' and watchers' focus on comprehending game language. A further limitation is the manner in which the participants were grouped into "high" and "low" language and game proficiencies. One threat to generalizability is the treatment media; the results from watching or playing a game in a typical video game playing environment (e.g., on a sofa in a friend's living room) might be different, and longer or repeated playing or watching sessions may have resulted in better learning outcomes for both groups. The results of this study are also limited in their ability to generalize to the English as a Foreign Language population at large, or to other topics or aspects of second language acquisition.

Implications

This study did not attempt to determine that one media (e.g., a video game or a video) was better or worse than another at supporting second language acquisition, since all media are complex combinations of technological affordances and communication between designers and users (Clark, 2001). This study carefully manipulated one aspect of a video game in order to provide an initial understanding of how interactivity affects recall and attention of second language vocabulary. As some have argued (e.g., Arnseth, 2006; Squire, 2002), the power of games for educational purposes may not reside in the games themselves, but in the context and activities related to and extending from play. Further educational game research (from various perspectives) and careful design and pedagogy are required.

Implications for research

Although the basic stimulus-response interactivity of this study's game negatively impacted attention and recall, the interactivity of other games may have different outcomes. Further studies should investigate interactivities that more closely align with the language of the game (e.g., many sports games' voice commentary describes player actions), or give the learner deeper choices about in-game actions (e.g., many simulation and strategy games allow great agency). Purushotma (2005) describes the link between player choice and goal-related incidental language learning (with remediated text glossed by images and animations) in the life simulation game "The Sims;" that game's interactivity might lead to positive learning outcomes for the players in a replication of the current study. Continued interactivity research could utilize Sims' (1997) taxonomy of interactivity as well as perspectives such as endogenous fantasy (Habgood, Ainsworth, & Benford, 2005) or action memory (Engelkamp, 2001).

This study focused on the initial exposure to vocabulary items and immediate and delayed recall. Future research should examine how interactivity helps or hinders other stages of the second language acquisition process. Studies that examine how game vocabulary is integrated with previous knowledge (i.e., how interactivity affects understanding), or is used communicatively, could greatly benefit digital game-based language learning research. Other affordances of video games (e.g., stories, play, subtitles, repetition, feedback, and visual representations of language) should continue to be examined. As well, studies should focus not only on vocabulary acquisition, but also on phonetic, syntactic, pragmatic knowledge building, and the transfer of these skills to communicative use.

Further research regarding language acquisition through video games could examine how various instructional techniques affect the learning process. These studies could focus not only on the scaffolds game designers use to introduce players to the mechanics of a particular game (outlined in Gee, 2003; Prensky, 2003; Um & deHaan, 2005), but also strategies that multimedia designers and classroom teachers use to encourage learners to focus more explicitly on the linguistic content of materials. Paribakht and Wesche (1997) suggest that explicit instruction may support a more complete acquisition of vocabulary; studies on instructional techniques might range from pre-gameplay activities (i.e., schema activation) to multimedia glosses of vocabulary (as suggested by the studies reviewed by Plass & Jones, 2005) or intelligent feedback in the video game environment to individual or class debriefings following gameplay (according to the focus on form approach delineated by Long, 1991).

In this study, the players of the interactive video game experienced higher extraneous cognitive load (i.e., perception of material difficulty) than the watchers of the non-interactive video did. As Ben-Shaul (2003) emphasizes, it is important to explore how the interactivity of video games affects cognitive load and knowledge building. Researchers should investigate the wide variety of video game interactivities and their various cognitive effects.

The use of various empirical perspectives could provide a deeper understanding of how video games affect second language acquisition. Experimental studies can be useful for systematic comparisons and generalizations of features, but ethnographic work may provide a more valid understanding of gameplay and learning with foreign language video games. Naturalistic gameplay studies (as called for by Squire, 2002) are needed of players of games in a second language. Action research (i.e., precise accounts and analyses of actual classroom practice) may provide valuable insights regarding teaching methods and learning outcomes with foreign language video games. Observations, interviews, and stimulated recalls of more natural gameplay habits (e.g., turn taking, pausing to reflect on gameplay, discussing the game with friends, using Internet resources) may provide valuable insights into how to design and teach with digital games. Conducting mixed methods research with a variety of game genres seems to be a logical next step for digital game-based language research due to the early nature of the field.

Implications for instructional design

Designers of educational games for the teaching of foreign languages should consider the type of interactivity they are requiring from their users, especially if their game is based on a similar interactivity as that used in this study. The incorporation of additional ludic (e.g., cooperative or competitive modes of play) or social tasks (e.g., recording and sharing video of gameplay) may foster better attention and processing of the game's language. Although the results of this study cannot be widely generalized to other types of video games or other multimedia environments used for language instruction (e.g., interactive DVDs or websites), designers of those media should carefully consider the degree and type of interaction they require from their users in order to avoid overwhelming them. Purushotma, Thorne and Wheatley (2008) offer numerous principles for the design of digital games for language learning.

Implications for self study

Students use a variety of media to autonomously learn a foreign language. As video games continue to gain popularity, it seems likely that learners will import or download foreign language games. Students should realize that not all video games are useful for language learning; they should choose their study materials carefully. If students want to use a game like *Parappa the Rapper 2*, they should be aware of the difficulty in balancing their attention between gameplay and language. Students may not be as overwhelmed as the players in this study by: repeating levels, taking breaks between sessions, using notes and dictionaries, recording their play to watch later, consulting online forums and guides, and playing with friends (perhaps alternating and discussing the game and its language after each turn). Video games used in conjunction with learner strategies may be more beneficial than this experimental study's controlled play and tasks. Students, for example, may choose a game of a different genre than the game used in this study.

Implications for pedagogy

Because of students' enjoyment of video games, language teachers may be interested in using games in their classrooms. While games do contain a wealth of comprehensible language, the results of this study suggest that teachers should carefully consider the interactivity of the games they want to use in class and design pedagogical strategies for scaffolding students' play and language learning with mindfully-selected games. Teachers may like to choose a game of a different genre than the game used in this study. Scaffolds might be used before, during or after gameplay.

Before gameplay, a teacher might ask the students to brainstorm vocabulary of the situation in the game (e.g., a fast food restaurant), since more complete schema can contribute to lower cognitive load (Douglas & Hargadon, 2001; Sweller, 1994). A teacher might discuss the difficulty in balancing gameplay and attention to language, perhaps emphasizing this point by having one student play the game in front of the class and talk about her experience and foci of attention during play. Pre-teaching vocabulary using drills or dictionary work, or viewing a non-interactive video of the game before play might also be effective pre-play scaffolding.

During gameplay, a teacher might suggest that pairs of players and watchers alternate playing and watching to balance gameplay and linguistic analysis. These pairs could be asked to transcribe or complete a cloze activity of the game's language together. During gameplay, a teacher could use a focus on form approach to draw students' attention to unique phonetic, morphological, or syntactic elements of the game's language (especially after errors made during students' meaningful L2 communication about the game), and then have students continue playing to examine the language in its natural context.

After gameplay, students could write definitions and original sentences for the unfamiliar words noticed during gameplay. Students could also create gameplay tips for other players in order for the other players to free up cognitive resources for attention to and analysis of language. In order to push the students toward linguistic output (Swain, 1995), a teacher might have the students write and perform original role-plays based on the vocabulary of the video game (e.g., co-workers in a fast food restaurant). If a variety of video games are used in the classroom, the class might create a database of language noticed during gameplay and then investigate word collocations in various video game contexts.

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ABOUT THE AUTHORS

Jonathan deHaan is an Associate Professor in the Faculty of International Relations at the University of Shizuoka. He earned his Ph.D. in Educational Communication and Technology from New York University. His research focuses on second language learning and teaching with games and simulations.

E-mail: dehaan@u-shizuoka-ken.ac.jp

W. Michael Reed was a retired professor of Educational Communication and Technology at New York University and the IRB/IACUC Administrator for Radford University in Virginia. His research interests spanned over a 25-year period and focused on educational computing, problem-solving, metacognition, and composing processes.

Katsuko Kuwada is a doctoral student in the International Cultural Studies program at Tohoku University. She investigates language and culture; her current research compares the use of first-person subjects in Japanese and English based on different cultural backgrounds.

E-mail: k-kuwada@u-aizu.ac.jp

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APPENDIX. *Parappa the Rapper 2* Vocabulary Written Recall Test

Instructions: Fill in the blanks with the words from the rap you just heard.

That's right,
I'm in the house,
Here it comes!

<Lesson 1>
Extra extra, read all about it,
The best burgers in town from all around!
People from around the world come and get it,
The line goes around like a merry go round!

Cut!
Heat!
Toast!
Cook!
Cut!
Heat!
Toast!
Cook!

<Lesson 2>
Burgers to fries, a shake or a friend,
If you're hungry simply line up at the end.
Come on people, gather round
We got everything you want from all around!

Cut the lettuce,
Heat the grill,
Toast the buns,
Cook the patties,
Serve the drinks [Serve them!]
Melt the cheese [Ow!]
French the fries [French them!]
Sweep the floors.

<Lesson 3>
The ketchup, the mustard, the salt and the pepper,
Pour it on right cos we got no extras,
Yo, watch the grill, control the flame guys,
Follow the rules, stay productive and wise.

Cook those burgers,
Turn the patty over!
Watch them fries,

Better execute sooner!
Bring on the ketchup,
Don't forget the cheese,
Bring on the mustard,
Handle it with ease!

<Lesson 4>
Burgers, burgers, is all we have in mind
We cook the best, better get in line
Put it on the tray, is it for here or to go?
Any which way it tastes good you know.

Cook those burgers, turn the patty over!
Cut the lettuce, don't forget the cheese!
Toast the buns, French the fries!
Bring on the ketchup, sweep the floors!