The relationship between video game play, dream bizarreness, and creativity

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Summary. Past research has shown that high-end video game play is associated with bizarre dreams (Gackenbach, Kuruvilla, & Dopko, 2009a). The purpose of this study was to determine if the higher bizarreness in gamers' dreams could be replicated and if so, to inquire if it is due to the unusual worlds they are exposed to during video game play, or to higher creativity. Through a questionnaire, a two-week dream diary and face-to-face administration of two creativity tests, this study partially replicated the bizarreness advantage associated with gaming previously found. This time number of hours playing a video game the night before was controlled. It was also found that video game play history is related to figural creativity. The positive bizarreness, gaming, creativity association was partially confirmed for males while video game play was associated negatively with bizarreness for women with no creativity link. In separate and joint factor analyses of the major variable clusters (i.e., media use including gaming, bizarreness, and creativity) it was clear that any associations were to gaming and not to other media use the day before the dream.

Keywords: video game, dream, dream bizarreness, creativity, Torrance Tests of Creativity, electronic media, dream content analysis

1. Introduction

Our world today revolves around technology. This technology (such as computers and cell phones) affects even our basic cognitive abilities like writing and mathematics (Sternberg & Preiss, 2005). For instance, it takes more cognitive effort to review writing documents using a word processor than by longhand (Kellogg & Mueller, 1993). However, little research has examined the effect that technology has on consciousness. The most technologically demanding and psychologically absorbing experience of technological mediation on mental functioning is video game play. A video game is played on a digital device either at the arcades, on the Internet, on a game console, or with a handheld unit (Baranowski, Buday, Thompson, & Baranowski, 2008). Video games can be played alone or interactively. In America, 72% of households play computer or video games (Entertainment Software Association, 2012). It has been shown that, at the very least, video games affect mental functions. For instance, higher levels of nonverbal problem solving in the specialized cognitive ability of visual-spatial information processing are emerging in people who play video games (Greenfield, 1996; Subrahmanyam, Greenfield, Kraut, & Gross, 2001). But much of the past research on video games has focused on the potential negative consequences like aggression (Anderson & Dill, 2000; Anderson, Berkowitz, Donnerstein, Huesmann, Johnson, Linz, Malamuth, & Wartella, 2003) and addiction (Grusser, Thalemann, & Griffiths, 2007). Research is now suggesting that playing video games can produce positive benefits, especially in the realm of cognitive abilities (Sims & Mayer, 2002). Among other effects, video games have been found to impact elements of consciousness. For example, video games positively affect psychological absorption (Wood, Griffiths, Chappell, & Davies, 2004; Glicksohn & Avnon (1997-1998), flow (Voiskounsky, Mitina, & Avetisova 2004; Choi & Kim, 2004; Chou & Ting, 2003) attention (Green & Baveller, 2003; Boot, Kramer, Simons, Fabiani, & Gratton, 2008), and most recently dreams (Gackenbach, 2006; 2008; et al., 2009b). The purpose of this research was to examine the role that video game play has on (bizarre and non-bizarre) dreams and creativity.

Research has demonstrated that video games impact dreams. For instance, Gackenbach et al. (2009b) found that high-end gamers had a higher number of dead and imaginary characters in dreams. This led to an inquiry about dream bizarreness and how it relates to video game play history (Gackenbach, Kuruvilla, & Dopko, 2009a). Bizarre features in dream are defined as the "impossible, unlikely and inconsistent features in dreams" (Revonsuo & Salmivalli, 1995, p. 169). According to these authors there are three types of bizarre features in dreams. They can be classified as 1) discontinuous; where something suddenly appears, disappears, or transforms, i.e. my dog turned into a robot 2) vague; where a feature (such as location) is unknown 3) incongruous. The incongruous elements are further classified as distorted, exotic, or impossible. Distorted elements have one feature that is not consistent with waking i.e. my house was larger in my dream than in real life. Exotic elements are possible but unlikely i.e. I was in a spaceship. Finally, impossible elements are those that are not possible i.e. I was fighting an alien on Planet Mars.

Although dreams are sometimes filled with these bizarre

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features, they occur less often than previously thought. In a re-analysis of a previous data set, Domhoff (2007) demonstrated that dreams (in the laboratory and outside laboratory settings) are more rational than previously suggested. Dreams are now thought to resemble the realistic simulation of waking life in both the number of scene changes and the number of thought disruptions. In terms of whether bizarre elements in dreams have figurative meaning or are just the result of cognitive flaws, the information available to date suggests that some unusual elements in a dream series probably have figurative meaning, but that many others do not. In the Gackenbach, Kuruvilla and Dopko (2009a) study, dream bizarreness was examined as a function of video game play history. Consistent with Domhoff (2007), they found that gamers, both high- and low-end, had more non-bizarre elements than bizarre ones. However, of the bizarre elements, high-end gamers' dreams were coded as containing more incongruent and vague elements than low-end gamers. No gamer group difference was found for discontinuous elements. Revonsuo (2006) points out that discontinuous elements in dreams illustrate that these:

> *transformations prefer to take routes where the underlying activation patterns slide smoothly across the networks of sensory and semantic features, instead of jumping abruptly from one type of object to an object belonging to a completely different or arbitrary category. (p. 245)*

Thus, a wider network of connections, which is hypothesized as one reason for higher-end gamer incongruent dream bizarreness, would not be expected to be evidenced in the discontinuous scores.

Given this high-end gamer advantage in some types of dream bizarreness, the question becomes why. The first and most obvious reason is because gamers are submerged in strange worlds during the day in their video game play. Thus, all we are seeing here is straight dream incorporation of daytime activities. However, the subjects themselves rated whether there was any reference to electronic media in the dreams that were content-analyzed in this study and there were no gamer group differences. This finding is especially interesting in the context of the significantly higher electronic media exposure that the high-end gamers reported from the day prior to the dream. One might conclude that despite high-end gamers being exposed to more bizarre media elements while awake, there was no group difference in morning after reports of media content in the dreams. This weakens the reasoning that bizarre dream content is purely a function of waking exposure to bizarre media (Gackenbach , Kuruvilla, & Dopko, 2009a).

An alternative reason for the higher bizarreness in gamers' dreams may be due to the nature of their semantic networks. Specifically, Revonsuo and Salmivalli (1995) state that:

> *One possible way to understand the underlying mechanisms of dream incongruity is to think of them in terms of connectionist networks (Antrobus, 1993). During dreaming there is no sensory input to constrain the possible combinations of activation patterns, which may result in an atypical configuration of activation in the network. Such activation could be reflected in subjective experience as incongruous dream imagery. (p. 183-184)*

One might argue that a more diverse network allows for more incongruous dream bizarreness. This interpretation is consistent with other research on high-end video game players who have been found to evidence a variety of cognitive type skills, which may implicate more diverse neural networks. Henderson (2005) summarized these differences and concluded that gamers showed advances in choice reaction time, spatial relations ability, spatial visualization, perceptual speed, scientific problem solving skills, intelligence, reasoning inductively and deductively, reasoning meta-cognitively and reflective decision making. Such diverse networks may also lead to higher creativity.

Creativity is "the ability to produce work that is both novel (i.e., original, unexpected) and appropriate (i.e., useful, adaptive concerning task constraints)" (Sternberg & Lubart, 1999, p. 3). Several studies link the degree of bizarreness in dreams to waking measures of imaginative creativity (Hunt, 1989). Adelson (1974) found that college girls who had more creative dreams were also advanced students in creative writing classes. Schecter, Schmeidler, and Staal (1965) found that university students in an arts program recalled more imaginative dreams compared to students enrolled in science or engineering.

In 1989, Wood, Sebba, and Domino identified four theories in psychology that link creativity with dreams. The first was psycho-dynamically theories (such as Freud) that thought dreams and creativity both involved unconscious thoughts breaking into consciousness. Next, according to these authors, researchers (such as Jung) believed that individuals who were imaginative during the day were also imaginative during their sleep. Third, cognitive theorists stated that waking reality and dreams both need more imagination and a larger semantic network to be creative. Finally, the physiologically based activation synthesis theorists believe the brain is active during sleep and therefore, can creatively solve problems.

The present study examined the relationship between dream bizarreness, creativity and video game play and built on research conducted by Gackenbach, Kuruvilla, and Dopko (2009a). This study examined if the gamers' dreams are more bizarre because they are exposed to bizarre stimuli while gaming during their waking hours, or are gamers more creative and thus do they have richer semantic networks, which allow for more bizarre dream elements?

1.1. Hypothesis

First, high video game players will report using more media compared to low video game players. Media will be analyzed by audio (MP3, radio, cell phone), video (TV, movies) and interactive (computer, internet, video games). Second, high video game players dreams will be most affected by their interactive media use. Third, this study will replicate the interaction Gackenbach, et al (2009a) found between gamer group and dream bizarreness. Specifically, while both high and low video game players had more nonbizarre than bizarre elements, within the bizarre elements high end gamers had more in their dreams (as analyzed from the judges' coding analysis) compared to low video game players. Fourth, this study will extend the dream bizarreness and video game play relationship reported from Gackenbach, et al (2009a) by examining its potential relationship with creativity. It is hypothesized that high-end gamers will have higher scores on figural creativity. However, high end gamers will not have higher verbal creativity because video games have only been show to increase visual-spatial skills and nonverbal problem solving (Greenfield, 1996; Subrahmanyam, Greenfield, Kraut, & Gross, 2001) but not verbal problem solving.

Fifth, when all three variables are combined (video game play, dream bizarreness, and creativity) dream bizarreness will be associated with creativity for high-end gamers.

2. Method

2.1. Participants

The participants for this study were selected from the introductory psychology pool at a western Canadian university that was comprised of approximately 2000 students. They were given course credit for participating. From this sample, 437 students filled out the pre-screening questionnaire completely. The participants were asked about their gaming habits and dream recall abilities in this questionnaire. Subject selection was based upon several video game history questions and dream recall questions. As in previous research (Gackenbach, 2006), video game playing history groups were identified along four dimensions: frequency of game play, length of play, and number of games played, and age when the participant started playing, with younger starts being coded higher. The subjects' responses to the four video questions were converted to z scores and then summed and ranked. The upper and lower thirds were selected. All of these who had high dream recall were invited to the orientation session for the study. Of the potential 150 participants, 67 attended the orientation session and signed the consent forms.

Fifty-two participants completed the entire study. There were 20 high video game players (12 female, 8 males) and 33 low video game players[1] (28 females, 4 males). The age range was 17 – 46 years old. The mean age for low-end gamers was 21.9 (*SD* = 6.6) and the mean age for high-end gamers was 20.94 (*SD* = 3.56).[2]

2.2. Materials

Pre-screening Inventory: These questions have been used in various research projects conducted by this group (summarized in Gackenbach, 2008). They include basic demographics (sex, age) as well as video game playing related questions and dream recall background.

Creativity Tests: The Torrance Test of Creative Thinking (TTCT, Torrance, 1974; 1998; Torrance & Safter, 1999) was chosen to measure creativity in this study because it is suitable for group use, appropriate for all ages, and simple to score (Swartz, 1988). Both the verbal and figural creativity tests were administered to participants because past research has shown that video gamers have higher spatial skills compared to non video game players (Green & Bavelier, 2003; Sims & Mayer, 2002). The verbal creativity test is completed by hand on paper and takes approximately 45 minutes to complete. It uses six word-based questions to measure three aspects of creative thinking: fluency, flexibility, and originality. The figural creativity test is also completed by hand on paper and takes approximately 30 minutes to complete. It uses three picture-based exercises to measure five aspects of creative thinking: fluency, originality, abstractness of titles, elaboration and resistance to premature closure. The TTCT shows acceptable inter- and intra-scorer reliability ($\alpha > .90$) and test-retest reliabilities ($r = .93$ for verbal, $r = .50$ for figural; Swartz, 1988). Although the figural test-retest reliability is lower, this was over variable sample sizes and ages. Also, the TTCT is the standard tool used to measure creativity, which speaks to its validity.

Dream and Media Use Instrument: When respondents signed onto the online dream collection site, they were given these instructions regarding how to report their dream from the night before. The instructions are a slight adaptation from the instructions suggested by (Schneider & Domhoff, 2008):

> *We would like you to write down the last dream you remember having from last night. Please describe the dream exactly and as fully as you remember it. Your report should contain, whenever possible: a description of the setting of the dream, whether it was familiar to you or not; a description of the people, their age, sex, and relationship to you; and any animals that appeared in the dream. If possible, describe your feelings during the dream and whether it was pleasant or unpleasant. Be sure to tell exactly what happened during the dream to you and the other characters.*

Following the dream collection, participants were instructed to fill out a questionnaire asking about their media use the day before the dream and how they think it might be related to the dream they reported. Items on this inventory asked about type of media used (i.e. cell phone usage, television, video games) and relevance to the dream reported (i.e. I talked on the phone to my friends right before I went to sleep and dreamt about them) as well as questions about which elements of the dream seemed bizarre to them. This is because an element may be bizarre to the dreamer but not appear so to the judge and vice versa (Revonsuo & Salmivalli, 1995).

Dream Content Analysis for Bizarreness: The content analysis was conducted using the system developed by Revonsuo and Salmivalli (1995). This method is a cognitively motivated content analysis, which distinguishes between dream elements and whether they are bizarre or non-bizarre. First, elements are identified into one of the fourteen contents (self, cognition, place, sensory experiences, time, objects, persons, events, animals, emotions, body parts, language, plants, and actions). Second, these elements are coded as either non-bizarre or bizarre. As described earlier in the introduction, these bizarre elements can either be discontinuous, vague, or incongruous elements. This last category is further classified as distorted, exotic, or impossible. Two judges were trained on this method and reached 80% agreement in scoring before they began coding all the dreams.

2.3. Procedure

All potential research participants were invited to take a pre-screening inventory that asked about their video game play and dream recall history. Those who were eligible to participate in the study were then contacted via phone or email and invited to attend an orientation session. At this session they completed the consent form and were introduced to the online procedures for recording their dreams. The participants had the opportunity to receive a 6% increase to their introductory psychology course grade. The first 2% came from participants signing onto the online dream diary at least five times per week for the first week, the next 2% were earned if the participants signed onto the online dream diary five times in the second week, and the last 2% is earned if the participants completed the creativity tests in a laboratory setting. The participants were told

they would still receive the credit if they simply signed in and then signed off without reporting a dream or filling in the questionnaire; thus all responses were voluntary. It was also explained, however, that they would not be eligible to participate in the laboratory part of the research unless they fulfilled the two week dream diary sign-in requirement. Additionally, a list of dream-recall tips were handed out and briefly reviewed.

This online dream diary was managed by the Department of Psychology at a western Canadian university. This system recorded who signed into the system each day and the time. The participants were allowed to sign into the system and record their dreams anytime during that day but before midnight. Subjects were also required to keep these dream diaries for ten of fourteen nights during the subsequent 2-week period following the orientation session. They were instructed to type out their dreams in as much detail as possible. Participants were asked to complete a questionnaire about their previous day media-use experiences, whether or not they reported a dream. If relevant, participants were also asked to comment on the relevance of the media to their dreams and on any parts of the dream they found bizarre.

The participants had a 24-hour time period to type out their dream from the night before and submit it online. This timeline ensured that even the late afternoon risers would have time to complete the online component. After 24 hours the online session closed and the participants were no longer able to submit any dreams from that 24-hour period. Email reminders were sent out to all participants two to three times a week to ensure they were signing on to the system. After the two-week dream diary collection period was complete, participants who signed onto the system at least five times in each of the two weeks were invited to attend a laboratory session in order to take the creativity tests. During the laboratory sessions (comprised of 6-12 students) the verbal and figural creativity tests were completed in counterbalanced order. After this, the participants were debriefed. If participants did not complete both weeks of the online dream diary participation, they were emailed the debriefing statement.

3. Results

Data from the dependent variables will be shown in terms of three conceptual clusters: media use (e.g., video game play), dream bizarreness, and creativity. The study analyzed media use from the participants' self-reports of audio media, video media, and interactive media. The dream bizarre elements of the dreams were examined from the participants' subjective point of view (i.e., they were asked to indicate the elements of their dream they found to be unusual for them) and from a judges' point of view (using Revonsuo & Salmivalli's Content Analysis of Bizarre elements, 1995). Lastly, participants' creativity was assessed using the Torrance Test of Creative Thinking (both the verbal and figural tests). Finally, the interrelationships between dream bizarreness, video game play, and creativity were examined.

There were two ways to view the data collected in the daily dream diaries, dreams as individual cases or means across dreams for each subject. The former gives many more data points than the latter, but due to the extremely uneven participation of subjects (i.e., could range from one to 14 dreams) it confounds independent and dependent variables. Therefore, for each analysis initially means per person are considered and then as conceptually justified dreams as cases are considered with a mixed model approach.

Table 1. Descriptive Statistics for Average Media Used before Dreams.

Gamer group		*M*	*SD*	*N*
Sum audio media use predream	Low	5.24	1.19	32
	High	5.50	1.88	20
Sum video media use predream	Low	3.66	.92	32
	High	3.12	.96	20
Sum interact media use predream	Low	3.40	1.07	32
	High	4.16	1.13	20

3.1. Media Use/Video Game Play Analyses

Several inquiries about media use the day before the dream were included in the post dream recording questionnaire. These were combined into conceptual groupings: audio media included phone, CD/MP3, and radio; video media included TV/DVD and movie attendance; and interactive media which included computers/internet and video games. A gamer group MANCOVA, with sex of subject as the covariate[3], was computed on audio, video and interactive media use averaged across dream diary entries for each person. There was a gamer group main effect [Wilks' Lambda = .799, F(3,47) = 3.95, p=.04, partial eta squared = .20]. The means and standard deviations are portrayed in Table 1.

Two of the three types of media were higher for the gamer group while the third type, video media, was the opposite.

Gamer groups were also compared in terms of the media they reported using the day before the dream *which they thought might be relevant to the dream*. Media types were again collapsed into three categories: audio, video, and interactive. In order to determine self-reported media impact on dreams as a function of gamer group and type of media another 2 (gamer group: high vs. low) X 3 (type of media: audio, video and interactive) MANCOVA was calculated with sex of subject and total media used as covariates. Total media use was included so that shear amount of media consumption could not be pointed to as an explanation in case there were any affects. There were no main effects or interactions for self-reported possible media impact on dreams averaged across all dreams for each person.

Due to the primacy of interactive media, especially video game play, and the selection of subjects based on their video game history, the remaining dream bizarreness and creativity analyses will focus on video game play. That is, when number of hours playing a video game the day before the dream averaged across all dream diary entries per person was compared across gaming groups, the high end group reported significantly more (F(1, 49) = 4.866, p=.032, partial eta squared = .09). The high end gamer group reported on average almost an hour of play across all dreams collected (M=.7877, SD=.8319, N=20) while the low gamer group played almost not at all (M=.1574, SD=.4437, N=32). This both verifies the selection of the groups and justifies a control for day before game play effects in subsequent analyses.

Table 2. Mixed Model Univariate ANCOVA's for Gamer Group X Sex of Subject with Hours Played Video Game Day before the Dream and Number of Words in the Dream as Covariates on Various Judges and Dreamers Bizarreness Ratings.

Variable	*F-values*	*M*	*SD*
Nonbizarreness:	F(1, 349)= 8.419, p=.004,	Male = 0.724	.058
Sex of Subject	partial eta squared = .024	Female = 0.935	.044
Distorted Mean:	F(1, 349)= 5.696, p=.018,	Male = 0.089	.016
Sex of Subject	partial eta squared = .016	Female = 0.138	.012
Impossible Mean:	F(1, 349)= 4.226, p=.041,	Low gamer male = 0.027	.024
Video Game Group	partial eta squared = .120	Low gamer female = 0.035	.010
Sex of Subject	F(1, 349)= 3.130, p=.078,	High gamer male = 0.106	.017
Game Group x Sex	partial eta squared = .010	High gamer female = 0.032	.020
	F(1, 349)= 4.743, p=.030,		
	partial eta squared = .013		
Discontinuous Mean:	F(1, 349)= 4.299, p=.039,	Low gamer male = 0.003	.003
Game Group x Sex	partial eta squared = .012	Low gamer female = 0.009	.001
		High gamer male = 0.008	.002
		High gamer female = 0.006	.002

3.2. Dream Bizarreness Analyses

The number of dreams reported in the dream diaries over the two weeks did not differ as a function of gamer group (t(50)=1.24, ns), thus confirming that individuals with high dream recall were equally distributed across groups. The 32 low-end gamers reported on average 6.22 dreams over 14 nights with a standard deviation of 3.23. The 20 high-end gamers reported 5.20 dreams on average over 14 nights with a standard deviation of 2.19. Although the research literature is somewhat mixed about whether or not control for word count when doing bizarreness content analysis is important conceptually (Hunt, 1989; Antrobus, 1993), when sex and number of hours of play were controlled for there were no group differences in words per dream (F(1, 48)=.066, ns) nor when sex and hours played were not covariants (F(1, 48)=.032, ns). However, due to the conceptual issue regarding difficulty in explaining bizarre content in few words dream word count was used as a covariate in the bizarreness analyses.

Self Identified Unusual Dream Components. Each subject was asked to identify elements of their dreams which were unusual for them. Of the 359 dreams that were coded, 241 had comments left explaining something about their dream as unusual in their eyes. An ANCOVA for gamer group with sex of subject, number of words per dream and number of hours played video games the day before the dream (i.e., game play hours, GPH) as covariates was calculated on the total number of unusual comments per dream averaged across dreams for each subject. Instructions were to describe one element per comment line, up to 10 lines/dream. There was no gamer group differences in mean number of comments left about self-perceived unusual dream content (F(1,48)=2.84, ns). High end gamers reported on average 4.90 unusual elements in their dreams (SD=2.34) while low end gamers reported 5.97 such elements (SD=3.24). In other words, whether or not one plays video games people still see their dreams as unusual to the same extent.

Judges Dream Bizarreness Evaluations. From the 67 participants who completed various portions of the study, there were 688 dream entries over a two-week period. Of those, 247 did not enter any dream but logged on in order to get course credit. The remaining 441 entries were used in subsequent analyses with various proviso's (i.e. unanswered questions were dropped; entries with dreams that were under 40 words were dropped, etc.). These adjustments left 353 dreams, 231 were from low-end gamers, and 122 were from high-end gamers.

Unlike the previous analyses where means per person were utilized in these analyses a mixed method approach was undertaken for dreams as cases. Because of the extremely uneven cell sizes of gamer group x sex of subject, some individuals contributed 14 dreams while others as few as one dream, a mixed method analysis accounts for the number of responses. Thus the independent with the dependent variables are not confounded. A series of univariate mixed model analyses were undertaken with gamer group and sex of subject as the independent fixed variables. Covariates were number of words in the dreams and number of hours having played video games the day before the dream. The second covariate, total hours played, was included to control for any explanations of group differences in dream bizarreness as due to being exposed to more gaming. As noted in the previous section, there was a gamer group difference in the amount of media reported, including game play hours, as used prior to the dream, which favoured high end gamers. With these controls, any bizarreness differences in the dreams of gamers versus those who rarely game should not be explainable by these potential confounds because each is controlled for by being a covariate.

For each analysis, a Bonferroni adjustment for multiple comparisons was used. The significant findings are portrayed in Table 2. Non-significant results were found for the sum of all judges bizarreness assessments as well as for some specific judges assessments: exotic mean, incongruous mean (i.e., distorted, exotic, and impossible), and vague mean.

Table 3. Varimax rotated factor matrix on dream recall, media use and dream bizarreness variables.

	Factors (percentage of variance)						
	1 (15.9)	2 (15.3)	3 (9.6)	4 (8.43)	5 (7.67)	6 (7.53)	7 (6.45)
Genre played most*	.821	-.182	-.147	-.086	.018	.002	-.225
Hours played video game predream	.838	-.060	-.033	.092	.134	.009	-.114
Game history sum of z-scores	.785	-.093	.032	.062	-.225	.056	.317
Phone use predream	-.076	-.085	-.011	.709	.275	-.025	.086
CD/MP3 use predream	-.033	.076	.100	.839	-.139	-.016	-.109
TV/DVD use predream	-.156	.119	.123	.058	.843	.045	-.182
Computer/internet use predream	.135	.068	-.289	.184	.265	.723	-.081
Radio use predream	.025	-.020	-.528	.414	.021	.218	-.036
Movie theatre use predream	.406	.100	-.139	.058	.504	-.021	.306
Sex of subject (1=M;2=F)	-.637	.268	-.195	.296	.083	-.061	-.173
Number of dreams reported in diary	-.105	.365	.084	-.185	.133	.389	.397
Dream recall sum of z-scores	.015	-.080	-.006	-.008	-.082	-.049	.850
Average number of words in dreams	-.042	.872	.085	.015	-.075	.284	-.019
Discontinuous bizarre mean	.078	.775	.270	-.006	-.052	-.061	-.087
Vague bizarre mean	.055	.098	.300	-.113	-.217	.704	.010
Distorted incongrous bizarre mean	-.245	.741	-.039	.004	.294	-.230	-.044
Exotic incongrous bizarre mean	.128	.354	.765	.088	-.108	.201	-.145
Impossible incongrous bizarre mean	.640	.294	.440	-.167	-.121	.126	-.026
Average of sums of unusual elements in dreams	-.068	-.164	.679	.275	.333	.020	.136
Nonbizarre mean	-.245	.775	-.180	-.008	.152	.285	.105

*Genre played before dream (0=nonplayed, 1=casual, 2=hardcore, i.e. action, first person shooter, massively multiplayer, etc.)

It can be seen that for two of the four significant bizarreness variables it was sex of subject alone that accounted for the finding, while in two cases video game play was either a main effect and/or combined with sex of subject. Judges perceptions of dream bizarreness resulted in two findings. The impossible dream elements were no different as a function of gamer group for women but considerably higher among men for the high end gamers than the lows. The overall impossible coding was low for all women and non-gaming men, which of course accounted for the main effects. There was also an interaction for discontinuous bizarre dream content as assessed by judges. This one was slightly different than the previous interaction. Here the marker group was the low gamer males who had the least discontinuous elements in their dreams.

Due to the limits of the previous analysis (i.e., inability to do multivariate analyses, lack of accounting for a wider variety of media and dream variables), and to further investigate any possible relationships between additional dream bizarreness and media use variables, a factor analysis was computed using a varimax rotation for people not cases. The rotated factor matrix is portrayed in Table 3.

Seven factors loaded above the eigenvalue 1.0 accounting for 70.89% of the total variance. Factor loadings of .5 or greater were considered in interpretations of each factor. The hypothesized relationship between gaming and dream bizarreness was evident in the first and most important factor which accounted for 15.9% of the variance. All the measures of video game play loaded positively with the judge's ratings of impossible incongruous dream bizarreness. It is important to keep in mind that nongaming media use did not load on this factor but that sex did, with males showing this association.

One other factor loaded media use with dream bizarreness, factor 3. This factor accounted for 9.6% of the variance and loaded judge's ratings of exotic incongruous bizarreness in dreams, subjects self-rating of unusualness with a lack of radio time the day before the dream. The second factor was characterized by number of words in the dream and several dream bizarreness variables, both present and absent. It accounted for 15.3% of the variance. This is on the one hand the classic it takes more words to describe bizarre dream findings but on the other hand nonbizarreness was also associated on this factor. Factor 4 was simply phone use, while five was movie theatre attendance and TV/DVD viewing. One variable loaded on each of factors 6 and 7 as well.

As with Gackenbach, Kuruvilla, and Dopko (2009a), high end gamers were found to evidence more of some forms of bizarre content in their dreams, as determined by judge's ratings. This is not accounted for by other types of media use the day before the dream.

Table 4. Means and standard deviations for verbal creativity scores of high and low video game players

	Low-End Gamers (n = 32)		High-End Gamers (n = 20)	
Verbal factor	**M**	**SD**	**M**	***SD***
Fluency S.S.	104.47	16.67	104.30	16.52
Flexibility S.S.	103.41	16.21	100.40	21.71
Originality S.S.	118.72	14.72	115.20	19.76
Verbal Mean S.S.	108.38	15.63	108.85	12.87
Fluency N.P.	56.91	25.53	59.60	22.84
Flexibility N.P.	55.97	25.10	54.90	25.31
Originality N.P.	77.91	20.05	77.95	16.10
Verbal Mean N.P.	64.41	24.30	66.35	21.82

Note. S.S. stands for standard score and N.P. stands for national percentile

3.3. Torrance Test of Creativity

These analyses are done purely on people, not on cases (i.e., dreams). Thus the small sample size of some cells who actually participated in the creativity testing makes a gamer group x sex of subject analysis impossible. Separate Verbal and Figural creativity multiple analyses of variance (MANOVA) were computed with gamer groups as the between subject independent variable. The various subscale scores of the Verbal or Figural Torrance tests were the dependent variables. In each analysis a Bonferroni adjustment was done.

A chi-square of sex of subject x gamer group on those who took the creativity tests was significant ($X2(1) = 13.04$, $p<.0001$). There were four males in the low gamer group and 12 males in the high gamer group. The females included 28 low gamers and 8 high gamers. While not ideal, it was decided to use sex of subject as a covariate for the verbal scale analysis only. Past research has found that females outperform males on verbal creativity with this measure (DeMoss, Milich & DeMers, 1993). On the figural analyses, sex was not controlled for because females and males usually perform the same (DeMoss, Milich & DeMers, 1993).

None of the 19 scores on verbal creativity showed a gamer group difference. However the means for both groups for the average standard score were above the average listed in the TTCT manual (low end gamer mean= 108.65, high end gamer mean= 107.24 compared to the average standard score= 102.0). On the national percentile, both groups

Table 5. Means and standard deviations for figural creativity scores of high and low video gamers

	Low-End Gamers (n = 32)		High-End Gamers (n = 20)	
Figural factor	**M**	**SD**	**M**	***SD***
Fluency S.S.	106.59	12.19	115.00	16.30
Originality S.S.	106.84	14.22	116.50	16.19
Elaboration S.S.	94.22	18.22	101.00	25.54
Abstractness S.S.	108.69	19.55	123.20	20.35
Resistance S.S.	92.34	12.71	93.70	18.09
Fluency N.P.	61.75	20.23	71.80	22.99
Originality N.P.	60.22	22.31	74.10	23.51
Elaboration N.P.	41.09	28.51	49.35	34.50
Abstractness N.P.	62.50	27.98	79.30	24.50
Resistance N.P.	37.31	19.80	42.60	25.50
Figural Bonus	9.56	3.60	9.80	3.16
Figural S.S.	101.75	9.79	109.90	12.59
Figural Index	111.00	11.68	119.40	14.11
National Percentile	53.31	69.40	67.38	27.82

Note. S.S. stands for standard score and N.P. stands for national percentile

Table 6. Varimax rotated factor matrix on media use and creativity variables.

	Component (percentage of variance)						
	1 (18.4)	**2(15.6)**	**3(12.3)**	**4(8.5)**	**5(8.0)**	**6(7.3)**	**7(7.0)**
Genre played most *	.817	.017	.116	-.105	-.138	.039	.103
Game history sum of z-scores	.607	-.077	.163	.026	-.545	-.069	.380
Hours played video game predream	.933	.046	.063	.058	.076	.112	.054
Sex of subject (1=M;2=F)	-.636	.107	-.150	.113	.160	.347	.026
Video game played predream	.940	.048	.067	-.004	.084	.111	.033
Phone use predream	-.077	-.008	-.009	.812	.129	-.018	.260
CD/MP3 use predream	-.026	.180	-.040	.753	-.055	.248	-.201
TV/DVD use predream	-.091	.074	.040	.114	.842	-.004	.227
Computer/internet use predream	.142	-.261	.197	.122	.263	.512	.148
Radio use predream	-.012	-.019	.031	.085	-.073	.915	-.018
Movie theatre use predream	.236	.088	.149	.036	.192	.106	.715
Verbal fluency converted to standard score	.005	.915	.232	.142	-.006	-.110	.033
Verbal flexibility converted to standard score	.067	.947	-.008	-.010	.032	.009	.059
Verbal originality converted to standard score	-.050	.947	.107	.040	.023	-.035	.072
Figural fluency standard score	.124	.135	.788	-.183	-.016	.126	.275
Figural originality standard score	.075	.167	.752	-.197	-.175	-.008	.112
Figural elaboration standard score	-.056	.370	.172	.235	-.472	-.167	.478
Figural abstractness standard score	.406	-.098	.611	.289	-.090	.001	-.385
Figural resistance to premature closure standard score	.097	.106	.743	.313	.263	.048	-.006

*Genre played before dream (0=nonplayed, 1=casual, 2=hardcore, i.e. action, first person shooter, massively multiplayer, etc.)

scored above the national percentile (low end gamer mean= 65.00, high end gamer mean= 63.81). The means and standard deviations for each of the verbal creativity scores is presented in Table 4.

Another multiple analyses of variance (MANOVA) was computed, with gamer groups as the between subject variable, on 14 scores from the Figural TTCT. By chance alone it would be expected that at least one test would be significant, eight approached or reached conventional levels of significance with a Bonferroni adjustment. Specifically, significant group differences were for the standard score for fluency ($F(1,50) = 4.502$, $p = 0.039$, partial eta square = 0.083); the original national percentile ($F(1,50) = 4.571$, $p = 0.037$, partial eta squared= 0.084); the standard score for originality ($F(1,50) = 5.102$, $p = 0.028$, partial eta squared = 0.093); abstractness of titles national percentile ($F(1,50) = 4.870$, $p = 0.032$, partial eta squared = 0.089); and abstractness of titles standard score ($F(1,50) = 6.573$, $p = 0.013$, partial eta squared = 0.116). The overall mean standard score differed across groups ($F(1,50) = 6.838$, $p = 0.012$, partial eta squared = 0.120) as did the overall index ($F(1,50) = 5.419$, p= 0.024, partial eta squared = 0.098) and the national percentile ($F(1,50) = 4.937$, $p < 0.031$, partial eta squared = 0.09). The means and standard deviations for each figural score are presented in Table 5.

As with the bizarreness results, a factor analysis was computed on basic verbal and figural creativity scores with various media use variables and sex of subject. This was done to extend the creativity findings beyond the gaming history data to other media use the day before the dream. As before the media use variables are averaged across all dreams reported per subject. The varimax rotated factor matrix is portrayed in Table 6.

In this factor analysis six factors loaded above the eigenvalue of 1.0. Interpretation in this case used loadings above .4. The first factor showed the expected relationship between various video game play measures and one figural creativity score for males. The other media used the day before the dream (i.e., these are averages for each person) were not so associated. The second factor was verbal creativity alone. While the third factor described figural creativity. Not until the fifth and seventh factors was there again a relationship between media use and creativity. In both cases it was figural creativity. In factor 5 the lack of gaming history and watching TV/DVD the day before a dream was associated with a lack of figural elaboration. On factor 7 seeing a movie the day before a dream was positively associated with figural elaboration.

To summarize this set of analyses on creativity scale scores, there were no group differences for verbal creativity but there was a difference for figural creativity favouring gamers. The relationship of creativity to other media use was either non-existent or mixed.

Table 7. Factor Analysis of Selected Video Game, Media Use, Dream Bizarreness and Creativity Variables as a Function of Individuals.

	Component (percent of variance)						
	1(15.4)	2(15.1)	3(9.0)	4(8.0)	5(7.5)	6(7.0)	7(7.0)
Genre played most *	.848	-.133	-.046	.029	-.067	.042	-.195
Game history sum of z-scores	.821	.001	-.007	-.146	.041	-.119	.283
Mean # hrs played video game before dreams	.820	-.013	.042	.125	.083	.136	-.171
Sex of subject (1=M;2=F)	-.675	.150	-.027	.038	.305	.196	-.122
Phone use predream	-.054	-.161	.097	.300	.758	.001	.060
CD/MP3 use predream	-.044	.127	.136	-.151	.826	.095	-.117
TV/DVD use predream	-.233	.051	.300	.730	.015	.138	-.324
Computer/internet use predream	.176	.165	-.286	.764	.093	-.046	.144
Radio use predream	-.022	-.022	-.043	.097	.128	.767	.010
Movie theatre use predream	.350	.064	.238	.324	.016	.362	.130
Average number of words in dreams	-.104	.890	-.182	.094	.106	-.013	.072
Dream recall sum of z-scores	.020	-.148	.154	-.067	-.020	-.022	.779
Number of dream reported in diary	-.104	.457	.118	.212	-.218	.114	.450
Discontinuous bizarre mean	-.004	.800	.051	-.096	-.038	-.025	-.195
Vague bizarre mean	.132	.333	-.403	.181	.078	-.469	.219
Incongrous overall bizarre mean	.109	.758	.243	.024	-.010	-.262	-.203
Average of sums of unusual elements in dreams	-.045	-.016	.639	.189	.171	-.473	-.055
Nonbizarre mean	-.300	.731	-.053	.261	-.021	.172	.202
Verbal creativity sum	-.001	.028	.743	-.074	.114	.076	.154
Figural creativity sum	.445	.105	.534	.010	.060	.082	.243

*Genre played before dream (0=nonplayed, 1=casual, 2=hardcore, i.e. action, first person shooter, massively multiplayer, etc.)

3.4. Interrelationships between Variables

In this last section of the results the three variable clusters will be interrelated using factor analysis and partial correlation. First in order to check if the number of hours playing a video game, or the Entertainment Software Rating Board (ESRB) ratings of that video game, could account for the higher bizarreness ratings of the gamers a partial correlation was computed for 33 dreams for which there was specific information for a game which had been played the day before the dream. The ESRB rating was chosen as it gives some estimate of the violent and sexual content of the games. Sex of subject was controlled for in these partial correlations. Selected bizarreness measures were used, including mean of all non-bizarre elements, mean of all discontinuous means, vague mean, distorted mean, exotic mean, impossible mean, and incongruous mean. None of the 14 correlations reached significance. Thus for these 33 instances at least, where details on prior game play and dreams were available, volume of game play and ESRB ratings of games were not related to subsequent dream bizarreness.

Finally, selected variables from each conceptual cluster were entered into a varimax rotated factor analysis. As with the other two factor analyses, all variables were condensed into information about each person, rather than about each dream. Thus all bizarreness data is an average of bizarreness ratings across all dreams for each subject. When trying to view the relationship between all types of variables the data had to be approached in this way as the creativity information was only on each individual and not on each dream. The resultant factor analysis was on 52 subjects who provided all information. The relative influence of other media versus gaming was considered in the previous two factor analyses so to continue that perspective these figures were also included herein. This is thought to be important in order to look at the relative influence of gaming versus more passive media. The individual differences variable of sex of subject was also loaded as well as five basic dream bizarreness variables and two creativity ones . The resultant factor analysis is portrayed in Table 7.

While the preferred cut off for factor interpretation is .4, using .3 can be enlightening in places. The first factor loaded all the video game variables with figural creativity and with a .3 cutoff a lack of nonbizarre elements in the dreams. It's important to notice that none of the other media loaded on this important factor, except going to a movie in a theatre which is as high on immersion if not interactivity than gaming, nor did the three dream recall variables load here. This factor supports the major hypothesis to some degree although the marker of the factor is gaming. The second

factor was strickly a dream bizarreness/recall association but included nonbizarreness as well. Self report unusualness of dreams loaded with both creativity measures in the third factor but inversely with judges ratings of vague bizarreness. No media or gaming elements loaded for factor 3. The fourth and fifth factors were primarily media while the sixth factor combined media and dream bizarreness negatively. That is, using a radio was associated with the lack of judges ratings of dream vagueness and the lack of self-reported unusual elements in dreams. Dream recall was the marker for the last factor.

4. Discussion

This study's main purpose was to replicate and extend Gackenbach, Kuruvilla and Dopko's (2009a) previous study showing an association between gaming and dream bizarreness. In this case creativity was also assessed to see if it might mitigate the gaming/bizarreness relationship. Additionally, multiple dreams were gathered from the majority of subjects in this case while the previous study had only one dream per person. Two possible explanations of this earlier finding were suggested, one was that the unusual content of video games was simply incorporated into the dream. The second explanation was that the higher incidence of bizarre dreams among gamers may be an indicator of creativity due to both requiring extended semantic networks. In order to test these possibilities we undertook the current study. While we found again that high end video gamers showed more bizarre dreams than low end gamers it was only in the case of the most extreme bizarreness, impossible elements. We also found a relationship between gaming and figural creativity. All three were associated for one type of dream bizarreness in males in a limited factor analysis.

4.1. Media Use and Its Relevance to the Dream

We found that overall high-end gamers reported heavier media use the day before their dream but this was especially pronounced for interactive media, like video game play. This supports our decision to use hours of game play the day prior to the dream as a covariate in the various dream bizarreness analyses. Thus if gamer group difference emerged by controlling for number of hours played the day before the dream, we argue that the resulting bizarreness difference is probably due to something deeper than a situational determinant which may have developed or was self-selected and is part of long term game play. We suggest that may be expanded semantic networks. There were a variety of ways in which we approached the question of gaming, dream bizarreness and creativity inter-relationships. When asked if they thought their media use affected their dreams there were no group differences in self-perceived effects but there were group differences in media use.

4.2. Dream Bizarreness

When bizarreness was examined it was first viewed from the perspective of self-perceptions of unusual dream content. There were no gamer group differences in the total number of unusual elements identified in the dream by the dreamer. Not surprising everyone sees his or her own dreams as odd no matter their media/game use history. Thus so far we can conclude that gamers are likely heavier media users, but they are not any more likely to see their dreams more unusual than those less likely to game.

The second way that dream bizarreness was examined was in terms of judge's perceptions. In this section we will first discuss the findings that replicate the previous study (Gackenbach, Kuruvilla, & Dopko, 2009a) and then take up those that are an extension. In our previous study (Gackenbach, Kuruvilla, & Dopko, 2009a) the bizarreness/non-bizarreness main effect was found with no control for number of words in the dream. It should be noted that the main effect for overall judges bizarreness ratings did not occur in this sample but there were two interactions for two ratings scales.

There are three types of bizarreness coded by Revonosuo and Salmivalli (1995): discontinuous, vague and incongruent. As with Gackenbach et al (2009a), differential bizarre content was largely accounted for by one incongruous elements (impossible), but there were no group differences in distorted or exotic elements. There was also a gamer group x sex of subject interaction for the discontinuous ratings in this sample.

Incongruous Bizarre Dream Elements. According to Revonsuo & Salmivalli (1995) distorted elements are those that have one or more features about them that does not belong to it in reality i.e. my room is much bigger in my dream than it is in real life. Exotic elements are those that are highly unlikely to occur but the occurrence is possible i.e. I was in the army in Pakistan. Impossible elements are those that are not possible in the waking reality i.e. I was on an alien planet fighting against some monsters. The most bizarre it can be argued is the impossible elements. In this study high male gamers had more of these elements in their dreams than low males or high or low females. This is likely due to the type of game each of the high end gamer groups were playing. The female high end gamers played games 32% of the time before the day before the reported dream. Of these three quarters were casual games. The male high end gamers played a video game 58%[4] of the time on the day before they reported a dream. Of these games only 16% were casual games. In other words the male gamers were playing primarily hard core genre games (i.e. World of Warcraft, Halo, Resident Evil, etc.) while the female high end gamers were playing casual games (i.e. Sims 3, Spider Solitare, Bejewled, etc.). The difference between hard core genre games and casual genre games is that the latter is shorter to play and easy to learn with less sense of presence (Gackenbach & Bown, 2011). This consideration of genre type was taken up as one variable in the factor analysis. Hard core genre games with their increased presence, sense of being there, are likely to influence subsequent dream bizarreness more than the relatively short played and less absorbing casual genre. This is confirmed in the first factor anlaysis.

There was another interaction with gamer group and sex of subject on discontinuous types of dream bizarreness. In this case it was the gender difference among the low end gamers that seemed to primarily account for the interaction. And within the low end gamers it was the low end gaming males that had the least discontinuous elements in their dreams. Only 3% of the low end gamers played a game the day before the dream. Thus this finding is more about history of gaming that recent game played.

Creativity Extension. An alternative reason for some forms of higher bizarreness in gamers' dreams may be due to the nature of their semantic networks. Specifically, Revonsuo and Salmivalli (1995) point out that dreaming allows the

nature of the connectionist networks to be viewed unconstrained by the sensory input of waking. One might argue that a more diverse network allows for more incongruous, in this case of the impossible variety, dream bizarreness. This interpretation is consistent with other research on high-end video game players who have been found to evidence a variety of cognitive type skills which may implicate more diverse neural networks. Specifically, higher levels of non-verbal problem solving in the specialized cognitive ability of visual-spatial information processing are emerging in people who play video games (Greenfield, 1996; Subrahmanyam, Greenfield, Kraut, & Gross, 2001). Maynard, Subrahmanyam, and Greenfield (2005) reviewed the attention and video game play literature. These authors found that experimental manipulations with attention as the dependent variable resulted in improved attention among those assigned to the video game playing condition.

The verbal creativity test had no group differences between high and low gamers. Past research has suggested that woman score significantly higher on the verbal component (DeMoss, Milich, & DeMers, 1993). This means the lack of a gaming group difference could be because our high end gaming group was mostly males; therefore, if this group scored approximately even with the low end gaming group (mostly female), video games still could have increased the participant's verbal ability. Table 4 shows that the low end gamers' mean score (standard score) on the verbal test was 108.38 and the high end gamers' mean overall score (standard score) was 108.85. These scores are very close, and above the norms of the average standard score which is 102.0. This would mean that even though there was no significant difference between the gamer groups, the video games, or some unknown covariate of gaming history, still could have increased the participant's creative abilities to make the scores roughly even. This would explain why there were no statistically significant group differences in verbal creativity.

Unlike verbal creativity past research, previous research on the figural Torrance test has found no sex differences (DeMoss, Milich, & DeMers, 1993). In contrast to the verbal TTCT, the figural Torrance creativity test had significant differences between gamers and non-gamers. These combined results tend to confirm the hypothesis that high end gamers are more creative as measured by the Torrance tests of creative thinking. Also judging by the participants' standard score and national percentile it seems that this group of high gaming students scored higher than the rest of the general public (on both the verbal and the figural TTCT) while the low end group was at the national means. The mean standard score for high end gamers was 109.90 compared to 101.75 for low end gamers. According to the Torrance Test of Creative Thinking Norms-Technical manual, the mean standard score is 100.0. For the creative index the high end gamers had a score of 119.40 and the low end gamers had a score of 111.00 compared to the manual which was 109.9. As with the previous two creativity norms, the national percentile for the high group was higher than the national norms, with the high end gamers scoring 67.38 and the low end gamers scoring 53.31, near the 50% norm.

Although it is still possible that at least some of the video gamers' bizarreness scores are a result of the bizarre worlds video gamers are exposed to, we argue that the video games and the creative demands (i.e., planning a mission/attack, designing a character, and finding various ways to complete some goal) allow the individual to express various creative factors and therefore develop these relevant creative abilities. One might ask if there are differences in gaming competence which may be responsible for the creative abilities but the classification for high end gamers is very specific (must play a couple times a week, for 2-3 hours each time, must have started gaming before grade three, and must have played 50 or more formats) so we assume that all gamers are equally competent. However, as noted earlier when types of game preferred are considered, they may make a difference as there is a considerable range in the degree to which a player can change or create gaming worlds across games. Additionally, the effects of genre on presence in the gaming world and thus possible generalization to subsequent dreaming varies as a function of hard core versus casual genre. That said, there are always creative ways to simply play that often leaves gamers up against the wall of "stupid" artificial game intelligence and thus preferring the unpredictability of other humans in the games.

As with the bizarreness findings another factor analysis was computed for the creativity variables and a wider range of media used the day before the dream. There were different connections between media use and creativity. As found in the MANOVA's figural abstractness loaded with all gaming variables but not with other media used. Two other factors loaded media with creativity, one positively and one negatively. Lack of gaming history was associated with TV/DVD viewing and the lack of one form of figural creativity while in the other factor going to a movie was positively associated with the same type of figural creativity. The point is that gaming seems to evidence the strongest association to figural creativity.

4.3. Combined Findings

In order to understand the relationship between the three clusters of relevant variables, i.e., video game play, dream bizarreness, and creativity, another factor analyses was computed on subjects who provided all data. The first factor showed the hypothesized relationship between gaming, bizarreness and creativity if with several caveats, i.e. only figural creativity and only the lack of nonbizarre content rated by judges. As with the other two factor analyses focused upon each domain separately, media use other than gaming was for the most part not associated with bizarreness and creativity. The one exception in this analysis was going to see a movie at a theatre and this was likely due to it's high immersive value relative to viewing a movie on smaller screens. Additionally, as with the ANCOVA's, it seems that the hypothesized relationship is specific to this group, with these experiences. It could be that the superior spatial skills of high end gamers (Boot, et al, 2008), set them up for figural creativity superiority. But, as noted earlier, the lack of a gamer group difference in verbal creativity can be interpreted as an increase in male (most high gamers) increase in creativity as normally females (most low gamers) outperform males on that task.

An alternative explanation might be the association of sleeplessness and creativity. Healy and Runco (2006) and Wang and Chern (2008) report that highly creative people have disrupted sleep. So too gamers are notorious night owls and thus also experience sleep disruption. Such disrupted sleep leads to REM rebound in subsequent sleep times, like naps, and these subsequent REM dense sleeps

are higher in dream bizarreness. While we controlled for amount of play the day before the dreams collected, still we found that high end gamers did play more than low end gamers and one can assume that such sleep deprivation might be the result.

It should also be pointed out that the very nature of gaming is that it often results in problems to be solved. Researchers have shown that cognitive concerns from the day before are more likely to be incorporated into the dream (Cipolli, Boizani, Tuozzi, & Fagioli, 2001; Nielsen, Kuiken, Alain,k Stenstrom, & Powell, 2004). We addressed this to some extent with the partial correlations of various dream bizarreness measure with hours of play pre-dream and ESRB ratings, controlled for sex. There were no significant associations. If indeed the problems were incorporated then we would expect positive associations. That said, the ESRB is not the best way to examine gaming content in dreams and additional such dream content analyses are continuing in our laboratory (Gackenbach & Rosie, 2009). Specifically, different games carry different cognitive loads and we are in the process of identifying that for various games and genre's. This effort has been applied to our analysis of gamers dreams (Gackenbach, Sample, & Mandell, 2011). Additionally, as Boot et al (2008) pointed out regarding their examination of attention and memory in gamers, tens of thousands of game play hours, which is common of hard core gamers, is not made up in an even long laboratory session of hours, and we argue that such "training" differences results in brain structural differences, i.e., expanded semantic networks, in these young people.

4.4. Limitations

Limitations in the present study are that our high end group was comprised of mostly males and our low end group was comprised of mostly females. Although we did statistically control for sex either as a covariant in a few analyses but mostly using factor analysis or mixed model analysis, it would be preferable to have equal number of males and females in each group and with a larger sample size. Also because participants came into the study with their video gaming habits, we could not randomly assign them into the groups. This means that we did not have random selection or random assignment in our study. Additionally, while a non-playing group would have been ideal, they are virtually nonexistent in today's post-secondary population.

All the data that we collected was correlational, so no cause and effect conclusions can be drawn from the results. Another concern deals with the participants reporting's of bizarre elements. More specifically do high and low end gamers give similar ratings of bizarreness to the same dream. All we report here are the number of unusual attributions to the dream by the dreamer and not their content. It could be that high end gamers are more open to ambiguity and view impossible scenarios as less bizarre because they are exposed to them during the video game play thus the lack of group differences in unusual self-identified dream elements. To address this we had a judge code the comments but found no group differences.[5]

Our last concern deals with the measurement of creativity. Although we cannot be sure that the Torrance tests measured every form of creativity we do get a reasonable estimation of the participants' creative abilities and we are therefore still able to make appropriate conclusions.

4.5. Conclusion

This study shows some indication that high end gamers have more bizarre dreams at least of the impossible variety. Also while in part this may be due to game play, there is some indication that it is also associated with creativity. Thus the creativity and dream bizarreness findings herein may support the existence of wider semantic neural networks in those who have a history of playing video games quite a lot relative to those who do not. No such associations were found for users of other media the day prior to the dream.

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Notes

[1] While nonplayers would have been ideal, they are virtually nonexistent in contemporary post-secondary populations.
[2] It should be noted that while 52 participants finished the entire study, various data points may still be missing on an individual subject thus making the N's a bit different from analysis to analysis.
[3] There were too few male low end gamers (N=4) to justify with analysis of means across individuals, using sex as an independent variable.
[4] Keep in mind that number of hours of game play the day before the dream that was reported was a covariate on all analysis.
[5] For those who commented there was also no group differences in number of comments. None-the-less, to further examine their comments on unusualness, they were coded using a shortened version of the Revonsuo and Salmivalli (1995) method of bizarreness content analysis. That is, from the judge's perspective the comments about bizarreness of the dream were judged along several dimensions. If bizarre then the comment was classified as one of three types of incongruous bizarre element (i.e., internally distorted, exotic and impossible) or as vague or discontinuous bizarreness types. It's important to keep in mind that in the eyes of the dreamer everything they mentioned was unusual even if a judge would see the same element as non-bizarre. Thus subsequent analysis were computed on the above subcategories as well as on combined bizarreness scores and on the grand total of all unusual elements coded by the judge as well as those entered by the dreamer.

Typically number of words in a dream is used as a covariate in such analysis because the argument goes that in order to describe a bizarre element in a dream it takes more words. Mixed model ANCOVA's of gamer group by sex of subject with number of words in the comments about the unusual elements in the dreams as covariate. These ANCOVA's were computed on all judges coding categories (i.e., sum of bizarre codes, non-bizarre codes, individual bizarre codes) and none resulted in gamer group differences. Thus by the judges evaluations and by the dreamers evaluations (number of comments), there was no difference between groups in unusual elements thought by the dreamer to be something that others would not notice. In other words while for the dreamer these elements were unusual (i.e., I'm not pregnant but dreamt I was.) the judge did not see these things as odd as a function of gamer group.