PREDICTORS OF PRESENCE IN VIRTUAL REALITY

by

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ABSTRACT

The subjective experience of presence is considered to be important in the treatment of anxiety disorders using virtual reality. Presence can be defined as a psychological phenomenon through which one's cognitive processes are oriented towards another world. Most of the research on presence has focused on the roles of technological factors influencing presence, while the number of studies focusing on the personality and physiological predictors are far fewer. Thus, the present study examined the relationship between various personality variables and presence, along with physiological correlates of presence when engaged in a virtual environment. The Presence Questionnaire, to determine their experience of presence, and a small battery of personality-related questionnaires were administered to 70 young adults who participated in 3 different virtual reality scenarios. Participants' physiological responses were recorded in the form of heart rate, galvanic skin levels, and galvanic skin responses were assessed as were urges to drink (craving). Data analysis showed that expectations, levels of craving, and drinking history played a significant role in the experience of presence.

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TABLE OF CONTENTS

PREDICTORS OF PRESENCE IN VIRTUAL REALITY

Virtual reality (VR) is defined as "an artificial environment which is experienced through sensory stimuli provided by an interactive computer" (Merriam-Webster's' dictionary, 2004, p. 809). Throughout the years, the concept of a virtual world became popularized through movies and books. Although VR seems relatively recent, the idea of alternate realities has been present throughout human history. Artists, poets, and playwrights would engage people in alternate realities though their creative efforts. In the 1950's, Morton Heilig put his own artistic spin on VR by creating one of the first multisensory virtual experiences that engaged a users' sense of motion, sound, sight, and smell. The more modern definition of VR dates back to the late 1960's, when Ivan Sutherland created the first head mounted display (HMD) (Sutherland, 1968). Since that time, current research has focused on making the virtual environment (VE) more realistic as well as understanding what makes the VE seem realistic to a user.

One factor that has that has been considered central to the experience of the VE is presence (Banos et al., 2008). The concept of presence was originally defined by Marvin Minsky (1980) as a "sense of being physically present with virtual objects at a remote teleoperator site." Sas and O'Hare (2003) describe presence as a "psychological phenomenon, through which one's cognitive processes are oriented towards another world." According to Schloerb and Sheridan (1995), presence occurs when "the person perceives that he or she is physically present" in a remote environment. Although there have been many different definitions of presence, there is a general agreement that presence consists of a person "being in" one environment when they are actually physically present in different one.

Over the years, researches have examined which the elements comprise "being there".

Fontaine (1992) describes this phenomenon as being a shift in attention, while others describe it as a combination of both involvement and immersion (Witmer & Singer, 1998). According to Witmer and Singer (1998), "involvement is a psychological state experienced as a consequence of focusing one's energy and attention on a coherent set of stimuli or meaningfully related activities and events." Involvement is dependent on the significance or meaningfulness of a stimulus for that person. As a user becomes more involved with a particular stimulus, their sense of presence will increase. For example, one common VR scenario involves flying in an airplane. During the ride the user may experience anxiety provoking situations (such as severe turbulence) that may or may not occur during a typical flight. In this case, if the user views the turbulence as something meaningful or significant, their focus will shift towards this stimulus. Through this shift in attention and meaning put towards the stimulus ("The plane might crash") their experience of "being there" will increase. If the user does not view the turbulence as something meaningful or significant, their focus may shift towards something unrelated to the VE (such as the VR equipment or even their own personal life). By shifting attention away from the VE, the user would experience a decreased sense of presence.

Immersion, on the other hand, "is a psychological state characterized by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experiences" (Witmer & Singer, 1998). According to Bjork and Holopainen (2005), immersion consists of four components: spatial immersion, emotional immersion, cognitive immersion, and sensory immersion. Spatial immersion involves how much the VE feels like it is physically there. This concept can also be seen as how much the VE isolates a person from the actual physical environment. Emotional immersion is the degree to

which the VE elicits certain emotional responses. For example, if a user experiences physiological reactions (increased heart rate and sweating) and a subjective report of fear to a virtual stimulus, they may be considered to be emotionally immersed. Cognitive immersion consists of the user directing cognitive resources (such resources used to solve a particular problem) to the VE. Scenarios that require the user to memorize sequences, engage in a conversation, or solve a logic puzzle generally lead to higher reports of cognitive immersion. Lastly, sensory immersion measures the relation of the senses to the VE. Over the years, VEs have expanded to include more senses than just sight and sound, which greatly increases sensory immersion. For example, Sallnas (1999) utilized haptic feedback while a user was engaged in a VE, which significantly increased their sense of presence. In terms of VR, haptic feedback consists of the ability to "feel" the interface with which they interact, which adds the sense of touch to the VE. Although Bjork and Holopainen (2005) defined four parts of immersion, a user can still be considered "immersed" even if they do not experience all four aspects. For example, a person could report feeling immersed during a puzzle simulation that contained no emotional stimuli (to suggest emotional immersion). Because individual factors play a role in the experience of presence (Sacau, Laarni, & Hartmann, 2007), different combinations of these four elements could elicit different feelings for different people. One person could report being immersed by experiencing a combination of spatial and sensory immersion, while another person could report being immersed by only experiencing emotional immersion.

The combination of both involvement and immersion are necessary for experiencing presence (Witmer & Singer, 1998). Although involvement and immersion are different aspects of presence, they are interdependent. In other words, if a user is experiencing a high level of

involvement, then their experience of immersion will increase. Also, if a user is experiencing a high level of immersion, then their experience of involvement will increase as well. This most likely happens because attentional focus solely on the VR will enhance noticing only the VR, making the user feel as if the physical world is not there. Or, if a user begins to confuse the VE with the real world, the user's attention will shift from the real world to the virtual world.

In addition to involvement and immersion, research has focused on how user and media characteristics (IJsselsteijn et al., 2000) affect this experience. User characteristics "refer to the range of individual differences (age; gender; the users' perceptual, cognitive, or motor abilities; personality characteristics; etc.)" that may influence the degree to which a person feels present in a VE. Some user characteristics include empathy (Wallach et al., 2009), creative imagination (Sas & O'Hare, 2003), and cognitive ability (Sacau, Laarni, & Hartmann, 2007). Although considered to play an important role in the experience of presence, little research has investigated the role of user characteristics. According to Sas and O'Hare (2003), a "large amount of work has been carried out in the area of technological factors affecting presence. Comparatively, the amount of studies trying to delineate the associated human factors determinant on presence is significantly less." One personality variable that has been assessed is absorption. According to Kremen and Block (2002), absorption is a "disposition to enter under conducive circumstances psychological states that are characterized by marked restructuring of the phenomenal self and world." Murray, Fox, and Pettifer (2007) found this construct to have a weak correlation with presence which contradicted other findings (Banos et al., 1999) that absorption was significantly correlated with presence. The contradiction may be explained by the fact that both of the former studies used different measures of presence, with Banos et al. (1999) using a single scale item.

These findings suggest absorption needs to be more closely examined with a more standardized measure of presence.

On the other hand, media characteristics refer to aspects of the VR itself that affect the experience of presence. These characteristics can be broken down into two variables: media content and media form (Banos et al., 2008). Media content refers to the characters, objects, and even events that a user may encounter while in VR. For example, in a public speaking simulation, the audience, their reactions, and the speech itself would all be considered media content. Media form refers to the physical, objective properties of the VR display medium (IJsselsteijn, 2000). For example, in a public speaking simulation, the amount of pixels used to create the environment and the VR equipment itself would all be considered media form. One type of media form that has been investigated includes update rate (Barfield & Hendrix, 1995) Update rate is defined as the "frequency (in frames per second) at which computer generated images change in response to user actions or to other dynamic aspects of the simulation" (Witmer & Singer, 1998). Barfield and Hendrix (1995) results' suggest that when compared to lower update rates, higher update rate significantly affects a user's sense of presence.

Researchers have focused on not only the definition of presence, but the measurement as well. Sheridan (1992) reasons that because presence is a "mental manifestation", that "subjective report is the essential measurement" (Sheridan, 1992). Several ratings scales have been created to measure this experience (Slater et al, 1994; Welsch et al., 1996), with the Presence Questionnaire (PQ) (Witmer & Singer, 1998; Witmer, Jerome, & Singer, 2005) being one of the most popular. The PQ is a 32 item self-report measure that explores the degree to which a user experiences

presence in a VE. A cluster analysis showed that the questionnaire can be broken into four subscales: Involvement/Control, Adaption/Immersion, Sensory Fidelity, and Interface Quality (Witmer, Jerome, & Singer, 2005). These subscales are consistent with the idea that involvement, immersion (naturalness) (Witmer & Singer, 1998), and media characteristics (IJsselsteijn et al., 2000) all play a key role in the experience of presence.

Despite validity of the PQ, these types of rating scales are subjective. Therefore, objective measures in conjunction with subjective measures are recommended to gain a better understanding of presence. Some objective measures could include reflexive responses (e.g. moving out of the way of an incoming virtual train), socially conditioned responses (e.g. smiling), and task performance (IJsselsteijn et al., 2000). Wiederhold, Davis and Wiederhold (1998) compared levels of immersion and physiological responses by looking at measures of heart rate, respiration rate, skin temperature and skin conductance rate (SCR). Objective measures tap into the involvement and immersion aspects of presence without relying on a subjective self report. For example, reflexive responses show spatial immersion through the fact that the stimulus is confused as being there when it really is not. In an anxiety-provoking simulation, physiological responses can imply involvement and emotional immersion because of the meaning and reaction towards the situation or stimulus. Although in theory all these objective measures seem to be reliable indicators of presence, little research has been conducted to empirically examine these claims. IJsselsteijn et al. (2000) suggest that "more extensive studies are needed to investigate whether SCR, heart rate, or other physiological correlates of presence provide a reliable corroborative measure."

The purpose of this study was to investigate several user characteristics (IJsselsteijn et al., 2000) that predict the experience of presence, as well as the utility of using physiological measures as a corroborative measure of presence. As previously mentioned, a few characteristics have yielded contradictory findings, while others have only been minimally investigated. These characteristics include the relationship between absorption and presence as well as the relationship between presence and the individual's expectations and general beliefs about VR. Expectations and beliefs are important factors because they have been found to play a role in other processes, such as hypnosis (Benham, Woody, Nash, 2006) and treatment outcome (Meyer et al., 2002), which suggests that they may play a role in VR as well. Finally, anecdotally video gamers' are described as being able to "lose themselves" while playing a video game. Because of this, the relationship between the individuals gaming experience and their experience of presence in the VR will be examined. It is hypothesized that: (1) these trait-related factors (expectations, absorption level, and video game experience) will be significantly associated with the experience of presence and (2) physiological measures (heart rate, galvanic skin level, and galvanic skin response) will be correlated with the experience of presence.

METHOD

Participants

Thirty one males (44%) and 39 females (56%) participated in the study. The participants age ranged from 21 to 53 (M =23.76, SD = 5.74). There were 41 (58.6%) Caucasians, 13 (18.6%) Latinos/Latinas, 7 (10%) Asians, 6 (8.6%) African Americans, and 3 (4.3%) multi-racial adults. Because the VR program involved alcohol related stimuli, each participant was required to be 21 years or older.

Virtual Reality Equipment and Environment

The Alcohol Com Ed program created by Virtually Better© is designed to assess cravings for alcohol as the individual encounters different aspects of a party at a home. Below, the kitchen (figure 1a), bar (figure 1b), and baseline (figure 1c) scenes are illustrated. When engaged in the environment, the participants wore an eMagin Z800 3DVisor© head mounted display and Phillips SBC HN110 noise-cancelling earphones. Participants were automatically led through the VE and were allowed to look around the environment by moving their head.

Procedure

Prior to entering the VE, participants were given the Tellegen Absorption Scale (Tellegen & Atkinson, 1974), Gaming Experience Questionnaire (Taylor, Singer, & Jerome, 2009), Simulator Sickness Questionnaire, a revised time-line follow back to measure alcohol intake (Lewis-Esquerre et al., 2005), and a brief 3 item questionnaire designed for this study that

assessed general beliefs about VEs. In addition, participants were assessed for an initial craving of alcohol based on a 0 to 10 scale. Next, they were fitted with the VR head mounted display and electrodes that recorded heart rate, galvanic skin levels, and galvanic skin responses were attached. Prior to introducing the experimental stimulus there was a 5 minute baseline period to establish resting physiological levels. After baseline, a virtual reality baseline scene was presented where the participant moved through a room with different pictures of aquariums (see figure 1c). No alcohol related cues were present in the baseline VE. Next, participants were led through two different scenes. The order of these scenes was randomized for each participant. The first scene placed the participant in a virtual bar with a bartender and one peer (see figure 1a). The participant walked through the room which eventually led to an interaction with both the peer and bartender. In the second scene, the participant was presented with alcohol related stimuli in a virtual kitchen environment (see figure 1b). Both scenes were on a set path that moved the participant automatically. The bar and kitchen scene lasted approximately three and a half minutes, while the baseline scene lasted approximately two and a half minutes. In addition, the participant was able to focus on any stimuli by moving their head towards it. The participant could not control the direction or pace of their movement through the environment. After each scene the participant reported how much they craved alcohol during the scene on a 0 to 10 scale Upon completion of the VR presentation, the participant completed the Presence Questionnaire (Witmer & Singer, 2005) to measure their experience of presence.

Self-Report Measures

Presence Questionnaire (PQ; Witmer & Singer, 2005). The PQ is a 33 item questionnaire that measures a users' experience of presence within a virtual world. Each item is rated on a Likert-type scale (1= not at all, 7= completely) that assesses the users' experience in the VE. During the data analysis, a subset of items (#1,2,6,7,9,12,13,14,15,16,17,21,22,24,26,28,31,32,33) were removed because they did not relate to the VE in this experiment. For example, question #13 asks, "How well could you actively survey or search the virtual environment using touch." Because this environment did not include touch, it was removed for the purpose of this experiemnt. Overall, the items included in this investigation were based on a study that utilized the same PQ and VR (Bordnick et al., 2008).

Tellegen Absorption Scale (TAS, Tellegen & Atkinson, 1974). The TAS is a 34 item questionnaire that measures aspects of absorption in a particular person. Questions are answered by using a dichotomous ("yes" or "no") scale. A content analysis showed that the scale can be broken into 9 categories that include: (1) Is responsive to engaging stimuli, (2) Is responsive to inductive stimuli, (3) Often thinks in images, (4) Can summon vivid and suggestive images, (5) Has crossmodal experiences, (6) Can become absorbed in own thoughts and imaginings, (7) Can vivdly re-experience the past, (8) Has episodes of expanded awareness, and (9) Experiences altered states of consciousness. (Tellegen, 1982).

Gaming Experience Questionnaire (Taylor, Singer, & Jerome, 2009). The GEQ is a 28 item questionnaire that measures an individual's gaming experience. It asks questions about previous gaming history as well familiarity with certain gaming systems.

Revised Time-Line Follow Back (Lewis-Esquerre et al., 2005). The revised time-line follow back is a questionnaire that assesses the amount of alcoholic drinks a person has consumed over a certain amount time. The questionnaire required participants to fill out a 2 week calendar according to the amount of drinks and hours they drank for a given day.

A brief 3-item questionnaire was designed for this study to measure certain beliefs and expectations about VR as a whole. The questionnaire reworded 3 items from the Reality Judgment Questionnaire (Banos et al., 2000). Each item is based off of a Likert-type scale (1= strongly disagree, 5= strongly agree) that asks how much a person agrees with the given statement. The statements include: (1) My interactions with the virtual world will seem natural to me, like those in the real world, (2) Virtual reality is boring and something that is uninteresting to me, and (3) I expect to feel immersed within the virtual world.

Craving of alcohol was assessed at baseline and after each scene by asking the participant how much they craved alcohol during the scene on a 0 (none at all) to 10 (more than ever) scale.

Psychophysiological Measures

Heart rate, galvanic skin level, and galvanic skin response, were recorded continuously throughout the experimental and baseline sessions using the BIOPAC psychophysiological materials and Acqknowledge software. To measure heart rate, an electrode was placed on the tip of the index finger of the left hand. Finally, to measure skin conductance, two electrodes were placed on the left palm near the bottom of the thumb and pinky finger as well as one grounding electrode on the middle of the left forearm

RESULTS

Self Report Measures

Table 1 shows the means and standard deviations of each measure. All self-report measures and psychophysiological measures were correlated with the adapted Presence Questionnaire to determine their relationship. As illustrated in Table 2, there were significant correlations between presence and the following variables: GBQ question 3 ("I expect to feel immersed within the virtual world") ($r(68) = 0.251$, $p < .05$), number of days the participant drank during the 2 week period ($r(68) = 0.267$, $p < .05$), the number of drinks the participant drank during the 2 week period ($r(68) = 0.252$, $p < .05$), craving ratings during the VR bar scene ($r(68) = 0.339$, $p < .01$), and craving ratings during the VR kitchen scene ($r(68) = 0.283$, $p < .05$). There were no significant correlations between presence and any other self-report variables. A series to t tests were conducted to assess for potential gender differences on the self report variables. Only one variable, gaming experience, was significantly different ($t(68) = 3.310$, $p < .01$) (table 3). Males reported higher gaming experiences when compared to females.

Psychophysiological Measures

To assess for their relationship to presence, both means (table 4) and change scores (table 5) from the five minute resting baseline for heart rate, galvanic skin level, and galvanic skin response were correlated with the Presence Questionnaire subscale. Mean scores were calculated as the average score for each individual scene. Change scores for all three measures were

calculated by subtracting the mean score during a scene from the mean score at baseline. Galvanic skin response was converted into a rate for each scene by counting the number of responses (frequency) and dividing it by the length of scene. A response was defined as a minimum amplitude change of .05 micromohs (Cacioppo et al., 2007). Response rates and their change scores from the five minute baseline were correlated with the Presence Questionnaire subscale. There were no significant correlations between any of the psychophysiological measures and presence.

Further analysis showed a significant gender difference (table 6) for heart rate during the 5 minute baseline ($F(1, 68) = 6.842$, $p < .05$), bar ($F(1, 68) = 6.512$, $p < .05$), and kitchen scene ($F(1, 68) = 8.834$, $p < .01$), galvanic skin response during the 5 minute baseline ($F(1, 67) = 7.836$, $p < .01$), bar ($F(1, 67) = 6.057$, $p < .05$), and kitchen scene ($F(1, 67) = 5.139$, $p < .05$), as well as galvanic skin level during the kitchen scene. ($F(1, 67) = 4.183$, $p < .05$). After controlling for 5 minute resting baseline differences (table 7), no significant gender differences were found.

Sample Restricted to Participants Reporting Alcohol Use in Past Two Weeks

Because the original sample consisted of 21 (30%) participants that reported having 0 drinks over a 2 week period, the above data analysis was repeated using only participants who reported having one drink or more on the Timeline Followback. No significant differences in outcome occurred when the analysis was restricted to this subset of participants.

DISCUSSION

The results of this investigation suggest that expectations, craving levels, and drinking experience play a role in the experience of presence in an alcohol related virtual environment. These findings are consistent with the previous literature that describes how behaviors (such as alcohol use) and subjective feelings (such as craving) play a role in the experience of presence in virtual environments. The results are also consistent with the literature that addresses the role of expectations in processes such as hypnosis (Benham, Woody, Nash, 2006) and treatment outcome (Meyer et al., 2002). Throughout the literature, people who score high on certain emotional dimensions have higher presence when in a VE, including test anxiety in a test taking VE (Alsin-Jurnet & Gutierrez-Maldonado, 2010), snake phobia in a snake VE (Bouchard et al., 2004), spider phobia in a spider VE (Renaud et at., 2002), and height phobia in a height VE (Robillard et al., 2003). In addition, some temporary states that have been linked to higher presence include in-session anxiety in an anxiety provoking VE (Alsin-Jurnet, Gutierrez-Maldonado, & Rangel-Gomez, 2011; Price & Anderson, 2007), craving to smoke in smoking VEs (Ferrer-Garcia et al., 2010), sadness in a sad VE (Banos et al., 2004), as well as relaxation in a relaxing VE (Riva et al., 2007). In this study, higher presence was related to two different measures of alcohol use (frequency of drinking and quantity of alcohol consumed) and to the desire to drink (craving) in the environment. Therefore, consistent with the research relating behaviors and emotions to presence has focused on anxiety VE's, the results of this investigation indicate that these same elements are at work when the focus is on other types of behavior and VE's, such as alcohol related VE's. Although the directional nature of this interaction is unclear,

it may be those who drink more alcohol were more able to related to and therefore more likely to immerse themselves in the VE, which in turn produced craving for an actual drink.

Other user characteristics (absorption and gaming experience) and the psychophysiology measures were not significantly correlated with presence. One potential reason for the lack of significant relationships could be the nature of the VE that was used in this investigation. Overall, participants reported lower presence scores compared to other investigations. For example, Bordnick et al. (2008) used the same VE but included olfactory cues, which appeared to elicit higher levels of presence than that found in this study. Thus, incorporating the ability to stimulate a third sensory channel (ie., olfaction) beyond sight and sound may function to enhance presence (Meehan et al., 2005; Sallnas, 1999). In addition to the lack of olfactory cues, the lower levels of presence found in this investigation may be attributed to the fact that the VE that was used is considered a passive, not active VE. Passive VEs has been found to elicit lower levels of presence when compared to active VEs (Slater et al., 1998) and to elicit different psychophysiological reactions. In one investigation, reactions in skin conductance and heart rate were found to be higher in active VEs compared to passive VEs (Jang et al., 2002). Further research with alcohol cues should include the possibility for the participant to actually interact with the environment.

Another consideration for the lack of a significant relationship between presence and the physiological measures was the use of a non-clinical sample. In this investigation, the sample consisted of 21 (30%) participants who reported having 0 alcoholic drinks over a 2 week period. These participants were very unlikely to have a physiological based craving reaction given their

limited use of alcohol. In an attempt to examine whether non-drinks were significantly affecting the study outcome, the data were analyzed excluding people who had 0 drinks over a 2 week period (n = 49). No significant differences were found between the original and subset analysis which suggests that the relationships between the personality variables, psychophysiological responses, and presence were similar between nondrinkers and mild drinkers.

Like most studies, more questions were raised than answered. Because this study consisted of a non-clinical sample, the relationship between the variables investigated and presence were examined in non-drinkers and mild-drinkers. Future research should investigate if the relationships are the same for heavy drinkers and people with a diagnosis of substance abuse or substance disorder. Furthermore, although the relationship among gaming experience, perception of boredom in the VE, and presence are unclear, future research should investigate the role of gaming experience on presence in different types of VE's.

The fact that presence in the VE was associated with expectations, craving, and alcohol use during a 2 week period supports the idea that both user characteristics and media characteristics play a role in the experience of presence (IJsselsteijn et al., 2000), implying that the interaction between the VE and user characteristics determines the amount of presence experienced (Steuer, 1992). Furthermore, it may suggest that different user characteristics can interact differently with different media characteristics in the experience of presence. For example, a users' *expectations* that they will experience presence could be a significant predictor of presence in one VE but not in another. In a VE that has low media characteristics, people with both high and low expectations could potentially experience a low level of presence. In a VE that

has high media characteristics, people with low expectations could continue to have low levels of presence, while people with high expectations could experience higher levels of presence. As a result, the relationship between expectations and presence would be stronger in the VE with high media characteristics. This could help explain contrasting findings for several user characteristics relationship to presence including absorption (Banos et al., 1999 ; Murray et al., 2007), immersive tendencies (Bouchard et al., 2004 ; Murray et al., 2007), as well as task performance being related (Cornia et al., 2004 ; Mania & Chalmers, 2001). Further research should further investigate the relationship between different user characteristics among different media characteristics.

Overall, this study investigated potential personality and psychophysiological correlates of presence. It was found that expectations, drinking history, and craving were significant predictors of presence, while there were no significant correlations between presence and other self-report variables assessed in this investigation. In addition there were no significant correlations between presence and the psychophysiological measures.

APPENDIX A: FIGURES

Figure 1a

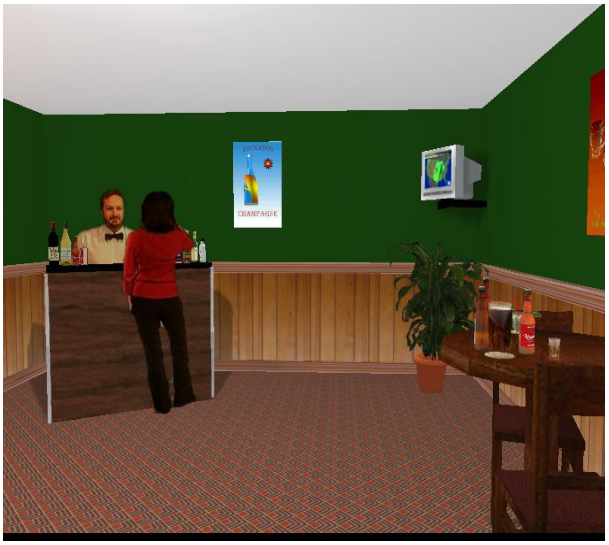

Figure 1b

Figure 1c

APPENDIX B: TABLES

Table 1

Questionnaire	Mean	SD
PQ	65.98	11.64
GBQ 1	2.89	0.79
GBQ 2	1.87	0.79
GBQ 3	3.43	0.77
TAS	19.21	5.78
Days	2.11	2.36
Drinks	6.74	9.97
Hours	6.29	8.03
Gaming	2.29	0.72
Initial Crave	0.53	1.34
Crave Base	0.43	1.09
Crave Bar	1.54	2.09
Crave Kitchen	1.79	2.17

GBQ = General Belief Questionnaire, TAS = Tellegen Absorption Scale, Days = Amount of days on the Timeline Followback, Drinks = Amount of drinks on the Timeline Followback, Hours = Amount of hours on the Timeline Followback, Gaming = Gaming Experience Questionnaire

Table 2

Questionnaire	1	2	3	4	5	6	7	8	9	10	11	12
1. PQ												
2. GBQ 1	.227											
3. GBQ 2	-.220	-.299*										
4. GBQ 3	.251*	.413**	-.286*									
5. TAS	.073	.078	-.082	.222								
6. Days	.267*	.061	-.054	.116	.095							
7. Drinks	.252*	.077	.010	.099	.139	.775**						
8. Hours	.199	.030	-.082	.094	.187	.824**	.823**					
9. Gaming	.098	.154	-.326**	.215	.172	.250*	.227	.218				
10. Initial Crave	.162	.207	-.192	.044	.030	.135	.359**	.269*	.141			
11. Crave Base	.109	.207	-.218	.122	.109	.014	.233	.129	.175	.853**		
12. Crave Bar	.339**	.068	-.201	.224	.029	.408**	.495**	.440**	.313**	.671**	.662**	
13. Crave Kitchen	.283*	.032	-.216	.192	.058	.170	.306*	.278*	.263*	.683**	.748**	.814**

*p < .05, ** p < .01

Table 3

Questionnaire	t
1. PQ	1.425
2. GBQ 1	.772
3. GBQ 2	-.004
4. GBQ 3	-1.024
5. TAS	-.689
6. Days	1.485
7. Drinks	.915
8. Hours	.391
9. Gaming	3.310**
10. Initial Crave	.822
11. Crave Base	-.475
12. Crave Bar	1.376
13. Crave Kitchen	1.213

*p < .05, ** p < .01

Table 4

Questionnaire	1	2	3	4	5	6	7	8	9	10	11
1. PQ											
2. Skin_Bar	-0.002										
3. Skin_Kitch	0.075	0.914**									
4. GSL_Bar	-0.070	-0.205	-0.278								
5. GSL_Kitch	-0.085	-0.149	-0.229	0.961**							
6. HR_Bar	-0.175	0.010	0.087	0.031	0.030						
7. HR_Kitch	-0.119	-0.012	0.083	-0.010	-0.011	0.975**					
8. GSR_Bar	-0.018	-0.089	-0.137	0.796**	0.746**	0.181	0.116				
9. GSR_Kitch	0.008	-0.209	-0.281	0.765**	0.789**	0.070	0.048	0.818**			
10. Rate_GSR_Bar	-0.018	-0.089	-0.137	0.796**	0.746**	0.181	0.116	1.000**	0.818**		
11. Rate_GSR_Kitch	0.008	-0.209	-0.281	0.765**	0.789**	0.070	0.048	0.818**	1.000**	0.818**	

*p < .05, ** p < .01

Table 5: Change Scores

Questionnaire	1	2	3	4	5	6	7	8	9
1. PQ									
2. GSL_Bar	-0.027								
3. GSL_Kitch	0.009	0.769**							
4. HR_Bar	0.059	0.131	0.119						
5. HR_Kitch	-0.125	0.095	0.086	0.802**					
6. GSR_Bar	-0.067	0.570**	0.386**	0.125	0.072				
7. GSR_Kitch	-0.096	0.539**	0.578**	-0.024	0.061	0.716**			
8. Skin_Bar	0.101	-0.138	-0.087	-0.183	-0.062	-0.180	-0.070		
9. Skin-Kitch	0.034	-0.090	-0.095	-0.223	-0.032	-0.113	0.013	0.936**	

*p < .05, ** p < .01

Table 6

Gender	**F**	**p**
HR 5 min	6.842	0.011*
HR Bar	6.412	0.013*
HR Kitch	8.834	0.004**
GSR 5 min	7.837	0.007**
GSR Bar	6.057	0.016*
GSR Kitch	5.939	0.017*
GSL 5 min	3.769	0.056
GSL Bar	2.637	0.109
GSL Kitch	4.183	0.045*

HR= Heart Rate, GSR= Galvanic Skin Response, GSL= Galvanic Skin Level

*p < .05, ** p < .01

Table 7

Gender	F	p
HR Bar	0.94	0.76
HR Kitch	2.327	0.132
GSR Bar	0.587	0.446
GSR Kitch	0.588	0.446
GSL Bar	0.115	0.736
GSL Kitch	0.427	0.516

HR= Heart Rate, GSR= Galvanic Skin Response, GSL= Galvanic Skin Level

*p < .05, ** p < .01

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