Psychophysiological Differences in Individual and Cooperative Video-Game Play: An Exploratory Study

by

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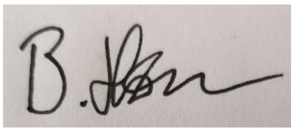
Signature of Candidate 

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Abstract

To advance knowledge on the notions of "coordination cost" and "team learning", this study sought to explore differences in psychophysiological functioning among individuals playing a video-game (1) in a solo condition or as part of a dyadic team; (2) over three consecutive games in a dyadic team. Data from twenty-four dyads were collected for Study 1 and Study 2. The participants were all male with no less than 30 hours of experience in the video-game and 21 years of age on average. In Study 1 the participants played FIFA-17 (Xbox) against the computer in a solo and in a dyad condition. In Study 2 the participants played three consecutive games in a dyad against the computer. Performance measures, subjective psychological self-reports, and objective psychophysiological data were collected for both studies. In Study 1 *Heart Rate Variability* (p <.01, d = -.57) decreased, whereas power on the central (*C4*; p = .04, d = .78), parietal and temporal areas of the brain increased in the dyadic condition (*Pz;* p = .03, d = .44, *T6;* p = .04, d = .63). Therefore, playing in a team, in contrast to playing alone, was associated with higher cognitive neural load. In Study 2, *Number of Fouls* (p <.01, d = 2.41) *and HRV* (p <.01, d = .55) increased over time, whilst a decrease in power was observed in the frontal area of the brain (*Fp1* p = .05, d = -.36, *Fp2*; p = .05, d = -.40). These findings suggest that conflicts occur in the initial stages of team development, and that learning of team (and motor) tasks leads to hypofrontality. Collectively, these findings advance the literature by demonstrating that (1) cognitive-neural and affective processes change in individual and team settings in line with the notion of "coordination cost"; and (2) team dynamics and individuals' brain patterns change over time due to "team learning" and intra-team conflict.

Keywords: Psychophysiological, Team Mental Models, Video-games, EEG, Heart Rate Variability

Introduction

Video-gaming is a growing industry and in 2014 video-games sales reached $64.9 Billion (Egenfeldt-Nielsen, Smith, & Tosca, 2015). The video-gaming industry has also grown as a field of study (Palaus, Marron, Viejo-Sobera, & Redolar-Ripoll, 2017). Video-games have been increasingly used in neuropsychological research as they increase participants' motivation to perform the task, in comparison to traditional non-interactive laboratory tasks (Boot, 2015; Lohse, Shirzad, Verster, Hodges, & Van der Loos, 2013). Moreover, video-games have been used to study social psychology constructs, including teamwork and cooperation (Badatala, Leddo, Islam, Patel, & Surapaneni, 2016). However, there are few studies on team dynamics in active video-game play and neuropsychological methods. In the present study, changes in team dynamics and performance during cooperative video-game play were explored using psychophysiological methods.

Team Dynamics

To become a team, a group of individuals must share a common goal (Carron & Hausenblas, 1998). A team can be defined as a collection of two or more individuals working towards a shared goal (Brown, 2000). Once a common goal is established, different team processes (e.g., cohesion, team mental models) can emerge (DeChurch & Mesmer-Magnus, 2010). Team dynamics concerns the inter-relationship among different team processes and team outcomes (Mcewan, Ruissen, Eys, Zumbo, & Beauchamp, 2017). Noteworthy, the smallest possible team consists of two individuals; i.e., "a dyad team" (Wickwire, Bloom, & Loughead, 2004).

Multiple theoretical models have attempted to explain how team dynamics change over time. These models include; the Linear, Cyclical and Pendular perspective (for a review see Weinberg & Gould, 2015). The Linear Model is compiled of 4 stages, beginning with the *forming stage* wherein interpersonal relationships are formed and a team structure is developed.

In the *storming stage* interpersonal conflicts and resistance to control the group arise. In the *norming stage* conflicts are resolved, and the team develops cooperation. Finally, in the *performing stage* team members combine their knowledge and skills to perform optimally.

The Cyclical or Life Cycle Perspective emphasises the eventual breakup of the team or, in other words, the ‘death’ of the team. This model consists of three stages, namely the ‘birth’, ‘growth’ and ‘death’ of a team (Beck, 1996). Another model of team dynamics development is known as the Pendular perspective, which suggests that teams do not move through stages in a linear manner. Rather, team dynamics is considered an ever-changing process that resembles the movement of a pendulum. Specifically, according to the Pendular perspective, teams go through the ‘orientation’, ‘differentiation and conflict’, ‘resolution and cohesion’ and finally ‘termination’ stages. Noteworthy, all these models suggest that, as different team processes (e.g., cohesion, cooperation) develop, team dynamics changes greatly over time.

The present study focuses on team dynamics within dyadic teams, specifically: (a) exploring psychophysiological differences between playing alone and in dyad team, and (b) exploring whether psychophysiological states may change over time due to team practice. It is important to better understand the differences between solo and team-based dynamics to advance knowledge on the notion of “coordination cost” (i.e., what abilities and performance are lost as a result of playing in a team) in team settings. Furthermore, it is important to study how teammates develop a “collective mind” or team mental models (TMM; see Stajkovic, Lee, & Nyberg, 2009) over time.

Team Mental Models

According to Cooke et al. (2003, p. 153) TMM consist of “collective task and team-relevant knowledge that team members bring to a situation”. TMM allow members of a team to maximize coordination and performance (Fernandez et al., 2017) for example, in the team-based video-game FIFA 17, both players must work together (e.g., by giving their partner options to pass to) for play to develop. To perform optimally, teams must have TMM, which allow teammates to use their combined knowledge and coordinate their actions in high-pressure situations (Mohammed, Ferzandi, & Hamilton, 2010).

Noteworthy, TMM can be divided into at least three types of knowledge, namely declarative, procedural, and strategic. Declarative knowledge considers ‘what’ (know-what) should be done, whilst procedural is ‘how’ (know-how) the task should be done. Strategic knowledge pertains to the general game plan (know-why) that is integral for successful coordination of actions (Lewis, Belliveau, Herndon, & Keller, 2007). These different types of knowledge interact and influence other team processes, such as cohesion, collective efficacy, and team outcomes (Gershgoren et al., 2016).

The relationship among TMM, Team Processes, and Team Outcomes

The Integrated Framework of Team Dynamics proposes that TMM share a positive relationship with other team processes and team performance (Filho, Yang, & Tenenbaum 2014; see Figure 1). Specifically, the quality and quantity of TMM is dependent on cohesion within the team, related to collective efficacy, and influences team performance. In other words, several team processes are needed for optimal performance in team settings. When a team's cognitive, affective, and behavioral resources are appropriately aligned with task demands, the team is effective (Kozlowski & Ilgen, 2006).

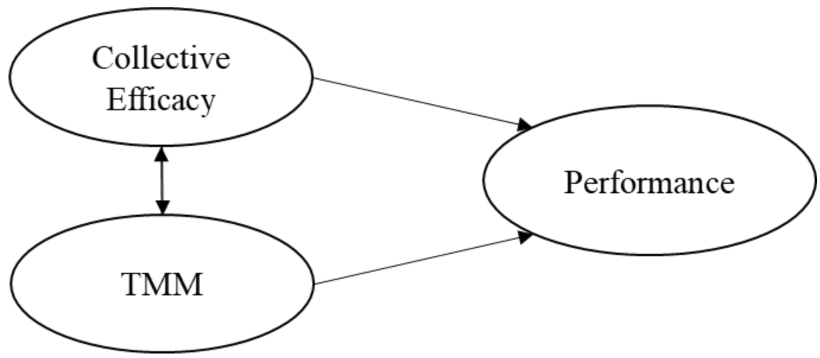

Figure 1. Integrated nomological network of team dynamics in sport.

Note. Adapted from "Cohesion, Team Mental Models, and Collective Efficacy: Towards an Integrated Framework of Team Dynamics in Sport," by E.Filho, G. Tenenbaum and Y. Yang, 2014, *Sport Sciences*, 33, 649.

Firstly, the cognitive dimension of team processes is related to TMM and expressed by explicit (i.e., spoken language) and implicit (i.e., non-verbal) communication. Communication has been found to influence team performance (Cooke, Gorman, Myers, & Duran, 2012). Explicit and implicit communication facilitate information and knowledge sharing processes that are important for decision making and coordination (Fiore et al., 2010).

Secondly, the affective dimension of team processes is expressed through cohesion and collective efficacy, both of which have been linked to team performance (Mathieu, Rapp, Maynard, & Mangos, 2009; Leo, Sánchez-Miguel, Sánchez-Oliva, Amado, & García-Calvo, 2013). Team cohesion has been defined as ‘‘a dynamic process that is reflected in the tendency for a group to stick together and remain united in the pursuit of its instrumental objectives and/or for the satisfaction of member affective needs" (Carron, Brawley, & Widmeyer, 1998, p. 213). Team cohesion involves both *task* and *social* aspects, with task cohesion relating to how a team comes together and stays together to achieve performance related goals. Social cohesion pertains to the notion that teams come and stay together for social reasons, such as enjoyment and friendship (Warner, Bowers, & Dixon, 2012). These two constructs have been positively linked to performance (Filho, Dobersek, Gershgoren, Becker, & Tenenbaum, 2014), and efficacy beliefs (Leo, González-Ponce, Sánchez-Miguel, Ivarsson, & García-Calvo, 2015).

Efficacy pertains to the inner belief that yourself (Self-efficacy) or someone else (Others' efficacy) can successfully accomplish a specific task (Bandura, 1998). Psychologists have studied efficacy beliefs regarding the self, others, and collective efficacy. Self-efficacy can be defined as an individual's belief in his/her own skill to succeed in a specific task (Bandura & Wessels, 1997). Others' efficacy can be defined as the belief someone has in his/her teammate's skills to complete a specific task to an expected level (Lent & Lopez 2002). Collective efficacy is the measure of overall efficacy that a team possesses as a whole (Goddard, Hoy, & Hoy, 2004).

Both Self-efficacy and Others' efficacy have been shown to influence performance in various settings (Emich, 2012; Haddad, & Taleb, 2016). For instance, Self-efficacy has been found to predict performance in sports and in an equestrian (dressage) dyad setting (Beauchamp & Whinton, 2005). Whilst Others' efficacy in performance has been found to supersede the effects of Self-efficacy in a dyad video-game setting (Dunlop, Beatty, & Beauchamp, 2011). Collective efficacy has been found to positively influence team performance when teammates need to closely interact (i.e., high-task interdependence) and coordinate their efforts to accomplish a team goal (Katz-Navon & Erez, 2005).

In addition to being related to cohesion and efficacy beliefs, TMM have also been found to share a positive relationship with performance (Lim & Klein, 2006; Mohammed et al., 2010). TMM have also been linked to the ability of a team to reach its maximal performance potential (Gardner, Scott, & Abdelfattah, 2017; Stumpf, Doh, Tymon, Budhwar, & Varma, 2010). Previous research also suggests that the relationship between team performance and TMM varies over the life-cycle of a team. Specifically, Marques Santos, & Passons (2013) observed that performance peaks during the middle of a team's life-cycle and reaches its lowest point towards the end of a team's life cycle. Moreover, TMM positively influences performance in high-pressure situations, as they provide a heuristic route to decision-making (Van den Bossche, Gijselaers, Segers, Woltjer, & Kirschner, 2010).

Overall, support for the notion that TMM is linked to performance can be found in many settings including medicine, management, and sports (Burtscher, Kolbe, Wacker, & Manser, 2011; DeChurch & Mesmer-Magnus, 2010). Although many studies have targeted the link between team processes and performance, few studies have used psychophysiological methods to study team processes in interactive tasks (Thorson, West, & Mendes, 2017). In the present study, psychophysiological methods were used to advance research on team dynamics and performance.

Psychophysiological Methods and Team Assessment

Physiological methods have been used to measure central (i.e., dynamic brain activity) and peripheral (e.g., cardiovascular responses) markers of psychological concepts (Tenenbaum & Filho, 2016). Electroencephalography (EEG) has been used to measure central markers of performance (Sheikholeslami et al., 2007; Cheron et al., 2016). Moreover, EEG has been linked to features of team processes (e.g., TMM) in previous research (Filho et al., 2016). In the current study, Alpha Peak waves, Theta/Beta Ratio and individual Channel Power were measured via EEG, as these variables have been linked to skilled performance in visual motor tasks, such as video-game playing (Yarrow, Brown, & Krakauer, 2009). Increases in Alpha Peak is mostly used as a reference to a relaxed state (Wahbeh & Oken, 2012), but has also been linked to efficient sensory information processing and working memory (Klimesch, 2012; Clark et al., 2004). On the other hand, increases in Theta/Beta Ratio has been linked to increased attentional and cognitive overload in motor tasks (for a review see Pacheco, 2016). Channel Power refers to the power that is present at individual electrodes across the EEG system (Teplan, 2002). These channels are located in the frontal, temporal, central, parietal and occipital regions of the brain. In addition, these regions have been related to various functions. Activation in the frontal region has been previously associated with voluntary motor skills and memory function. Whilst the temporal region is related to visual attention and long-term memory. Increased activation of the central region is associated with integration of multiple brain pathways. The parietal region is related to touch and pressure senses. Finally, the occipital lobe is primarily responsible for sight (Biswal, 2010, Overwalle, 2008, & Teplan, 2002). Furthermore, these EEG measures also share a relationship with other physiological responses, such as Heart Rate and Heart Rate Variability (HRV; Kim, Lee, Kim, Whang, & Kang, 2013).

In the present study Heart Rate and HRV were also measures as they have been found to be reliable indicators of stress (Thayer, Åhs, Fredrikson, Sollers, & Wager, 2012). Heart Rate pertains to the number of heartbeats per unit of time (Logan, Reilly, Grant & Paton, 2000), whereas HRV can be defined as the time interval between heartbeats (Thayer, Åhs, Fredrikson, Sollers, & Wager, 2012). Heart Rate and HRV have been linked to performance in several different fields and team settings, including video-game play (McFarland, n.d.; Gabana, Tokarchuk, Hannon, & Gunes, 2017). For instance, Heart Rate has been shown to correlate with video-game experience (Drachen, Nacke, Yannakakis, & Pedersen, 2010). Furthermore, HRV has also been used to monitor the sympathetic and parasympathetic responses of video-game players (Subahni, Xia, & Malik, 2012), with a lower HRV being related to higher levels of somatic stress.

The Present Study

The current study aimed at expanding the knowledge of whether performance and psychophysiological processes change in an individual and in a dyadic video-gaming task (Study 1), and whether performance and these psychophysiological processes might change when participants play in a team over time (Study2). Specifically, in Study 1 the notion of a "Coordination cost" (i.e., psychophysiological cost to coordinate actions in team settings; see

Gorman, Amazeen, & Cooke, 2010; Gorman, 2014), whilst in Study 2 the notion of “team learning” (i.e., teammates develop shared and complementary knowledge over time; see Eys & Kim, 2017) was examined.

Study 1

Aim & Hypotheses

To explore differences in psychophysiological functioning (i.e., *Alpha Peak, Beta/Theta Ratio, Heart Rate* & *HRV*) among individuals playing a video-game (FIFA 17) in a solo participant condition or as part of a dyad team. It was hypothesized that performance (i.e., *Total Points*, *Goal Differential*, *Ball Possession* and *Number of Fouls*) would be lower in the dyad condition than in the solo condition (H1), due to the “coordination cost” to perform optimally in a team setting. In addition, it was hypothesized that the participants would show more negative affect and higher *Self-efficacy* when playing in the dyad condition due to the previously mentioned “coordination cost” (H2). Furthermore, it was hypothesised that when playing in a dyad, the participants would be in a more “stressed state” due to the coordination cost, and thus show lower *Alpha Peak*, higher *Theta/Beta Ratio*, higher *Heart Rate* and lower *HRV* (H3).

Methods

Participants. A priori power analysis (effect size = .60, power of .99, and an alpha level of .05) based on previous research on sport psychology (see Bertollo et al,. 2015) was used to determine the minimum sample size (N = 12) needed to detect a moderate to strong effect size on the variables of interest. Accordingly, one confederate and twelve individuals participated in the study. The twelve participants were assembled into 12 dyads, with the confederate being kept as “a constant” and thus playing in all dyads. All participants were male and ranged in age from 18 to 26 years old (M = 22 and SD = 2.4). All participants reported a minimum of 30 hours of experience playing FIFA 17. This experience was set at a minimum in agreement with evidence suggesting that 30 hours of practice are generally enough to secure learning in a motor task (Boot, Kramer, Simons, Fabiani, & Gratton, 2008; Achtman, Green, & Bavelier 2008).

The confederate was 20 years old and had two years of practice and reported playing FIFA 17 for approximately two hours a week. He was briefed on the overarching purposes of the study but was not aware of the specific hypotheses being tested. The confederate was kept as a constant to ensure the conditions were being compared with minimum team-level variability.

Experimental Task. The experimental task consisted of two conditions in which the participants played FIFA 17 using the XBOX ONE console system (Figure 2). The "Active Participant" (AP) played with and without the confederate in the dyad and solo conditions, respectively. Each match lasted 10 minutes (i.e., 5 minutes a half) and were played with pre-determined teams and a pre-established difficulty setting; (i.e., Barcelona-computer, Real Madrid-Participant at "professional difficulty level"). To prevent movement artifacts with the EEG equipment no communication was allowed during both conditions.

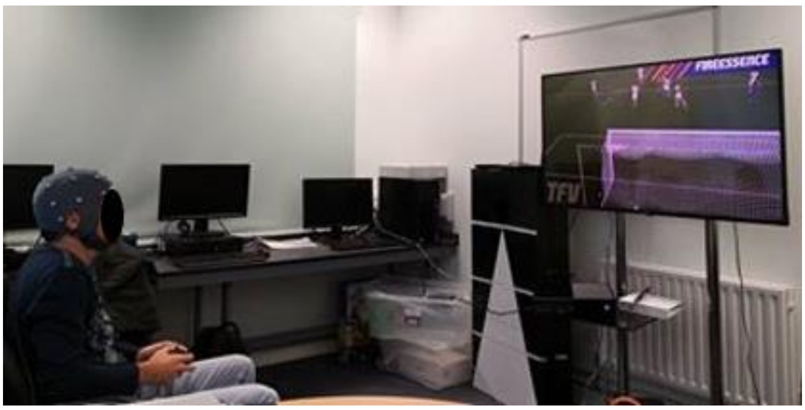

Figure 2. Lab based set up with participant using the EEG cap.

Measures. A variety of measures were used in the current study to explore effects on performance, physiological data and subjective perceptions.

Performance Measures. A number of different performance measures were taken from the matches. These were provided by the "match statistics" generated at the end of every match by the video-game software. Specifically, the performance measures used in the current study consist of the *Total Points*, *Ball Possession*, *Goals Differential*, and *Number of Fouls*.

Total Points. *Total Points* consisted of the amount of points awarded for a given outcome as follows: Win = 3 Points; Draw = 1 Point; and Loss = 0 Points. *Total Points* have been used in several real-world sports to estimate the current performance level of a specific team (Lago-Peñas, Gómez-Ruano, Megías-Navarro, & Pollard, 2016).

Ball possession. The overall amount of possession that was kept throughout the match was recorded. It represents the percentage against the opposing team (e.g., 70% vs. 30%). Of note, *Ball Possession* has been linked to psychological momentum in sports and is used as an index of team performance (Lago-Peñas & Lago-Ballesteros, 2011).

Goal differential. This measure consisted of the total number of goals scored minus the total number of goals conceded. *Goal differential* has been consistently used in football as a measure of performance (Ali, 2011).

Number of Fouls. The total amount of unfair/illegal sporting actions that occurred during the match was recorded. This measure might be indicative to the level of frustration (i.e., frustration-aggression hypothesis; see Schmierbach, 2010) expressed by the players.

Subjective Reports. A demographic form and **s**ingle-item questions were used to measure the participants' normative data and subjective psychological states, respectively (see Appendix 1B). Single item questions have been used in sport psychology because they can be easily administered in the laboratory (Gardner, Cummings, Dunham, & Pierce, 1998; Tenenbaum & Eklund, 2007).

Affect Grid. An adapted version of the Affect Grid was used to measure the two dimensions of core affect throughout the video-game task. Core affect is a by-product of two key affective areas: pleasure-displeasure and *arousal* levels (Killgore, 1998). Both *Arousal* and *Pleasantness* have been linked to performance in motor and cognitive tasks (Barnard, Broman-Fulks, Michael, Webb, & Zawilinski, 2011; Schmidt, Lebreton, Cléry-Melin, Daunizeau, & Pessiglione, 2012). Participants were asked to report their perceived *Arousal* levels on a likert scale ranging from 0 (*Sleepiness*) to 10 (*Highly Aroused*). Similarly, the participants were asked to report on "How pleasant you believe the task is?" on a likert scale ranging from 0 (*not pleasant*) to 10 (*very pleasant*).

Attention. *Attention* can influence performance in the execution of motor skills, such as video-game playing (Gray, 2011). Participants were asked to report their *Attention* states on a likert scale ranging from 0 (*distracted or unable to focus*) to 10 (*complete focus on task*). This scale was designed to reflect a continuum of attentional strategies ranging from 0 (*pure dissociation*) to 10 (*pure association*), in line with previous research in sport psychology (Razon, Hutchinson & Tenenbaum, 2012).

Self-Efficacy and Others' Efficacy. The participants were asked to rate ''The belief you have in your own skills/abilities to win the match.'' The participants were also asked to state their *Others' efficacy* by answering the question "The belief you have in your teammates abilities/skills to win the match.'' on a likert scale ranging from 0 (*no belief*) to 10 (*complete belief*). Both of these questions were designed in line with Banduras' (2006) recommendation for the development of efficacy measures.

Psychophysiological Data. The active player had their physiological states monitored. EEG data was continuously recorded using the Nexus-32 biofeedback system (Mind Media B.V., Herten, Netherlands). *Alpha Peak*, *Theta/Beta Ratio* and power across 21 different channels were collected at a sampling frequency of 256 Hz. The 21 Ag/AgCl electrodes were positioned over the scalp according to the 10/20 system (Oostenveld & Praamstra, 2001). EEG signals were recorded with the ground electrode in AFz positioned between Fpz and Fz. The common average reference approach was used, in which the reference is the average power across all electrodes. Low independence values were kept during the data collection (Z < 5 kO).

Alpha Peak. *Alpha Peak* is the lowest brain wave frequency for a conscious awake individual (Chapin & Russell-Chapin, 2014). *Alpha Peak* was of interest in the present study because it has been related to relaxation and optimal performance in both cognitive and motor tasks (Demos, 2005). *Alpha Peak* is measured in hertz (Hz; Angelakis, Lubar, Stathopoulou, & Kounios, 2004).

Theta/Beta. The ratio between *Theta* and *Beta* waves has been linked to optimal attentional focus and it is considered an index of cognitive load or "brain busyness" (Pacheco, 2016). In the present study, changes in *Theta/Beta Ratio* were used to explore differences in cognitive load across the two conditions. *Theta/Beta Ratio* is measured in Hz and presented in amplitude of its direction (Ogrim, Kropotov, & Hestad, 2012).

Power. Channel Power refers to the individual power activity present at individual electrode sites across the scalp (Teplan, 2002). In essence, examining power across the scalp allows for the identification of which brain regions are being activated during the performance of a given task. In the current study power at 21 different sites across the scalp were collected to explore differences in brain region activation across the two conditions. Power was measured in microvolts (µV) at the Frontal (*Fpz*), Temporal (*T*), Central (*Cz*), Parietal (*P*) and Occipital (*O*) areas (Figure 2). Noteworthy, in exploratory studies, researchers should examine the different brain regions (i.e., whole brain analysis), as certain brain areas might be more or less related to performance of a given task (Michel & Koenig, 2018).

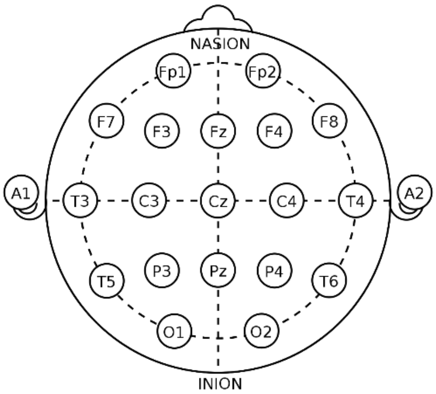

Figure 3. Topographical map of the 21 channel EEG cap electrode placement.

Heart Rate & Heart Rate Variability. A Polar H10 Heart Rate monitor device (Polar Electro, QY, 2017) was used to collect the participants' *Heart Rate* (bpm) and *HRV* indexes (RMSSD). RMSSD or Root Mean Squared of Successive Differences was used due to its strong backing from previous research (Luque-Casado, Zabala, Morales, Mateo-March, & Sanabria, 2013). In addition, both *Heart Rate* and *HRV* have been related to changes in affective states and cognitive load in both physical and cognitive tasks (McCraty, 2017). Specifically, HR and HRV are regulated by the coupling of the sympathetic and parasympathetic systems, which in turn modulates changes in affective, mood and emotional states (Tsao et al., 2013).

Procedures

Participants were recruited using a convenience sampling technique that incorporated the use of flyer advertisements (Appendices 1A) and the use of the Universities SONA student participant system. The goals and methods of the study were explained to the participants. Written consent was taken from every participant before the commencement of the study. Then, the participants were placed into a dyad with the confederate participant. Each experimental condition was preceded by a baseline assessment, during which the AP sat in silence for 2 minutes with their eyes open, and then for additional 2 minutes with their eyes closed. The baseline was used to ensure the equipment was working properly. Participants then completed a baseline assessment of the subjective measures.

For the alone condition, the AP played a match of FIFA 17 against the computer by themselves. For the dyad condition, the AP played together with the confederate against the computer using the same pre-determined teams and pre-established difficulty settings, as explained above (see Experimental Task on page 14). The two experimental conditions were counterbalanced to control for learning, motivation, and fatigue effects. During both games, the AP had their physiological responses (i.e., *Alpha Peak, Theta/Beta Ratio, Heart Rate* and *HRV*) monitored. Furthermore, the AP was asked to report on their perceived psychological states (i.e., *Arousal, Pleasantness, Attention, Self* and *Others' Efficacy*) before, at the half-time interval, and after the matches. These reports were taken as a baseline then, before (*pre*), at half-time (*during)* and after (*post*) each match. The confederate participant was also asked to report on their psychological states during the dyad condition at the same intervals, but his data was not integrated in the data analysis. The entire data collection procedure lasted approximately 2 hours.

Data Analysis

All data were inputted into IBM Statistics SPSS 24. All EEG data was collected, filtered and exported using the BioTrace+ software. All data was first down sampled to 32Hz, and then exported to excel and then to IBM Statistics SPSS 24. Relevant time stamps were used to remove any unwanted data segments. *Heart Rate* and *HRV* were both filtered and exported from Kubios (version. 3.1), with time stamps taken from the BioTrace+ software used to remove any unwanted data.

One entire match was used as the measure of analyses. Therefore, all data (Performance, Subjective-reports, Physiological data) collected during each match was averaged. Averaging data allows for more reliable estimates in studies addressing team settings and variables with different measurement errors (Thorson, West, & Mendes, 2017).

Assumptions of normality were met as indicated by skewness and kurtosis values within the range deemed acceptable (Tabachnick & Fidell, 2013).

Results

Performance Variables. Mean and standard deviations values, Cohen's *d* effect size differences, power, and p-values for all performance measures are reported in Table 1. Of note, Cohen (2012) classified effect sizes as small (d = .20), medium (d = .50), and large ($d \geq .80$). Single effects Repeated Measures ANOVAs with a Greenhouse-Geisser correction were ran for all match-statistic variables (see Appendices 2A). No statistical differences were observed for all variables, but magnitude effect size analyses suggested that *Goal Difference* was slightly lower (d = -.19) in the dyad condition. In contrasts, *Ball Possession* was slightly higher (d = .25) in the dyad condition. Furthermore, *Total Points* and *Number of Fouls* were found to be lower respectively in the dyad condition, but the effect is trivial (d <. 10).

Table 1

Post-Match Statistics of Solo and Dyad Condition

Variables	Solo M (SD)	Dyad M (SD)	N	1−β (power)	F (1, 11)	*p*	Cohen's *d* [95% CI]
Total Points	2.00 (1.27)	1.91 (1.16)	12	.05	.024	.88	-.07 [-.87, .73]
Goal Difference	1.00 (1.47)	.75 (1.05)	12	.07	.241	.63	-.19 [-.99, .61]
Ball Possession (%)	50.66 (1.62)	51.00 (.99)	12	.09	.488	.49	.25 [-.55, 1.06]
Number of Fouls	7.33 (2.83)	6.83 (2.12)	12	.07	.234	.64	-.02 [-1.00, .60]

Subjective Reports. Mean and standard deviations values, Cohen's *d* effect size differences, power, and p-values for all subjective self-reports are reported in Table 2. Single effects Repeated Measures ANOVAs with a Greenhouse-Geisser correction were ran for all self-report variables (see Appendices 2B). No statistical differences were observed for all variables, but magnitude effect size analyses suggested that *Arousal* (*d* = .27), *Pleasantness* (*d* = .27) and *Self-efficacy* (*d* = .25) were slightly higher in the dyad condition. A large effect size difference was observed for *Attention* (*d* = .89), indicating that much higher levels of attention were needed in the dyad condition.

Table 2

Subjective Self-reports of Solo and Dyad Condition

Variables	Solo M (SD)	Dyad M (SD)	N	1−β (power)	F (1, 11)	*p*	Cohen's *d* [95% CI]
Arousal	6.83 (1.08)	7.16 (1.32)	12	.08	.332	.58	.27 [-.53, 1.08]
Pleasantness	7.19 (.85)	7.44 (.99)	12	.13	.771	.39	.27 [-.53, 1.07]
Attention	6.83 (1.08)	7.66 (.77)	12	.49	4.61	.06	.89 [.05, 1.72]
Self-Efficacy	7.00 (1.32)	7.27 (.80)	12	.08	.335	.57	.25 [-.56, 1.05]

Psychophysiological Data. Mean and standard deviations values, Cohen's *d* effect size differences, power, and p-values for all psychophysiological data are reported in Table 3. Single effects Repeated Measures ANOVAs with a Greenhouse-Geisser correction were ran for all variables of interest (see Appendices 2C). Statistical differences were observed for *Heart Rate* and *HRV*, with magnitude effect size analyses suggesting that *Heart Rate* was lower (*d* = -.12) in the dyad condition, whilst *HRV* was moderately lower (*d* = -.57in the dyad condition. No further statistic differences were observed but magnitude effect size analysis suggested that *Alpha Peak* was higher (*d* = .34) in the dyad condition. Furthermore, *Theta/Beta Ratio* was lower (*d* = -.30) in the dyad condition.

Table 3

Psychophysiological Data from Solo and Dyad Condition

Variables	Solo M (SD)	Dyad M (SD)	N	1−β (power)	F (df1, df2)	*p*	Cohen's *d* [95% CI]
HR*	83.61 (5.66)	82.93 (5.80)	120	.51	4.01 (1, 119)	.05	-.12 [-.37, .14]
HRV**	71.18 (17.11)	60.78 (19.40)	120	.99	18.52 (1, 119)	< .01	-.57 [-.83, -.31]
Alpha Peak	9.95 (.19)	10.02 (.22)	12	.11	.583 (1, 11)	.46	.34 [-.47, 1.15]
Theta/Beta	.74 (.20)	.68 (.21)	12	.15	1.02 (1, 11)	.34	-.30 [-1.10, .51]

Note. HR stands for "Heart Rate" and HRV stands for "Heart Rate Variability".
$^{*}p < .05$; $^{**}p < .01$.

21-EEG Channel Power. Mean and standard deviations values, Cohen's *d* effect size differences, power, and p-values for all Channel Power are reported in Table 4. Single effects Repeated Measures ANOVAs with a Greenhouse-Geisser correction were ran for all 21 electrodes (see Appendices 2D). Statistical differences and medium to large effect sizes effects were observed for *T6* (*d* = .63), *C4* (*d* = .78), and *PZ* (*d* = .44), suggesting that greater neural activity occurred at these sites for the dyad condition. Moreover, a marginal statistical difference and a large negative effect (*p* = .07; *d* = -.65) was observed for *Fp1*, suggesting less engagement of this area of the brain during the dyad condition. Figure 3 shows these findings in relation to their individual brain regions, red highlights a negative effect whilst blue highlights a positive effect.

Table 4

21-EEG Channel Power from Solo and Dyad Condition

Brain Location	Electrode	Solo M (SD)	Dyad M (SD)	N	1−β (power)	F (1, 11)	*p*	Cohen's *d* [95% CI]
Frontal	Fp1	-5663.66 (3017.78)	-7339.64 (2064.68)	12	.45	4.09	.07	-.65 [-1.47, .17]
	Fp2	-5632.16 (3178.93)	-7091.16 (2613.27)	12	.32	2.67	.13	.50 [-1.31, .31]
	Fp7	-5606.85 (2293.56)	-5949.94 (1603.77)	12	.08	.33	.58	-.17 [-.98, .63]
	F3	3149.77 (4775.48)	2928.50 (5799.79)	12	.05	.04	.85	-.04 [-.84, .76]
	Fz	5178.52 (3084.92)	5747.06 (3175.68)	12	.07	.18	.68	.18 [-.62, .98]
	F4	-224.91 (3224.42)	341.18 (4668.82)	12	.07	.18	.68	.14 [-.66, .94]
	F8	-6306.69 (2887.22)	-7311.83 (1379.00)	12	.24	1.91	.19	-.44 [-1.25, .37]
Central	C3	7019.39 (4069.86)	6211.80 (4949.06)	12	.09	.49	.49	-.18 [-.98, .62]
	Cz	5844.20 (3425.89)	6356.95 (3758.24)	12	.06	.09	.77	.14 [-.66, .94]

Brain Location	Electrode	Solo M (SD)	Dyad M (SD)	N	1−β (power)	F (1, 11)	*p*	Cohen's *d* [95% CI]
	C4*	1122.72 (3487.14)	3844.87 (3490.10)	12	.66	6.72	.03	.78 [-.05, 1.61]
Temporal	T3	-6496.87 (2278.30)	-6654.02 (1204.76)	12	.06	.07	.79	-.09 [-.89, .71]
	T4	704.59 (2862.66)	506.18 (4476.76)	12	.06	.06	.82	-.05 [-.85, .75]
	T5	-3806.77 (2023.99)	-3717.82 (2022.14)	12	.05	.01	.91	.04 [-.76, .84]
	T6*	-4927.19 (5200.47)	52.69 (9890.00)	12	.55	5.25	.04	.63 [-.19, 1.45]
Parietal	P3	2984.42 (3267.83)	3837.01 (4614.97)	12	.07	.21	.66	.21 [-.59, 1.02]
	Pz*	-827.28 (5294.98)	1465.14 (5151.39)	12	.61	6.02	.03	.44 [-.37, 1.25]
	P4	552.76 (6753.54)	2533.11 (4916.76)	12	.21	1.58	.24	.34 [-.47, 1.14]
Occipital	O1	-252.48 (4273.56)	1403.43 (4378.96)	12	.49	4.48	.06	.38 [-.43, 1.19]
	O2	602.90 (5495.07)	2335.79 (4687.48)	12	.26	2.09	.18	.34 [-.47, 1.15]

$^{*}p < .05$; $^{**}p < .01$.

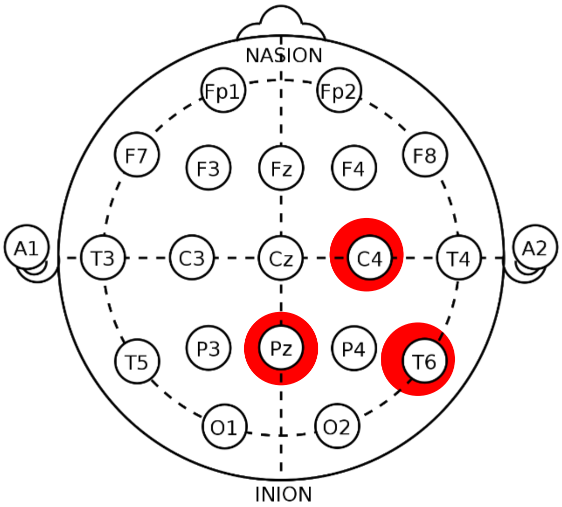

Figure 4. Topographical Map illustrating statistically significant differences between the two conditions. The red highlights illustrate an increase in power in the dyad condition.

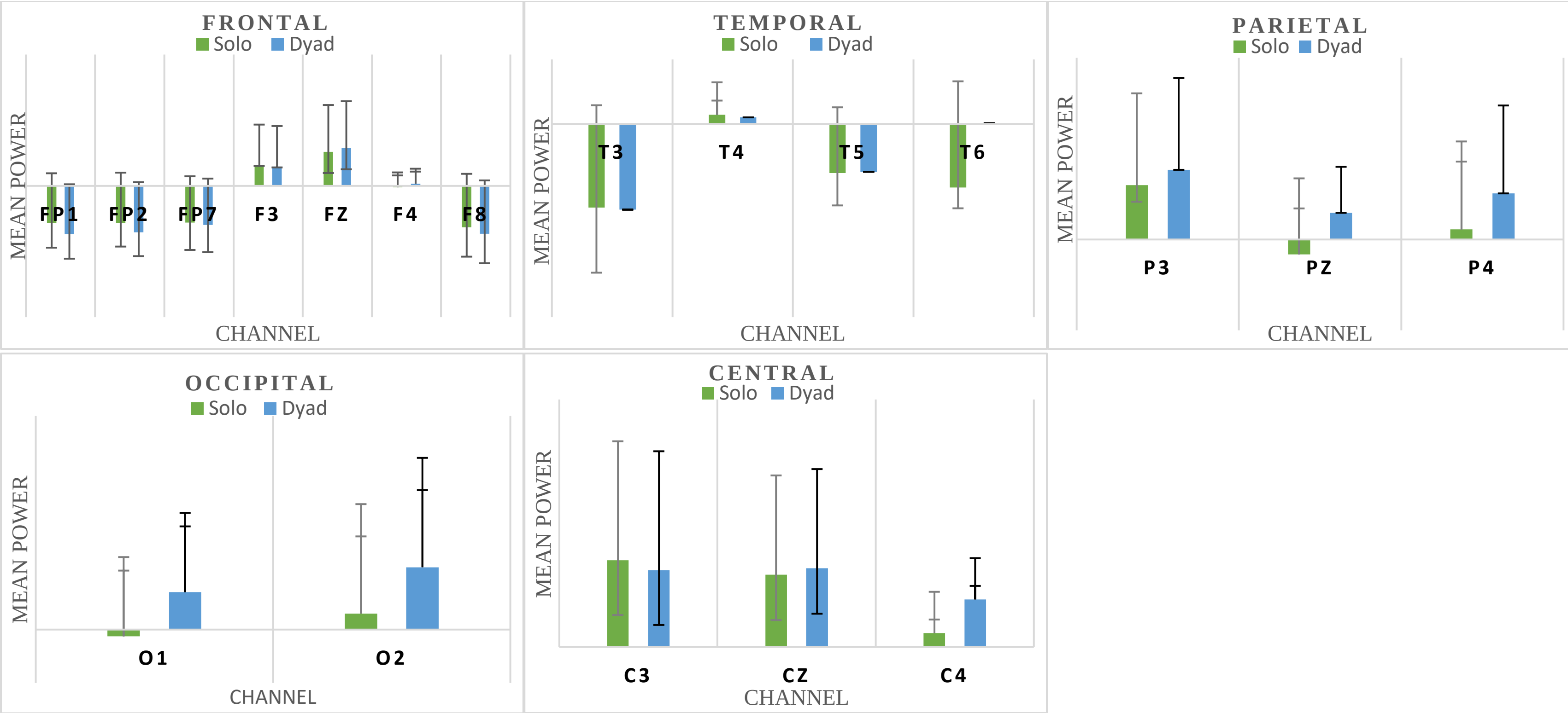

Figure 5. Mean Power and 95% Confidence Intervals for all 21 EEG channels across the frontal (left upper panel), parietal (right upper panel), temporal (central upper panel), occipital (lower left panel) and central regions (lower middle panel).

Discussion

The present study addressed team performance by exploring changes in psychophysiological states when participants played in a solo condition and in a dyad condition.

Performance Measures. No significant differences were observed in the performance data likely because power was limited. Magnitude effect size analyses revealed no meaningful differences for *Total Points* and *Number of Fouls*. However, *Ball Possession* was found to increase in the dyad condition. The effects were of small magnitude but still suggest that when playing in a team for the first time this has negative effects on performance in line with the idea that "coordination cost" leads to poorer performance in team tasks (Araújo & Davids, 2016; Bourbousson, Poizat, Saury, & Seve, 2010; Kanawattanachai & Yoo, 2007). The decrease in *Goal Differential* (i.e., more goals were conceded in the dyad condition) might also be related to the notion of "coordination cost" in team dynamics. This was evident as, during the first game, the dyads would not have the necessary TMM to coordinate their strategies. Without TMM the participants cannot predict each other's moment-to-moment decision making and potential game strategy (Eccles, 2010). Due to the participants having not met or played together before they would not have had enough time to develop any mental models for their team.

Psychological Factors. Magnitude effect size analyses revealed that all psychological factors measured in the study (i.e., *Arousal, Pleasantness, Attention* and *Self-Efficacy*) increased slightly (small effect) in the dyad condition, in comparison to the solo condition. The observed increase in *Arousal* might be related to the fact more psychological energy needs to be recruited when playing in a team, as the presence of someone else tends to increase motivation according to the *challenge-threat hypothesis* (Fonseca, Blascovich, & Garcia-Marques, 2014). This is in line with previous research which revealed that *Arousal* increased in a non-violent team-based video-game task, compared to a solo task (Lim & Lee, 2009). *Pleasantness* and *Self-Efficacy* also increased in the dyad condition probably because of the positive "social effect" of playing with another participant (Kawamichi et al., 2016). When playing with a partner the cooperative nature of video-game tasks increases enjoyment and belief in your own abilities (Diamantaki, Rizopoulos, Charitos, & Tsianos, 2010; Greitemeyer, Traut-Mattausch, & Osswald, 2012). *Attention* was found to increase greatly in the dyad condition probably because more focused attention is needed when you do not control all the factors in the environment (Qiu, Tay, & Wu, 2009) and do not know what your teammate is going to do next. Furthermore, the video-game task itself likely required increased amounts of visual attention (Green & Bavelier, 2006).

Psychophysiological Differences. No statistical differences were observed for *Alpha Peak* and *Theta/Beta Ratio*. However, magnitude effect size analysis revealed that *Alpha Peak* was higher, and *Theta/Beta Ratio* was lower in the dyad condition. *Alpha Peak* has been related to a relaxed mental state (Gutmann et al., 2015), and therefore exhibiting higher *Alpha Peak* levels in the dyad condition suggests the bio-psycho-social benefits of playing in a group environment and coincides with the participants' self-reports on *Pleasantness* and *Self-efficacy*. Furthermore, *Theta/Beta Ratio* has been found to be related to attentional control or "brain busyness" (Putman, Verkuil, Arias-Garcia, Pantazi, & Van Schie, 2013), and therefore the AP was in less overloaded in the dyad condition. Again, these findings coincide with the notion that "distributed cognition" occurred in the dyad condition, as the AP was not always engaged with the task (Sedig, Parsons, & Haworth, 2017). As it has been said, "two brains are better than one" and playing in a team allows for less overload of the brain. Altogether, these results suggest that playing in group leads to greater relaxation and less cognitive overload.

Although there was less cognitive overload across the whole brain, power was higher in part of the midline and temporal areas of the brain, suggesting that in the dyad condition a more focused attention was needed upon the visual stimuli of the task (Jin, 2011). Specifically, statistical differences of positive and large magnitude were observed in *Pz, C4* and *T6* in the dyad condition. The observed increase seen in *Pz, C4* and *T6* leads to the notion of a “focused attention”. That is, some specific neural networks in the brain where highly active during the task. Specifically, *Pz* and *C4* are located in the “midline” section of the brain region, which is responsible for the integration of information from the different regions of the brain, whilst *T6* is part of the temporal lobe responsible for visual attention (Biswal et al., 2010). The notion of increased focused attention in some specific neural networks is supported by the observed increase in self-report measures of attention and the decrease in *HRV* in the dyad condition.

HRV and *Heart Rate* and were both found to be statistically different in the solo and the dyad condition. However, magnitude effect size analysis revealed the decrease in *HR* values was trivial. On the other hand, the decrease in *HRV* in the dyad condition was of moderate magnitude. *HRV* is an indicator of the Autonomous Nervous System (ANS) and is related to stress (Dong, 2016). *HRV* was found to decrease in the dyad condition likely because more focused attention was needed during the dyad condition, as discussed above. In fact, previous research has suggested that during times of sustained focused attention a decrease in *HRV* is observed (Griffiths et al., 2017; Gazzellini et al., 2016).

Summary. In summary, the first hypothesis was that performance (i.e., *Total Points, Goal Differential, Ball Possession,* and *Number of Fouls*) would be lower in the dyad than in the solo condition (H1). H1 was not verified as no statistically significant differences between the two conditions were observed. Secondly, it was hypothesized that due to a “coordination cost’’ participants would show more negative affect and higher *self-efficacy* in the dyad condition (H2). H2 was not verified as no statistically significant differences between the two conditions were observed. Finally, it was hypothesized that participant would be in a more “stressed state’’ in the dyad condition due to coordination cost, and thus show lower *Alpha*

Peak, higher *Theta/Beta Ratio*, higher *Heart Rate; as well as* lower *HRV* and increased *Channel Power* across the brain. H3 was partially supported, as *HRV* and power in the central areas of the brain pointed to a higher cognitive load in the dyadic condition.

Study 2

Aims & Hypotheses

The purpose of this study was to explore differences in psychophysiological functioning (i.e., *Heart Rate, HRV, Alpha Peak, Theta/Beta Ratio*) over time in a dyad condition playing a video-game task. It was hypothesized that as participants played together over time, “team learning” would occur and thus improvements would be seen in performance, and psychological and physiological states. This would be evident through improvements in performance as a result of a “Team learning” that may occur (i.e., higher *Total Points*, higher *Goal Differential*, higher *Ball Possession* and lower *Number of Fouls*) over time (H4). Additionally, over time, participants were expected to show an increase in positive affect (i.e., higher *Arousal,* higher *Pleasantness,* higher *Self-Efficacy,* higher *Others' Efficacy and* higher *Likability*) and a decrease in the *Attention* devoted to the task due to the “social effect” of playing in a team (H5). Furthermore, the participants were expected to show lower signs of physiological stress and “cognitive load”, as indicated by a higher *Alpha Peak* and lower *Theta/Beta Ratio,* lower *Heart Rate* and higher *HRV* due to “Team learning” over the games (H6).

Methods

Participants. Twenty-four individuals participated in the study. Specifically, twenty-four participants were assembled into 12 dyads. All participants were male and ranged in age from 19 to 24 years old (Mean = 21 and SD = 1.7). All participants reported a minimum of 30 hours of experience playing the specified video-game (FIFA 17). Similarly to Study 1, a priori power analysis (effect size = .60, power of .95, and an alpha level of .05) was used to establish the minimum sample size (N = 10) needed to detect a moderate to strong effect size on the variables of interest.

Experimental Task. The same experimental task was used as in Study 1. However, participants played three consecutive matches. All data collection procedures remained the same as in Study 1.

Measures

The same performance, physiological and self-report measures collected in Study 1 were collected: *Total Points, Ball Possession, Goal Difference, Number of Fouls, Arousal, Pleasantness, Attention, Self-Efficacy, Others' Efficacy*, *Heart Rate, Heart Rate Variability Alpha Peak* and *Theta/Beta Ratio.* In addition, *Likability* was also collected.

Likability. The participants were asked to rate their perceived levels of *likability*, referring to how much they 'liked' their partner. Specifically, the participants were asked "Rate how likable you find your partner to be" on a Likert scale ranging from 0 (*very unlikable*) to 10 (*very likable*). *Likability* is a global, "gestalt like measure", as it represents a sum of several feelings, such as appearance and willingness (Takahashi, Kawachi, & Gyoba, 2015).

Procedures

Participants were given a short verbal introduction regarding the goals and methods of the study. Written consent was taken from every participant before the commencement of the study. Then, the participants were placed into a dyad with another participant. One participant from each dyad was chosen to be the “Active Participant” whilst the other participant was “Participant B”. Study 2 employed the same data collection procedures as Study 1 (i.e., Pre-established teams, difficulty setting and duration). The study consisted of a repeated measures design as the participants played three consecutive matches with one another against the computer.

Results

Performance Variables. Mean and standard deviations values, Cohen’s *d* effect size differences, power, and p-values for all performance measures are reported in Table 5. Cohen’s *d* effect size differences represent differences between Game 1 and Game 3. Differences for Game 2 and 3 are presented in charts in the Appendices (*Appendices 3E*). Single effects Repeated Measures ANOVAs with a Greenhouse-Geisser correction were ran for all performance variables (see Appendix 3A). Statistical difference was only observed for *Number of Fouls* ($p < .05$), but magnitude effect size analyses suggested that *Total Points* ($d = .32$) and *Goal Difference* ($d = .16$) and were slightly higher from Game 1-3. Moreover, *Ball Possession* ($d = .08$) was found to increase from Game 1-3 but the effect size was trivial. Furthermore, *Number of Fouls* greatly increased as the dyad played over time ($d = 2.41$). Post hoc tests using the Bonferroni correction revealed that *Number of Fouls* increased from Game 1-2 ($p = .002$). In addition, *Number of Fouls* increased from Game 1-3 ($p <.001$).

Table 5

Post-Match Performance Variables for Games 1-3

Variables	Game 1 M (SD)	Game 2 M (SD)	Game 3 M (SD)	1−β (power)	F (df1 = 2, df2= 22)	*p*	Cohen's *d* [95% CI]
Total Points	1.67 (1.44)	2.00 (1.28)	2.10 (1.16)	.10	.34	.72	.32 [-.48,1.13]
Goal Difference	.67 (1.90)	.75 (1.22)	.92 (1.44)	.06	.08	.92	.16 [-.64,.96]
Ball Possession (%)	51.33 (1.89)	52.00 (3.59)	51.54 (3.19)	.08	.19	.83	.08 [-.72,.88]
Number of Fouls**	4.42 (1.78)	8.33 (2.27)	9.92 (2.39)	1.00	18.41	<.01	2.41 [1.36,3.46]

**$p < .01$.

Subjective Self-reports. Mean and standard deviations values, Cohen's *d* effect size differences, power, and p-values for all subjective variables are reported in Table 6. Cohen's *d* effect size differences represent differences between Game 1 and Game 3. Differences for Game 2 and 3 are presented in charts in the Appendices (see *Appendices 3E*). Single effects Repeated Measures ANOVAs with a Greenhouse-Geisser correction were ran for all subjective variables (see Appendix 3B). No statistical differences were observed but magnitude effect size analyses suggested that *Arousal* (*d* = -.28) and *Self-efficacy* (*d* = -.32) were lower between Game 1 and Game 3. Changes in *Attention* (*d* = .12) and *Pleasantness* (*d* = .07) were trivial from Game 1-3. In addition, a moderate-to-large effect size was observed for *Others' efficacy* (*d* = -.58) indicating that *OE* decreased as the games progressed. A large negative effect size was observed for *Likability* (*d* = -.89) indicating that likability decreased over time.

Table 6

Subjective Self-reports for Games 1-3

Variables	Game 1 M (SD)	Game 2 M (SD)	Game 3 M (SD)	1−β (power)	F (df1, df2)	*p*	Cohen's *d* [95% CI]
Arousal	7.85 (.96)	7.76 (.82)	7.68 (.93)	.08	.23 (2, 46)	.79	-.28 [-1.08, .53]
Pleasantness	7.96 (.92)	7.67 (.82)	8.00 (.81)	.27	1.32 (2, 46)	.28	.07 [-.73, .87]
Attention	7.92 (.88)	8.00 (.98)	7.99 (.74)	.06	.07 (2, 46)	.93	.12 [-.68, .92]
Self-Efficacy	7.92 (.95)	8.11 (.66)	7.64 (.94)	.18	.86 (2, 22)	.44	-.32 [-1.12, .49]
Other's Efficacy	7.81 (.77)	7.67 (.75)	7.36 (1.23)	.21	1.06 (2, 22)	.36	-.58 [-1.39, .24]
Likability	8.26 (.94)	7.76 (.85)	7.68 (.88)	.53	2.82 (2, 46)	.07	-.89 [-1.73, -.06]

Psychophysiological Data. Mean and standard deviations values, Cohen's *d* effect size differences, power, and p-values for all psychophysiological data are reported in Table 7. Cohen's *d* effect size differences represent differences between Game 1 and Game 3. Differences for Game 2 and 3 are presented in charts in the Appendices (see *Appendices 3E*). Single effects Repeated Measures ANOVAs with a Greenhouse-Geisser correction were ran for all psychophysiological variables (see Appendix 3C). Statistical difference was observed for both *HR* (p = .02) and *HRV* (p < .05) magnitude effect size analyses suggested that the decrease in *HR* from Game 1 to Game 3was trivial (d = -.04). Post hoc using Bonferroni corrections revealed that *HR* increased from Game 1-2 (p = .049). Moreover, *HRV* (d = .55), and *Alpha Peak* (d = .53) were found to increase between Games 1-3. There was also a small increase in *Theta/Beta Ratio* (d = .15) from Game 1 to Game 3. Furthermore, post hoc tests revealed that *HRV* increased from Game 2-3 (p <.01). In addition, HRV increased from Game 1-3 (p <.01).

Table 7

Psychophysiological Data for Games 1-3

Variables	Game 1 M (SD)	Game 2 M (SD)	Game 3 M (SD)	1−β (power)	F (df1, df2)	*p* value	Cohen's *d* [95% CI]
HR*	81.10 (5.40)	82.50 (5.90)	80.92 (6.52)	.69	3.87 (2,238)	.02	-.04 [-.29,.22]
HRV**	50.78 (7.12)	50.50 (8.90)	55.21 (8.71)	.99	12.96 (1.89,224.60)	*p* <.01	.55 [.29,.81]
Alpha Peak	9.98 (.19)	9.93 (.17)	10.08 (.21)	.37	2.00 (2,22)	.16	.53 [-.28,1.35]
Theta/Beta	.62 (.25)	.60 (.26)	.65 (.18)	.07	.18 (2,22)	.84	.15 [-.66,.95]

Note. HR represents "Heart Rate" and HRV stands for "Heart Rate Variability".
*p < .05. **p < .01.

21-EEG Channel Power. Mean and standard deviations values, Cohen's *d* effect size differences, power, and p-values for all 21- EEG channel power is reported in Table 8. Cohen's *d* effect size differences represent differences between Game 1 and Game 3. Differences for Game 2 and 3 are presented in charts in the Appendices (see *Appendices 3E*). Single effects Repeated Measures ANOVAs with a Greenhouse-Geisser correction were ran for all 21-EEG channel power variables (see Appendix 3D). A decrease in activity in *Fp1* (p = .05; d = -.36) and *Fp2* (p = .05; d = -.40), was observed, as well as a decrease in *F7* (d=-.36) from Game 1 to Game 3. In addition, a large increase was observed for *Cz* (d=.79) from Game 1 to Game 3. Figure 5 illustrates these findings in relation to their individual brain regions.

Table 8

21-EEG Channel Power for Games 1-3

Brain Location	Variables	Game 1 M (SD)	Game 2 M (SD)	Game 3 M (SD)	1−β (power)	F (df1, df2)	*p*	Cohen's *d* [95% CI]
Frontal	Fp1*	-6354.00 (3063.51)	-9001.83 (2354.41)	-7262.61 (2325.28)	.58	3.38 (2,22)	.05	-.36 [-1.17, .45]
	Fp2*	-6495.59 (3368.97)	-9570.45 (3323.08)	-7677.94 (3474.58)	.58	3.38 (2,22)	.05	-.40 [-1.22, .40]
	F7	-5736.71 (2189.77)	-7131.61 (1912.33)	-6280.70 (1688.08)	.46	2.56 (2,22)	.10	-.36 [-1.16, .45]
	F3	3971.68 (5277.07)	5744.61 (3084.58)	5837.39 (2253.34)	.25	1.83 (1.10, 11.99)	.20	.69 [-.13, 1.52]
	Fz	4710.33 (2622.82)	5811.38 (4069.10)	6880.13 (3337.93)	.42	2.32 (2,22)	.12	.88 [.04, 1.72]
	F4	1316.19 (4287.58)	1175.36 (6703.62)	-342.37 (5284.06)	.17	.79 (2,22)	.46	-.46 [-1.27, .35]
	F8	-6602.63 (2672.71)	-8155.72 (952.34)	-6758.70 (1691.00)	.45	2.54 (2,22)	.10	-.08 [-.88, .72]
Central	C3	6969.30 (4289.84)	9126.25 (3584.26)	8620.09 (1447.42)	.52	3.00 (2,22)	.33	.73 [-.09, 1.56]
	Cz	5413.70 (2639.98)	7866.62 (3802.48)	7648.40 (3885.67)	.49	2.79 (2,22)	.08	.79 [-.037, 1.62]
	C4	2455.52 (4084.40)	4853.50 (3223.88)	2955.27 (3566.27)	.27	1.41 (2,22)	.27	.14 [-.67, .94]
Temporal	T3	-6361.20 (2085.23)	-6917.21 (1192.79)	-6536.37 (918.43)	.12	.50 (2,22)	.61	-.13 [-.93, .68]
	T4	7.62 (3809.56)	-1585.35 (5534.15)	-1737.18 (4251.06)	.16	.73 (2,22)	.49	-.45 [-1.26, .36]
	T5	-4069.87 (1919.55)	-3650.55 (2342.57)	-3484.01 (2003.23)	.11	.49 (2,22)	.63	.39 [-.42 ,1.2]
	T6	-1849.65 (9039.40)	1623.70 (11282.29)	-384.11 (9892.05)	.09	.33 (2,22)	.73	.14 [-.66, .94]

Brain Location	Variables	Game 1 M (SD)	Game 2 M (SD)	Game 3 M (SD)	1−β (power)	F (df1, df2)	*p*	Cohen's *d* [95% CI]
Parietal	P3	1856.37 (4011.48)	3717.65 (5173.88)	2681.14 (5080.18)	.17	.81 (2,22)	.46	.23 [-.57, 1.032]
	Pz	1863.85 (6550.56)	5300.74 (6530.30)	1499.11 (6213.71)	.27	1.79 (1.35,14.82)	.20	-.06 [-.87, .73]
	P4	455.82 (4957.44)	1884.34 (4144.54)	673.37 (3178.36)	.12	.52 (2,22)	.60	.06 [-.74, .86]
Occipital	O1	1126.60 (4750.18)	1976.14 (4533.64)	227.00 (4102.71)	.12	.61 (1.38,15.14)	.49	-.23 [-1.03, .57]
	O2	1568.08 (5356.00)	4379.13 (5666.97)	1990.73 (4855.95)	.22	1.11 (2,22)	.35	.08 [-.72, .89]

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

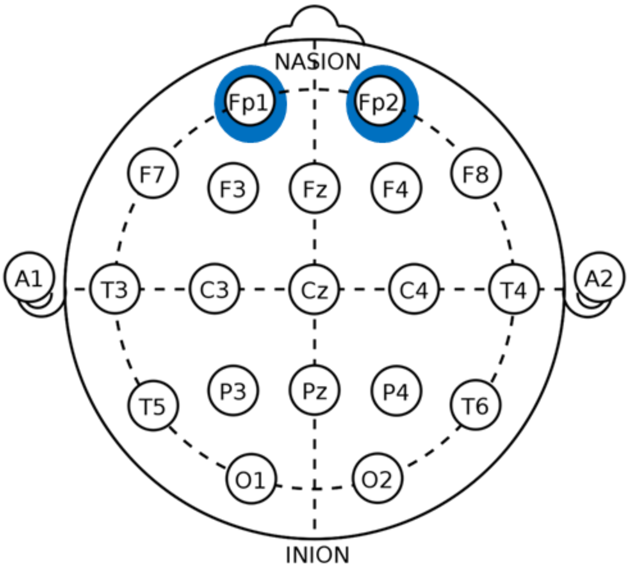

Figure 6. Topographical Map illustrating statistically significant differences between the Game 3 and Game 1. The blue highlight illustrates a decrease in power in Game 3.

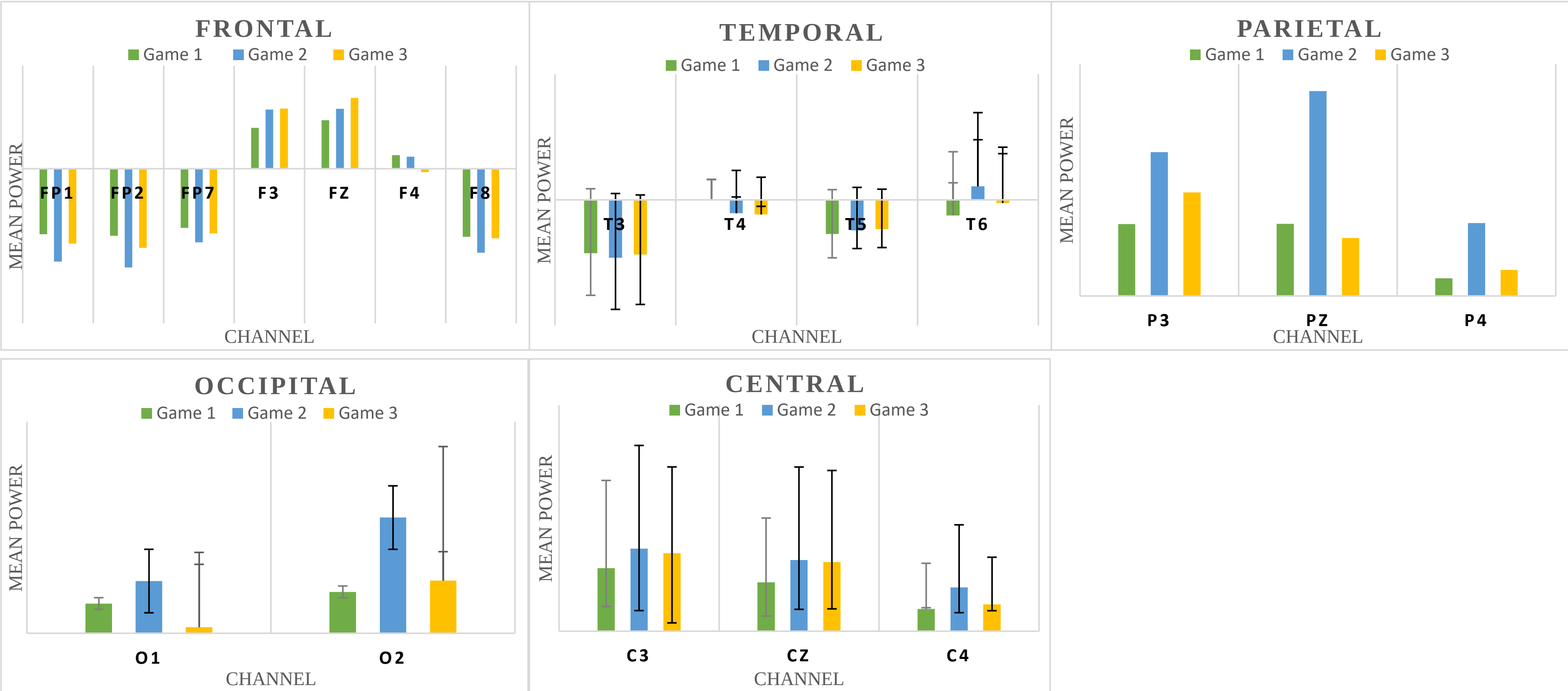

Figure 7. Mean Power and 95% Confidence Intervals for all 21 EEG channels across the frontal (left upper panel), parietal (right upper panel), temporal (central upper panel), occipital (lower left panel) and central regions (lower middle panel).

Discussion

In Study 2 the participants played three consecutive games of FIFA 17 in a dyad condition only. Study 2 extended Study 1 by exploring psychophysiological changes over time to assess whether "team learning" might have occurred over time.

Performance Changes. Among all performance variables, only *Number of Fouls* showed a large and statistically significant increase from Game 1 to Game 2, as well as from Game 1 to 3. The large increase in the observed *Number of Fouls* might reflect a strategy employed by the dyad to disrupt the opposing team's performance (e.g., committing a foul to prevent a counter-attack; see Silva, Garganta, Santos, & Teoldo, 2014). Alternatively, the participants might have experienced frustration, as they were unable to communicate during the game to resolve any emerging issues. In turn, this frustration might have triggered an increased number of fouls in the virtual game scenario, consistent with the "frustration-aggression" hypothesis (Gümüşdağ, Yıldıran, Yamaner, & Kartal, 2011).

Psychological Factors. No statistical differences were observed in the self-report psychological factors (i.e., *Arousal*, *Pleasantness*, *Attention*, *Self-Efficacy* and *Others-Efficacy*, and *Likability*). A marginal statistical effect was observed for *likability* suggesting that intra-team team conflicts might have emerged over time. Future research, based on a larger sample size, should further examine this effect.

Psychophysiological Differences. Statistically significant effects were observed in the psychophysiological measures of *HR* and *HRV*. However, magnitude effect size analysis revealed that the decrease in *HR* was trivial. In contrast, *HRV* (medium effect), *Alpha Peak* (medium effect), and *Theta/Beta Ratio* (small effect) were all found to increase from Game 1 to Game 3. The increase in *HRV* and *Alpha Peak* are related to an increase in a "relaxed mental state", which in turn might reflect a learning effect (Dong, 2016; Mathewson et al., 2012). In other words, as participants learned how to play the game together, they were more "cognitively" relaxed and therefore able to perform better (see *neural efficiency hypothesis;* Bertollo et al., 2013; Holbrook, Chestnut, Oliva, & Greenleaf, 1984; Lin et al., 2015). Although participants were "affectively" frustrated with their partners they were more "cognitively" relaxed as they learned to play the game over time (see the *cognitive-affective-behavioural linkage* in Tenenbaum, Basevitch, Gershgoren & Filho, 2013). A "relaxed mind" allows for more autonomy in the participants actions which has been previously linked to performance (Plante, & Booth, 1997; Piccinini & Craver, 2011; Hatzigeorgiadis, Galanis, Zourbanos & Theodorakis, 2013). However, *Theta/Beta Ratio* was found to increase slightly in Game 3, compared to Game 1. This is likely due to the fact that some areas of the brain were very active during the task, as indicated by the individual 21-EEG Channel Power analysis.

The 21-EEG Channel Power analysis revealed significant differences of small magnitude in *Fp1* and *Fp2*, from Game 1 to Game 3. *F7* showed a statistically significant decrease of moderate effect size, whilst *Cz* was found to have a large effect size increase, when comparing Game 1 to Game 3. This suggests that from Game 1 to Game 3 less use of the frontal brain region was needed, suggesting that learning occurred in agreement with the *neural efficiency hypothesis*. Neural efficiency tends to occur in the frontal lobe when individuals develop their skills in a given motor task. The participants start going into "auto-pilot" as less motor related resources were under demand. However, the large increase in the middle brain region suggests that the participants needed to integrate many different sources of information to be able to perform optimally (Biswal et al., 2010). In addition, due to the participants not being allowed to communicate during the task, they had to make sense of lots of information on their own and translate this into in-game strategy.

Summary. In summary, it was first hypothesized that over time performance (i.e., higher *Total Points*, higher *Goal Differential*, higher *Ball Possession* and lower *Number of Fouls*) would increase due to "team learning" (H4). H4 was partially verified as *Number of*

Fouls, which has been linked to performance, to increase in Game 1 and Game 2, in comparison with Game 3. Secondly, it was hypothesized that positive affect (i.e., higher *Arousal,* higher *Pleasantness,* higher *Self-Efficacy,* higher *Others' Efficacy and* higher *Likability*) would increase over time (H5). H5 was not verified as no statistically significant differences were observed over time. Finally, it was hypothesized that participants would show less signs of physiological stress and "cognitive load" due to "Team learning" (H6). H6 was confirmed as participants exhibited decreased physiological stress and "cognitive load" in Game 3, compared to Game 1 (i.e., higher *HRV* and evidence of hypofrontality).

General Discussion

Study 1 and Study 2 aimed to explore differences in psychophysiological functioning between solo and dyad play during a video-game based task. Study 1 explored this by comparing the differences between solo and dyad play, whilst Study 2 aimed to expand this by exploring the differences over three games. In Study 1 a "coordination cost" was observed in the dyad condition, as evident from the large increase in perceived *Attention* and power in the central and temporal areas of the brain, and a large decrease in *HRV*. Playing in a dyad led to an increased in focused attention (i.e., recruitment of specific neural pathways in the brain), which was probably needed to coordinate actions with the teammate. In Study 2 cognitive load was found to decrease over time, as seen through an increase in *HRV* and a decrease in frontal activation in the brain. As time goes on, players begin to "auto-pilot" more as they develop effective mental models to coordinate their actions efficiently.

Limitations & Strengths. The current study is not without limitations. Statistical power was relatively low across the two studies. For this reason, a multi-level analysis could not be performed. In addition, a higher sampling rate (higher than 256hz) would have been better for the EEG data. Despite these limitations, this study advances the literature as there has been little research on the notion of "Coordination Cost" from a psychophysiological view, including EEG measures (Filho, Bertollo, Robazza, & Comani, 2015). Moreover, most studies on team dynamics are not lab-based but rather cross-sectional in nature, whilst the present study was conducted in a controlled lab-based environment (McEwan & Beauchamp, 2014). Finally, this study further demonstrates the ecological validity of using video-games to study interactive tasks in a laboratory environment (for a review see Gray, 2017; Sankaranarayanan, Mirza-Babaei, & Da Rocha Tome Filho, 2015).

Future Research. The relationship between psychophysiological states and video-game performance must also be further examined with a larger sample size to replicate the findings of this study. Changes in performance and psychophysiological states for a longer period of time (more than three games) should also be examined. Future research should also examine the different team relevant roles (e.g., leader or follower) that participants may adopt over time. In addition, the role of communication in developing TMM's and its effect on performance should also be investigated. Finally, research must also be conducted with different groups (e.g., female and elite level gamers).

Conclusion & Applied Implications. The findings of the current study have applied implications. First, findings from Study 1 suggest that there is a greater bio-psycho-social cost of playing in a team compared to playing on your own. Second, findings from Study 2 suggest that "team learning" takes place over the course of the games and that teams go through intra-team conflict over time. Based on these findings, applied psychologists should encourage more "team-building" exercises (including the use of video-game tasks), as opposed to solo tasks, to increase positive affect in short term ("single shot") tasks. Furthermore, applied psychologists should endure to keep newly formed teams together for a long period of time to benefit performance, whilst also monitoring and promoting resolution of intra-team conflicts (e.g., through communication workshops) that may arise in the early stages of a team's development.

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Appendix 1 – Ethics and Questionnaires

Appendices 1A

Participant Recruitment Flyer Advertisement

uclan
University of Central Lancashire

Psychophysiological Differences in Individual and Cooperative Video-Game Play:

An Exploratory Study

We are seeking Male staff or students with no prior history of neurological disorders to participate in a study exploring the differences in individual and cooperative video-game playing. conducted by Benjamin Hoyle, School of Psychology Student at the University of Central Lancashire as part of his Masters degree.

Participants will be asked to play several matches of FIFA 17 with or without a partner whilst wearing biofeedback equipment (to the left) and responding to psychological questionnaires.

If this sounds interesting to you please contact Ben Hoyle using the contact information below.

Contact Information

- **Ben Hoyle, Email:** Bmhoyle@uclan.ac.uk **or Phone:** 07979416957
  Principal Investigator: **Edson Filho, Email:** Efilho@uclan.ac.uk

Students in the School of Psychology may also gain extra points through the use of SONA system which is also being used with this study.

Please feel free to take a contact slip to get in touch

Ben Hoyle
Phone:07979416957
E-mail: bmhoyle@uclan.ac.uk

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Appendices 1B

Single Item Questionnaires

Single Item Measures

Efficacy

Self-Efficacy

Rate the belief you have in your own skills/abilities to win the match. 0 being no belief and 10 being complete belief.

0	1	2	3	4	5	6	7	8	9	10

Others Efficacy

Rate the belief you have in your teammates abilities/skills to win the match. 0 being no belief and 10 being complete belief.

0	1	2	3	4	5	6	7	8	9	10

Attention

Rate your perceived attentional focus:

0 Distracted/Unable to Focus	1	2	3	4	5	6	7	8	9	10 Complete Focus on Task

Arousal

Rate your perceived arousal level:

0 Sleepiness	1	2	3	4	5	6	7	8	9	10 High Arousal

Pleasantness

Rate how pleasant you believe the task is:

0 Not Pleasant	1	2	3	4	5	6	7	8	9	10 Very Pleasant

Likability

Rate how likable the task is:

0 Very Unlikable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10 Very Likable**

Likability - Partner

Rate how likable your partner is:

0 Very Unlikable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10 Very Likable**

Appendices 1C

Participant Information Sheets and Debrief Forms Study 1 and 2 respectively

Psychophysiological Differences in Individual and Cooperative Video-Game Play:

An Exploratory Study

Researcher: Benjamin Michael Hoyle (bmhoyle@uclan.ac.uk)
Supervisory Team:
Edson Filho (EFilho@uclan.ac.uk)
Jamie Taylor (JATaylor2@uclan.ac.uk)

PARTICIPANT INFORMATION SHEET

The Purpose of the Study

This study is being conducted as part of my MSc by research degree at UCLan. The main aim of this research project is to explore the differences in psychophysiological functioning between individuals playing a video game in a solo participant condition or as part of a dyadic team. Therefore, this research aims to expand previous work on team dynamics in sport psychology.

What will I have to do?

The study will be conducted over the course of one meeting that should last approximately 2 hours. During this time, you will be required to play 1 match of FIFA 17 on your own against the computer on a pre-determined teams and difficulty setting. Then a further match with another participant that you have not met before under the same conditions. Throughout the experiment biofeedback equipment, EEG cap and heart rate monitor will have to be worn. Participants will also be asked to (1) respond to a demographic questionnaire and (2) report on several psychological measures.

Data Protection and Consent

All data collected in this study will be kept in a password protected file only accessible to the researchers. All participants will remain anonymous throughout the study with the use of a unique participant code.

One participant in each dyad will wear an EEG cap and both participants will wear a heart rate monitor during testing. These apparatuses are harmless, but some people may feel unconformable about having biofeedback sensors attached to their body. Due to the nature of the EEG cap, which is part of the biofeedback equipment, your hair may be messy at the end of the experiment. To address this, a washing area and towel will be provided to you at the end of the experiment.

You may drop out of the experiment anytime during the data collection phase. However, after leaving the location of the experiment, you will not be able to withdraw your data any longer, as the data will be anonymized.

Contact for further information

If you have any questions about your rights as a participant in this research project, or if you feel that you have been placed at risk, please contact the University Ethics committee at the University of Central Lancashire (OfficerforEthics@uclan.ac.uk).

Date……………………….

Psychophysiological Differences in Individual and Cooperative Video-Game Play:

An Exploratory Study

Researcher: Benjamin Michael Hoyle (bmhoyle@uclan.ac.uk)
Supervisory Team:
Edson Filho (EFilho@uclan.ac.uk)
Jamie Taylor (JATaylor2@uclan.ac.uk)

PARTICIPANT INFORMATION SHEET

The Purposes of the Study

This study is being conducted as part of my MSc by research degree at UCLan. The main aim of this research project is to explore the changes in psychophysiological and team functioning of individuals playing cooperatively in a video game setting. Therefore, this research aims to expand previous work on team dynamics in sport psychology.

What will I have to do?

The study will be conducted over the course of two sessions that should last between approximately 2 hours each. During this time, you will be required to play 3 consecutive matches of FIFA 17 with another participant against the computer with pre-determined teams and difficulty setting. Throughout the experiment, biofeedback equipment, a heart rate monitor, and EEG cap will have to be worn. Participants will also be asked to (1) respond to a demographic questionnaire during the first session; and (2) report on several psychological measures.

Data protection and consent

All data will be kept in a password protected file only accessible to the researcher and supervisor. All participants will remain anonymous throughout the study with the use of a unique participant code.

One participant in each dyad will wear an EEG cap and both participants will wear a heart rate monitor during testing. These apparatuses are harmless, but some people may feel unconformable about having biofeedback sensors attached to their body. Due to the nature of the EEG cap, which is part of the biofeedback equipment, your hair may be messy at the end of the experiment. To address this, a washing area and towel will be provided to you at the end of the experiment.

You may drop out of the experiment anytime during the data collection phase. However, after leaving the location of the experiment, you will not be able to withdraw your data any longer, as the data will be anonymized.

Contact for further information

If you have any questions about your rights as a participant in this research project, or if you feel that you have been placed at risk, please contact the University Ethics committee at the University of Central Lancashire (OfficerforEthics@uclan.ac.uk).

Date……………………….

Appendix 2 – Results Study 1

Appendices 2A

Match Statistics SPSS outputs; Total Points, Goal Difference, Ball Possession and Number of Fouls.

Descriptive Statistics

	Mean	Std. Deviation	N
Game1_Points	2.0000	1.27920	12
Game2_Points	1.9167	1.16450	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
GamePoints	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: GamePoints

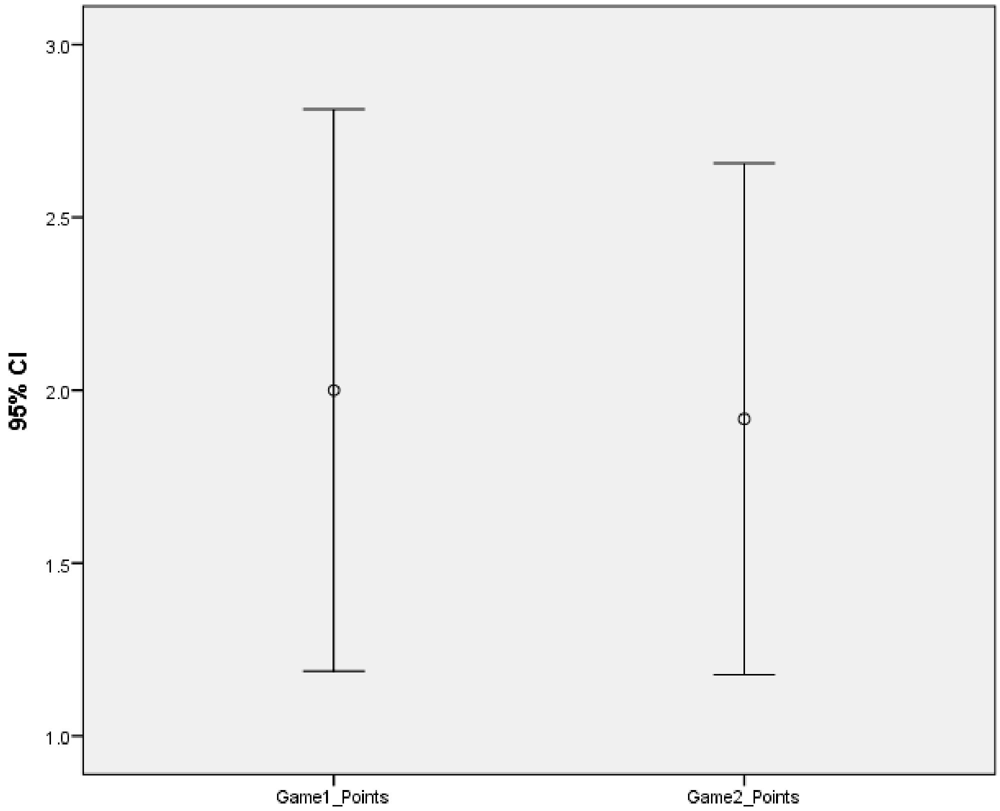
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
GamePoints	Sphericity Assumed	.042	1	.042	.024	.881	.002	.024	.052
	Greenhouse-Geisser	.042	1.000	.042	.024	.881	.002	.024	.052
	Huynh-Feldt	.042	1.000	.042	.024	.881	.002	.024	.052
	Lower-bound	.042	1.000	.042	.024	.881	.002	.024	.052
Error(GamePoints)	Sphericity Assumed	19.458	11	1.769					
	Greenhouse-Geisser	19.458	11.000	1.769					
	Huynh-Feldt	19.458	11.000	1.769					
	Lower-bound	19.458	11.000	1.769					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Game1_Goal_Differential	1.0000	1.47710	12
Game2_Goal_Diff	.7500	1.05529	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
GoalDif	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
 Within Subjects Design: GoalDif

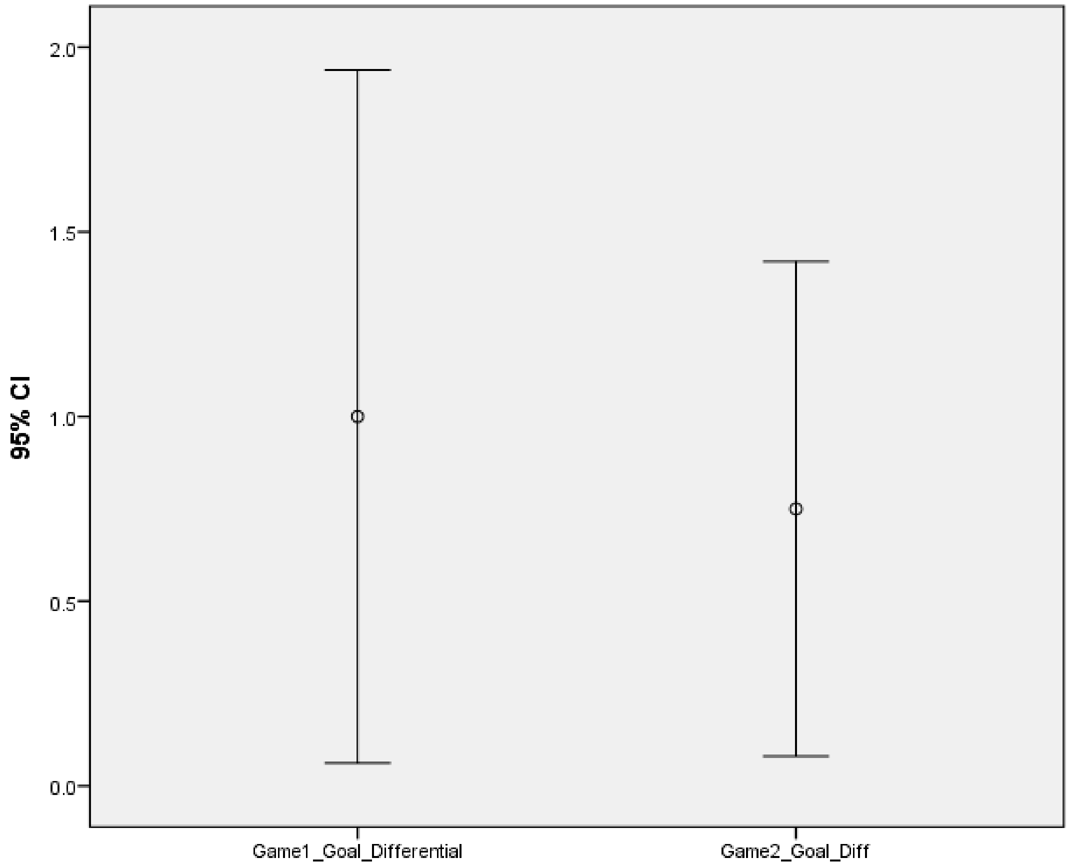
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
GoalDif	Sphericity Assumed	.375	1	.375	.241	.633	.021	.241	.073
	Greenhouse-Geisser	.375	1.000	.375	.241	.633	.021	.241	.073
	Huynh-Feldt	.375	1.000	.375	.241	.633	.021	.241	.073
	Lower-bound	.375	1.000	.375	.241	.633	.021	.241	.073
Error(GoalDif)	Sphericity Assumed	17.125	11	1.557					
	Greenhouse-Geisser	17.125	11.000	1.557					
	Huynh-Feldt	17.125	11.000	1.557					
	Lower-bound	17.125	11.000	1.557					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Solo_BallPos_Total	50.6667	1.62835	12
Dyad_BallPos_Total	51.0000	.99430	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
BallPoss	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: BallPoss

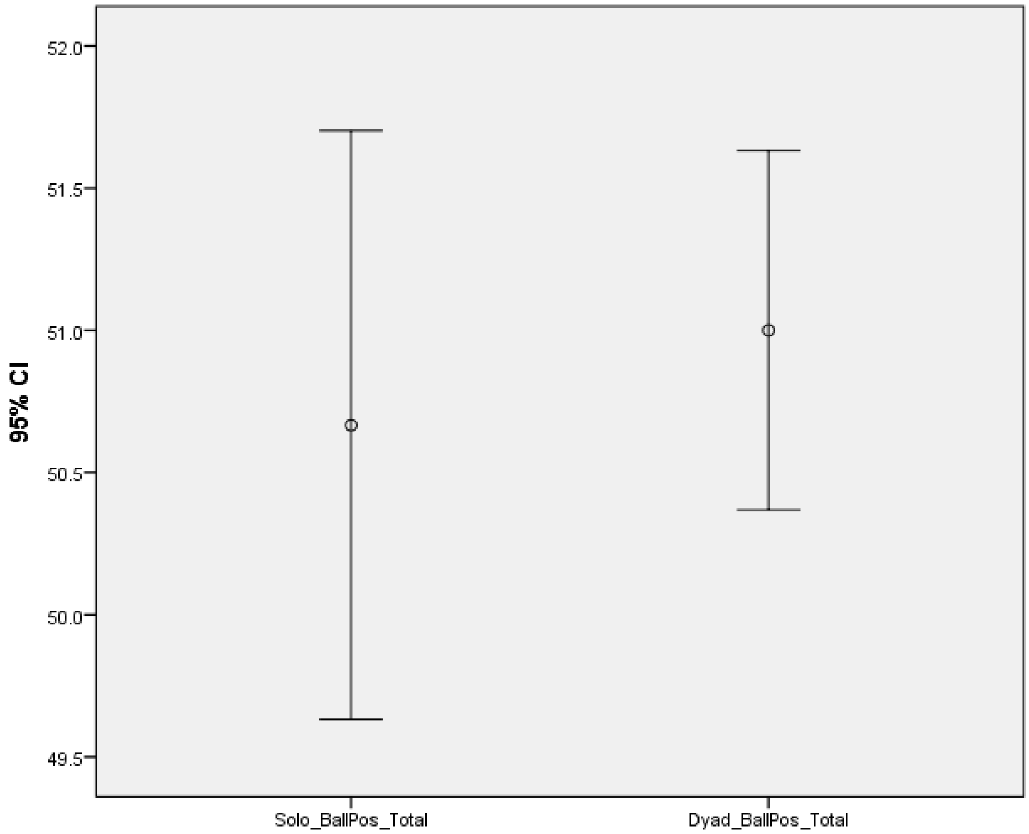
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
BallPoss	Sphericity Assumed	.667	1	.667	.488	.499	.042	.488	.098
	Greenhouse-Geisser	.667	1.000	.667	.488	.499	.042	.488	.098
	Huynh-Feldt	.667	1.000	.667	.488	.499	.042	.488	.098
	Lower-bound	.667	1.000	.667	.488	.499	.042	.488	.098
Error(BallPoss)	Sphericity Assumed	15.021	11	1.366					
	Greenhouse-Geisser	15.021	11.000	1.366					
	Huynh-Feldt	15.021	11.000	1.366					
	Lower-bound	15.021	11.000	1.366					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Game1_Fouls	7.3333	2.83912	12
Game2_Fouls	6.8333	2.12489	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Fouls	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Fouls

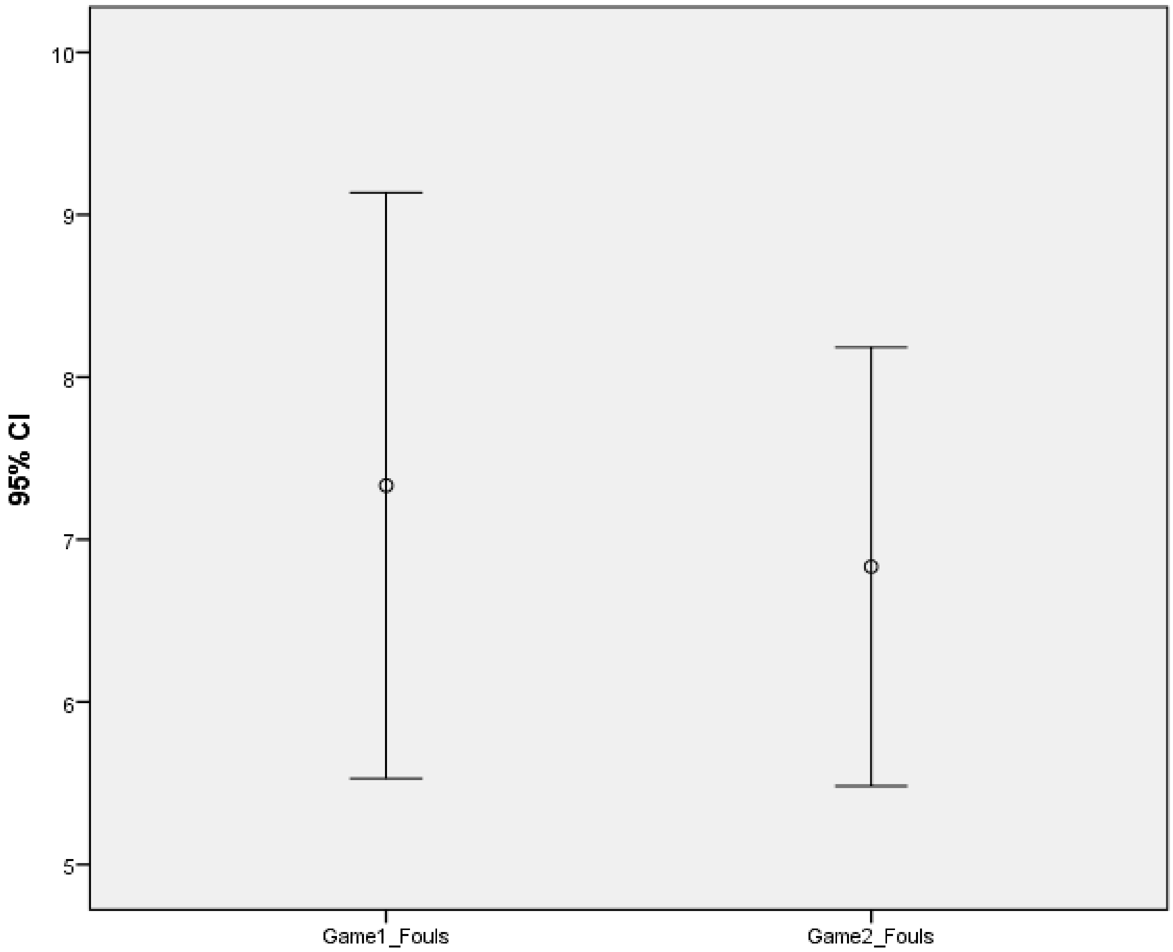
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Fouls	Sphericity Assumed	1.500	1	1.500	.234	.638	.021	.234	.073
	Greenhouse-Geisser	1.500	1.000	1.500	.234	.638	.021	.234	.073
	Huynh-Feldt	1.500	1.000	1.500	.234	.638	.021	.234	.073
	Lower-bound	1.500	1.000	1.500	.234	.638	.021	.234	.073
Error(Fouls)	Sphericity Assumed	70.500	11	6.409					
	Greenhouse-Geisser	70.500	11.000	6.409					
	Huynh-Feldt	70.500	11.000	6.409					
	Lower-bound	70.500	11.000	6.409					

a. Computed using alpha = .05



Appendices 2B

Subjective Self-report SPSS outputs; Arousal, Pleasantness, Attention and Self-Efficacy

Descriptive Statistics

	Mean	Std. Deviation	N
G1_Arousal	6.8333	1.08711	12
G2_Arousal	7.1667	1.32192	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Arousal	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Arousal

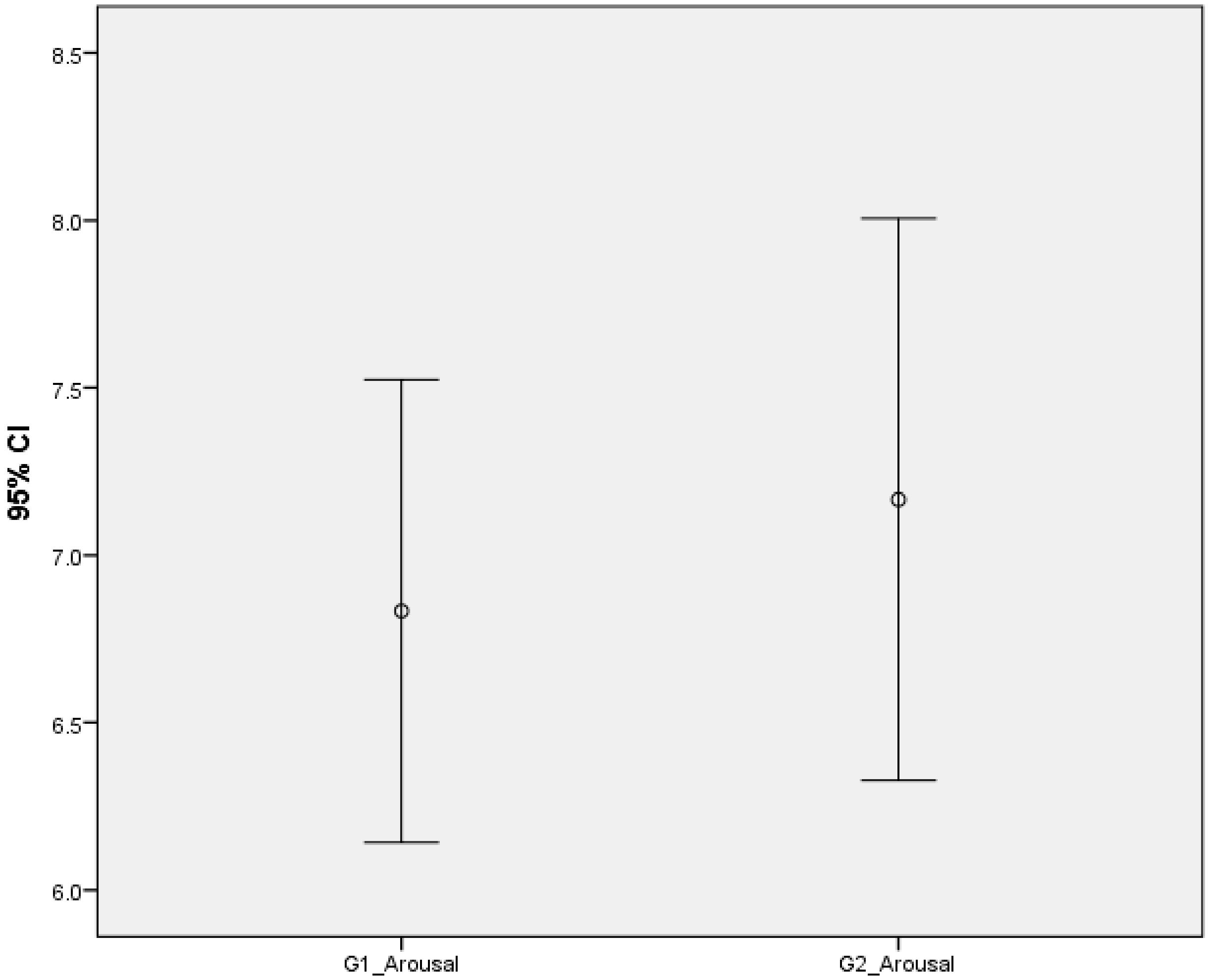
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Arousal	Sphericity Assumed	.667	1	.667	.332	.576	.029	.332	.082
	Greenhouse-Geisser	.667	1.000	.667	.332	.576	.029	.332	.082
	Huynh-Feldt	.667	1.000	.667	.332	.576	.029	.332	.082
	Lower-bound	.667	1.000	.667	.332	.576	.029	.332	.082
Error(Arousal)	Sphericity Assumed	22.111	11	2.010					
	Greenhouse-Geisser	22.111	11.000	2.010					
	Huynh-Feldt	22.111	11.000	2.010					
	Lower-bound	22.111	11.000	2.010					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
G1_Pleas_Total	7.1944	.85821	12
G2_Pleas_Total	7.4444	.99832	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Pleasantness	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Pleasantness

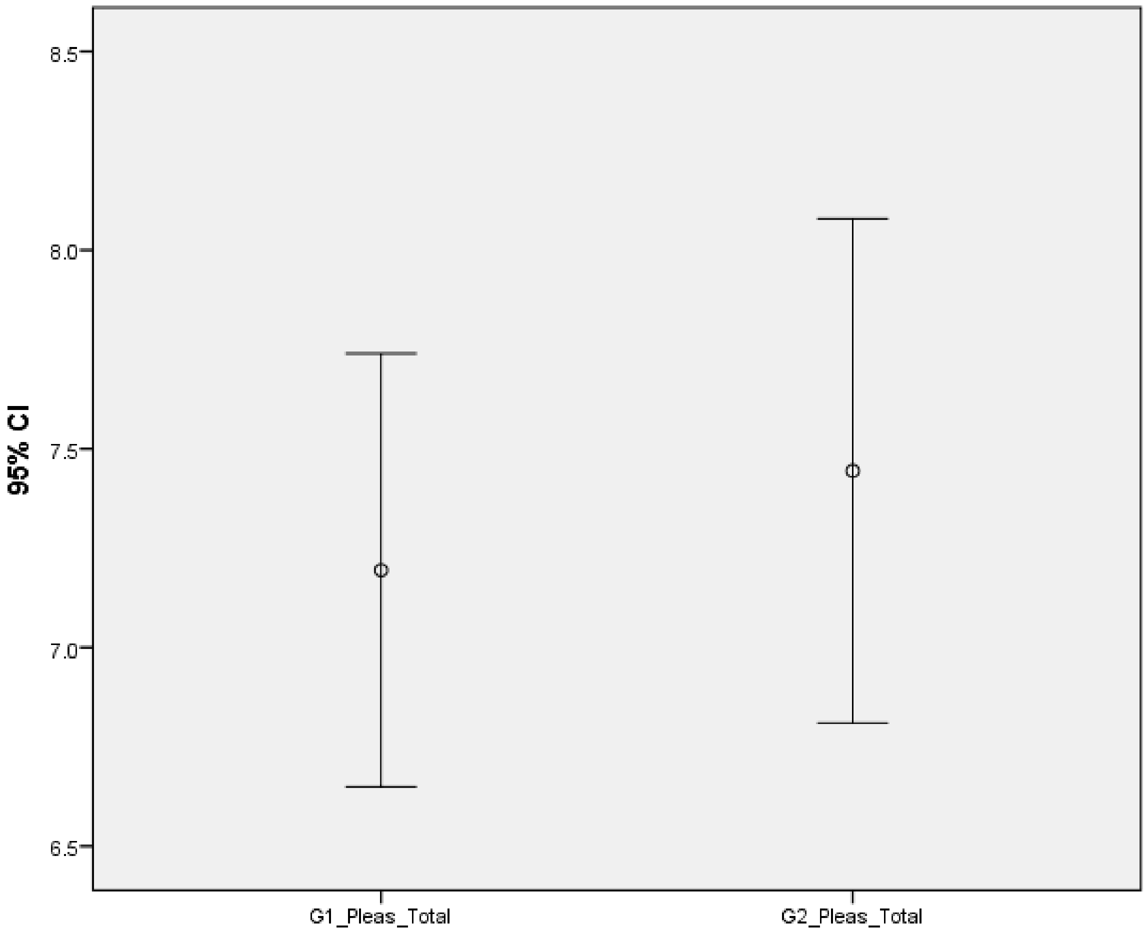
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Pleasantness	Sphericity Assumed	.375	1	.375	.771	.399	.066	.771	.127
	Greenhouse-Geisser	.375	1.000	.375	.771	.399	.066	.771	.127
	Huynh-Feldt	.375	1.000	.375	.771	.399	.066	.771	.127
	Lower-bound	.375	1.000	.375	.771	.399	.066	.771	.127
Error(Pleasantness)	Sphericity Assumed	5.347	11	.486					
	Greenhouse-Geisser	5.347	11.000	.486					
	Huynh-Feldt	5.347	11.000	.486					
	Lower-bound	5.347	11.000	.486					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
G1_Attention_Total	6.8333	1.08711	12
G2_Attention_Total	7.6667	.77850	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Attention	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
 Within Subjects Design: Attention

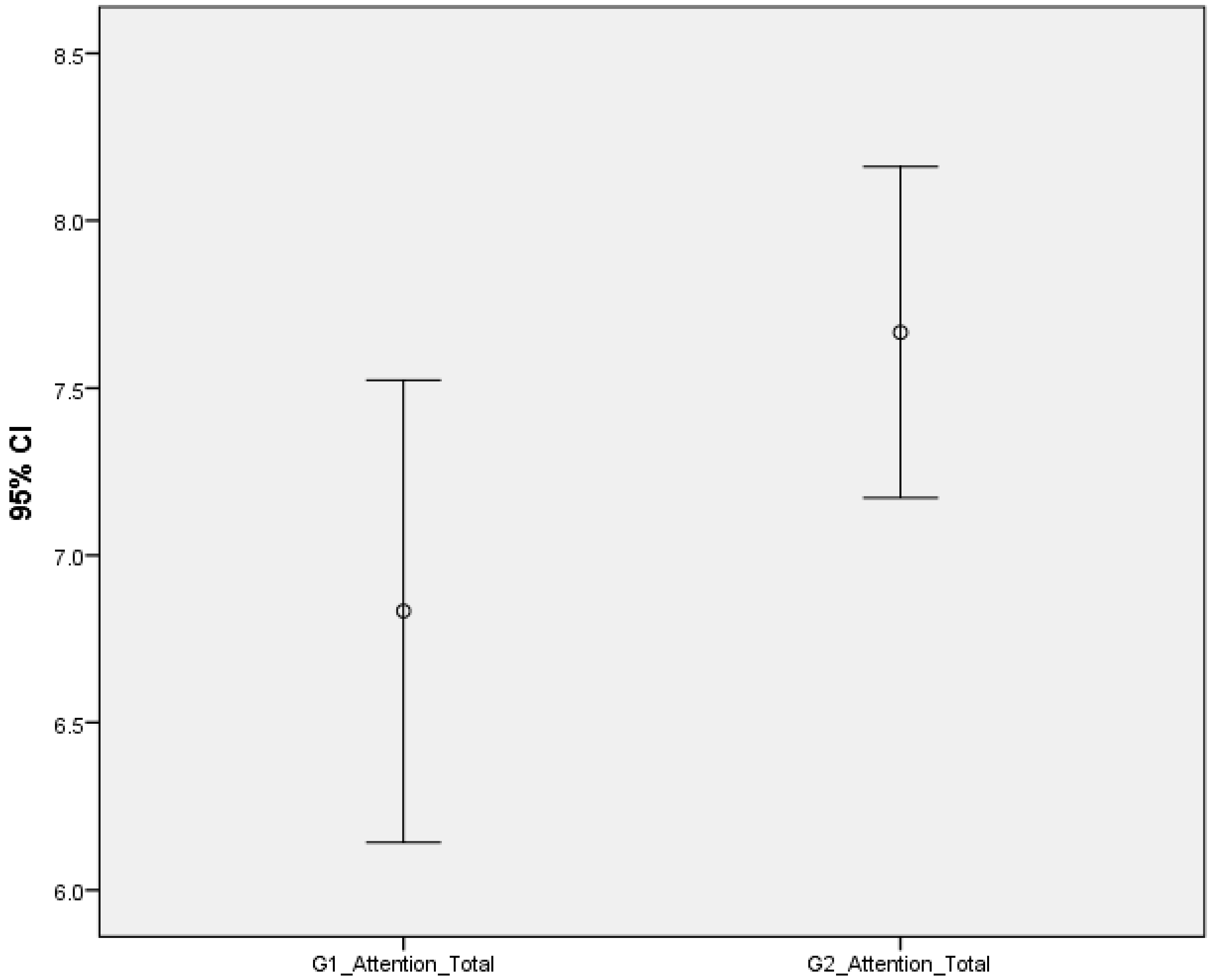
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Attention	Sphericity Assumed	4.167	1	4.167	4.609	.055	.295	4.609	.499
	Greenhouse-Geisser	4.167	1.000	4.167	4.609	.055	.295	4.609	.499
	Huynh-Feldt	4.167	1.000	4.167	4.609	.055	.295	4.609	.499
	Lower-bound	4.167	1.000	4.167	4.609	.055	.295	4.609	.499
Error(Attention)	Sphericity Assumed	9.944	11	.904					
	Greenhouse-Geisser	9.944	11.000	.904					
	Huynh-Feldt	9.944	11.000	.904					
	Lower-bound	9.944	11.000	.904					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
G1_SE_Total	7.0000	1.32574	12
G2_SE_Total	7.2778	.80193	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Self_Efficacy	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: Self_Efficacy

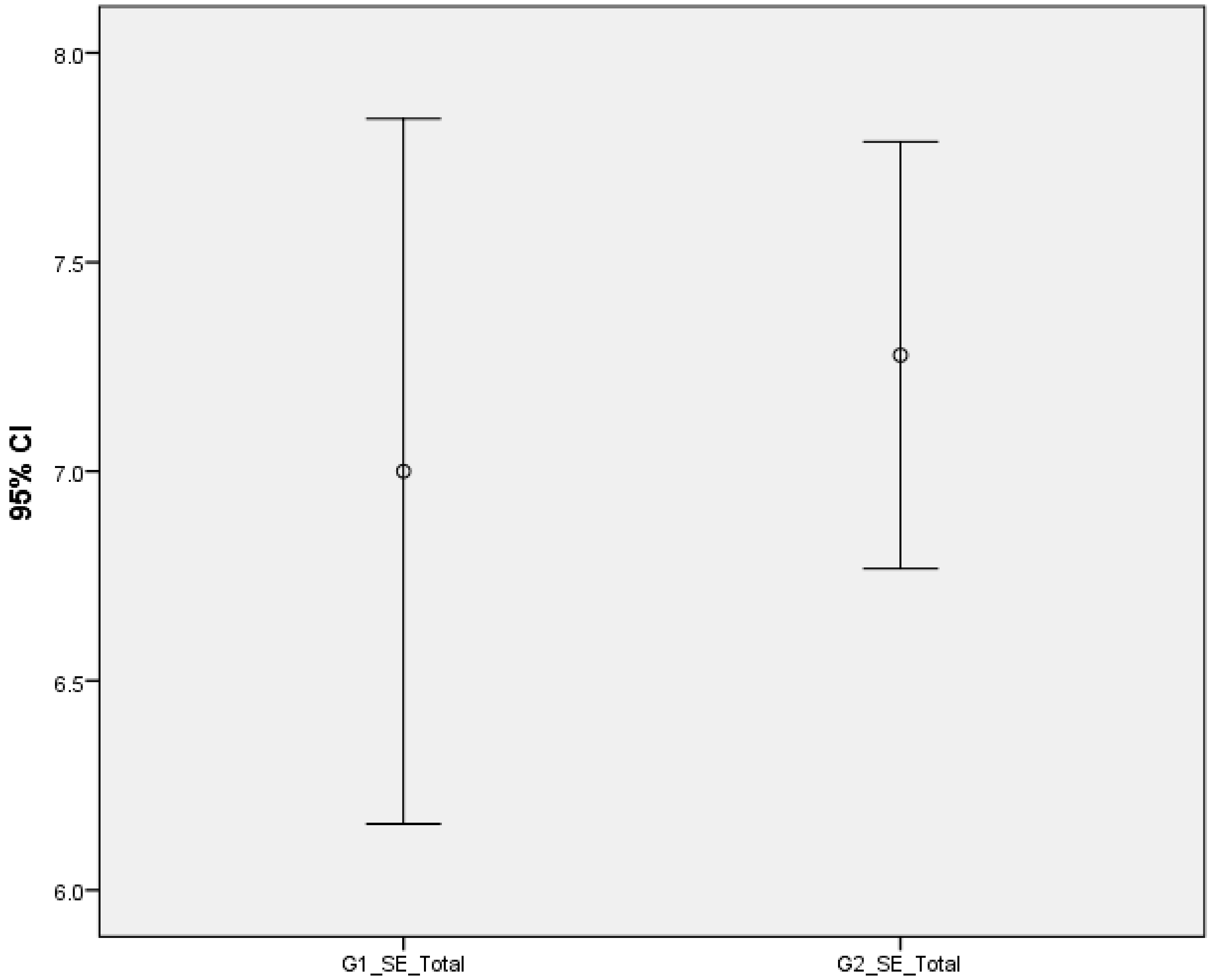
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Self_Efficacy	Sphericity Assumed	.463	1	.463	.335	.574	.030	.335	.083
	Greenhouse-Geisser	.463	1.000	.463	.335	.574	.030	.335	.083
	Huynh-Feldt	.463	1.000	.463	.335	.574	.030	.335	.083
	Lower-bound	.463	1.000	.463	.335	.574	.030	.335	.083
Error(Self_Efficacy)	Sphericity Assumed	15.204	11	1.382					
	Greenhouse-Geisser	15.204	11.000	1.382					
	Huynh-Feldt	15.204	11.000	1.382					
	Lower-bound	15.204	11.000	1.382					

a. Computed using alpha = .05



Appendices 2C

Psychophysiological data SPSS Outputs; Heart Rate, Heart Rate Varaiability, Alpha Peak and Theta/Beta Ratio

Descriptive Statistics

	Mean	Std. Deviation	N
Game1_HRTotal	83.6167	5.66047	120
Game2_HRTotal	82.9333	5.80420	120

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
HR	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: HR

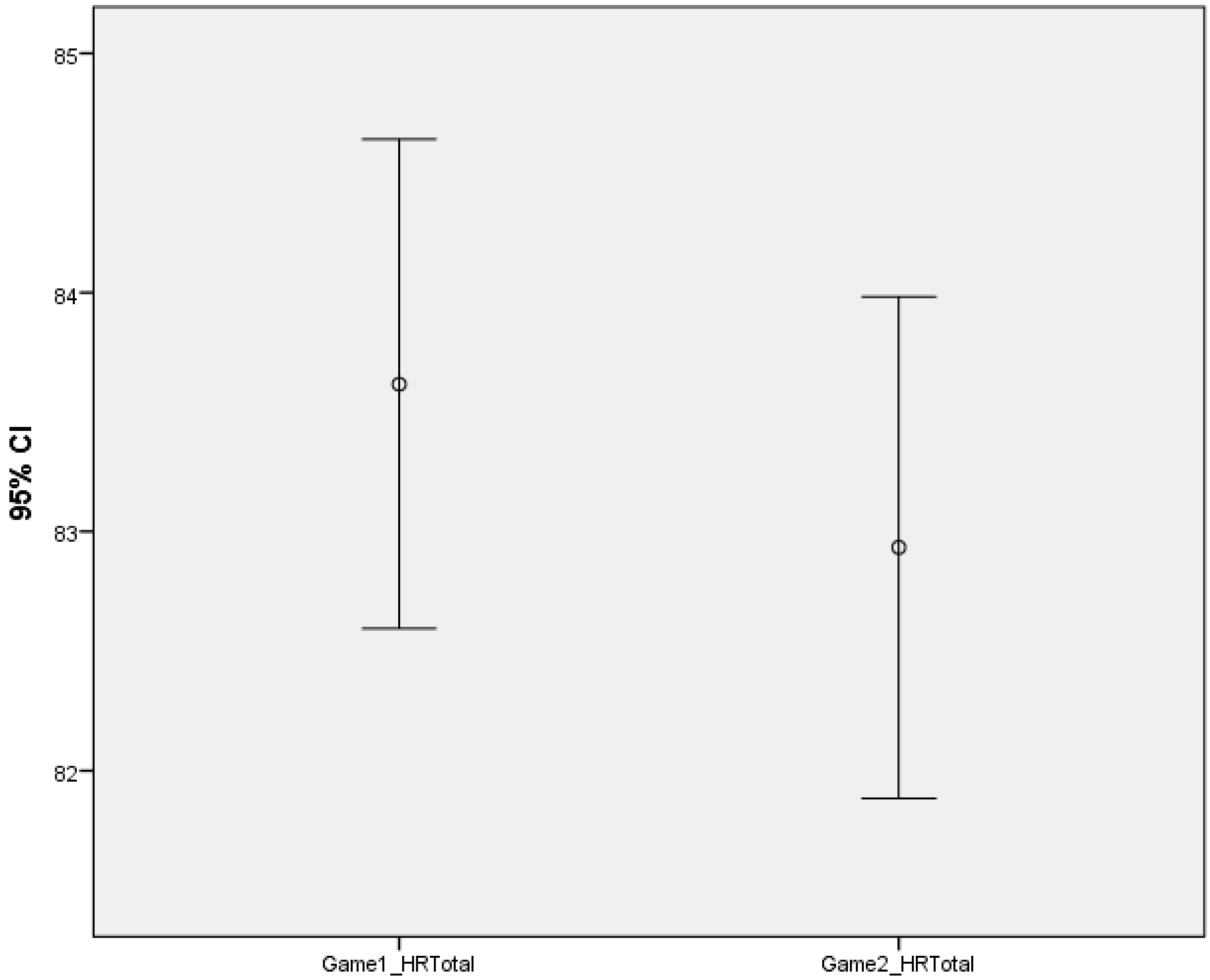
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
HR	Sphericity Assumed	28.017	1	28.017	4.008	.048	.033	4.008	.510
	Greenhouse-Geisser	28.017	1.000	28.017	4.008	.048	.033	4.008	.510
	Huynh-Feldt	28.017	1.000	28.017	4.008	.048	.033	4.008	.510
	Lower-bound	28.017	1.000	28.017	4.008	.048	.033	4.008	.510
Error(HR)	Sphericity Assumed	831.733	119	6.989					
	Greenhouse-Geisser	831.733	119.000	6.989					
	Huynh-Feldt	831.733	119.000	6.989					
	Lower-bound	831.733	119.000	6.989					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
RMSSD_Participant1	71.1833	17.11993	120
RMSSD_P1Game2	60.7833	19.40856	120

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
HRV	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: HRV

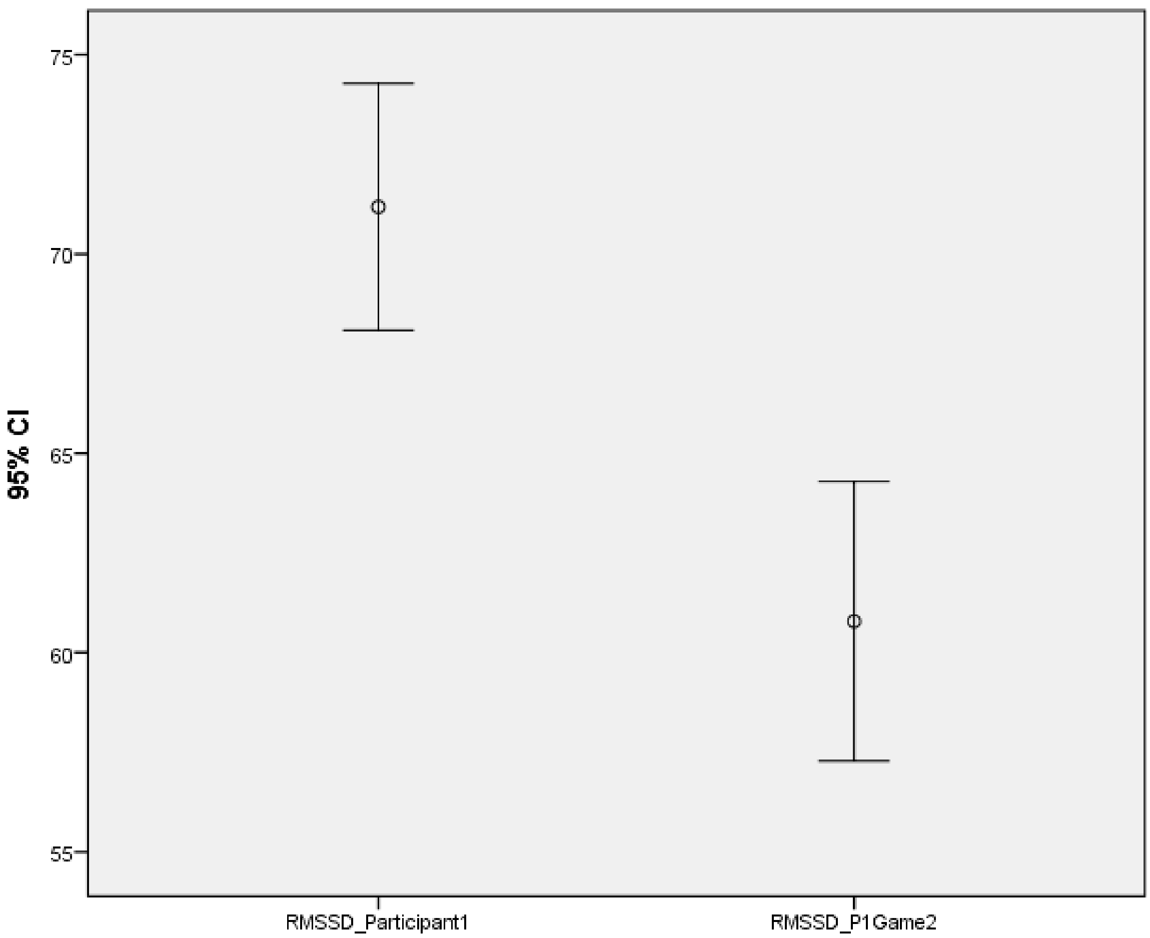
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
HRV	Sphericity Assumed	6489.600	1	6489.600	18.521	.000	.135	18.521	.990
	Greenhouse-Geisser	6489.600	1.000	6489.600	18.521	.000	.135	18.521	.990
	Huynh-Feldt	6489.600	1.000	6489.600	18.521	.000	.135	18.521	.990
	Lower-bound	6489.600	1.000	6489.600	18.521	.000	.135	18.521	.990
Error(HRV)	Sphericity Assumed	41697.400	119	350.398					
	Greenhouse-Geisser	41697.400	119.000	350.398					
	Huynh-Feldt	41697.400	119.000	350.398					
	Lower-bound	41697.400	119.000	350.398					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Alpha_Peak_TotalGame1	9.9571	.19183	12
Alpha_Peak_TotalGame2	10.0250	.22459	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Alpha	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Alpha

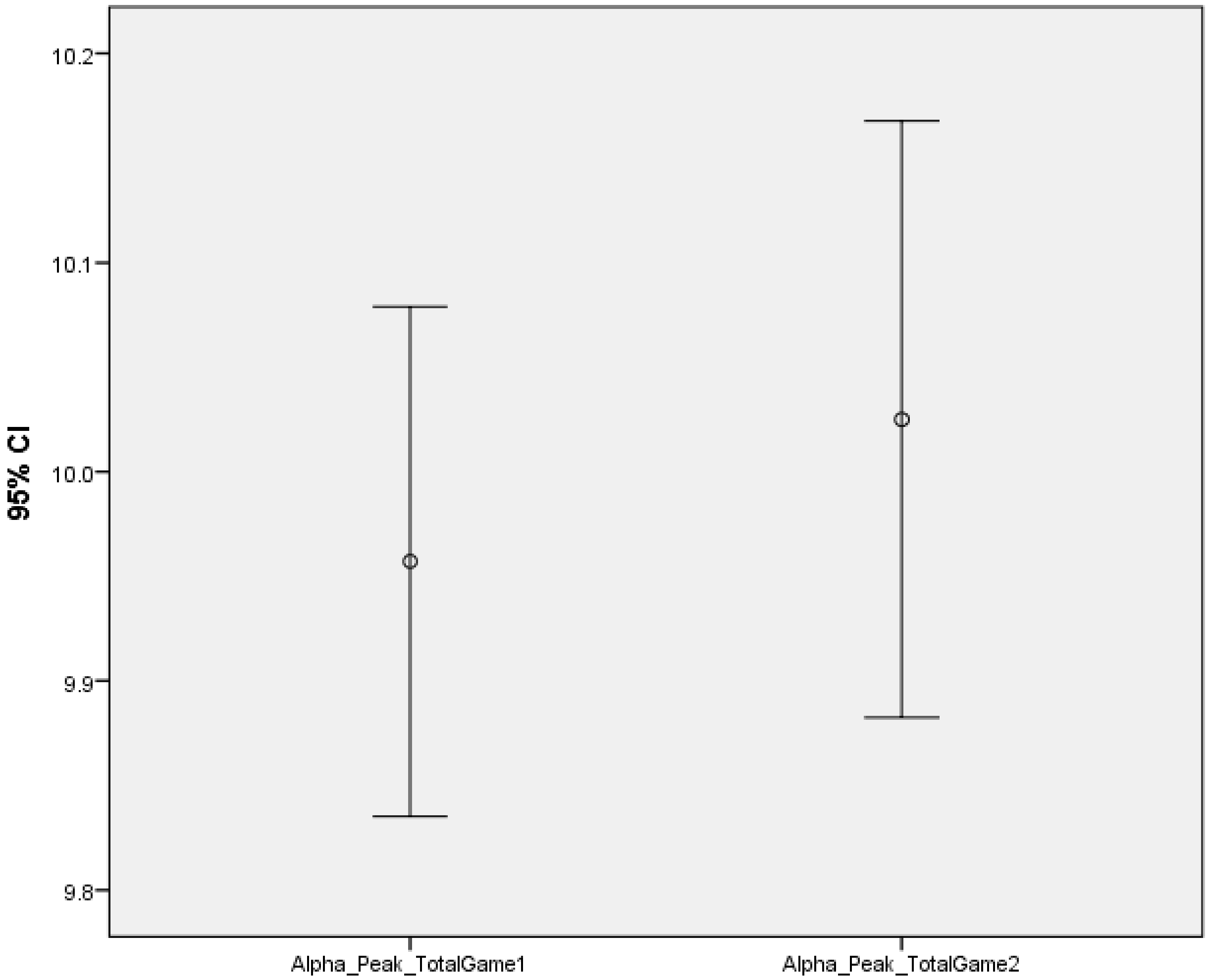
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Alpha	Sphericity Assumed	.028	1	.028	.583	.461	.050	.583	.108
	Greenhouse-Geisser	.028	1.000	.028	.583	.461	.050	.583	.108
	Huynh-Feldt	.028	1.000	.028	.583	.461	.050	.583	.108
	Lower-bound	.028	1.000	.028	.583	.461	.050	.583	.108
Error(Alpha)	Sphericity Assumed	.522	11	.047					
	Greenhouse-Geisser	.522	11.000	.047					
	Huynh-Feldt	.522	11.000	.047					
	Lower-bound	.522	11.000	.047					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Beta_Theta_Ratio_TotalGame1	.7433	.20090	12
Beta_Theta_Ratio_TotalGame2	.6838	.20637	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Epsilon[b] Huynh-Feldt	Epsilon[b] Lower-bound
Theta_Beta	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Theta_Beta

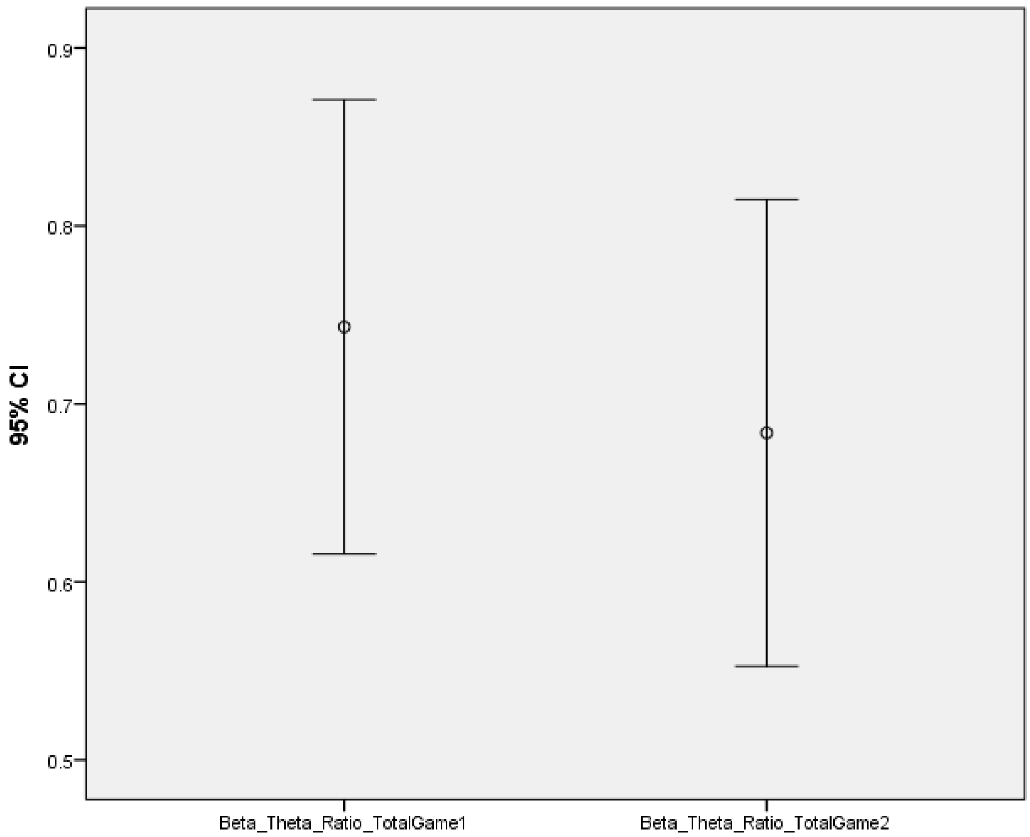
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Theta_Beta	Sphericity Assumed	.021	1	.021	1.018	.335	.085	1.018	.152
	Greenhouse-Geisser	.021	1.000	.021	1.018	.335	.085	1.018	.152
	Huynh-Feldt	.021	1.000	.021	1.018	.335	.085	1.018	.152
	Lower-bound	.021	1.000	.021	1.018	.335	.085	1.018	.152
Error(Theta_Beta)	Sphericity Assumed	.230	11	.021					
	Greenhouse-Geisser	.230	11.000	.021					
	Huynh-Feldt	.230	11.000	.021					
	Lower-bound	.230	11.000	.021					

a. Computed using alpha = .05



Appendices 2D

Channel Power SPSS Outputs; Fp1, Fp2, Fp7, F3, Fz, F4, F8, C3, Cz, C4, T3, T4, T5, T6, P3, Pz, P4, O1 and O2

Descriptive Statistics

	Mean	Std. Deviation	N
Channel_1_Game_1	-5663.6621	3017.78154	12
Channel_1_Game_2	-7339.6421	2064.68422	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_1	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_1

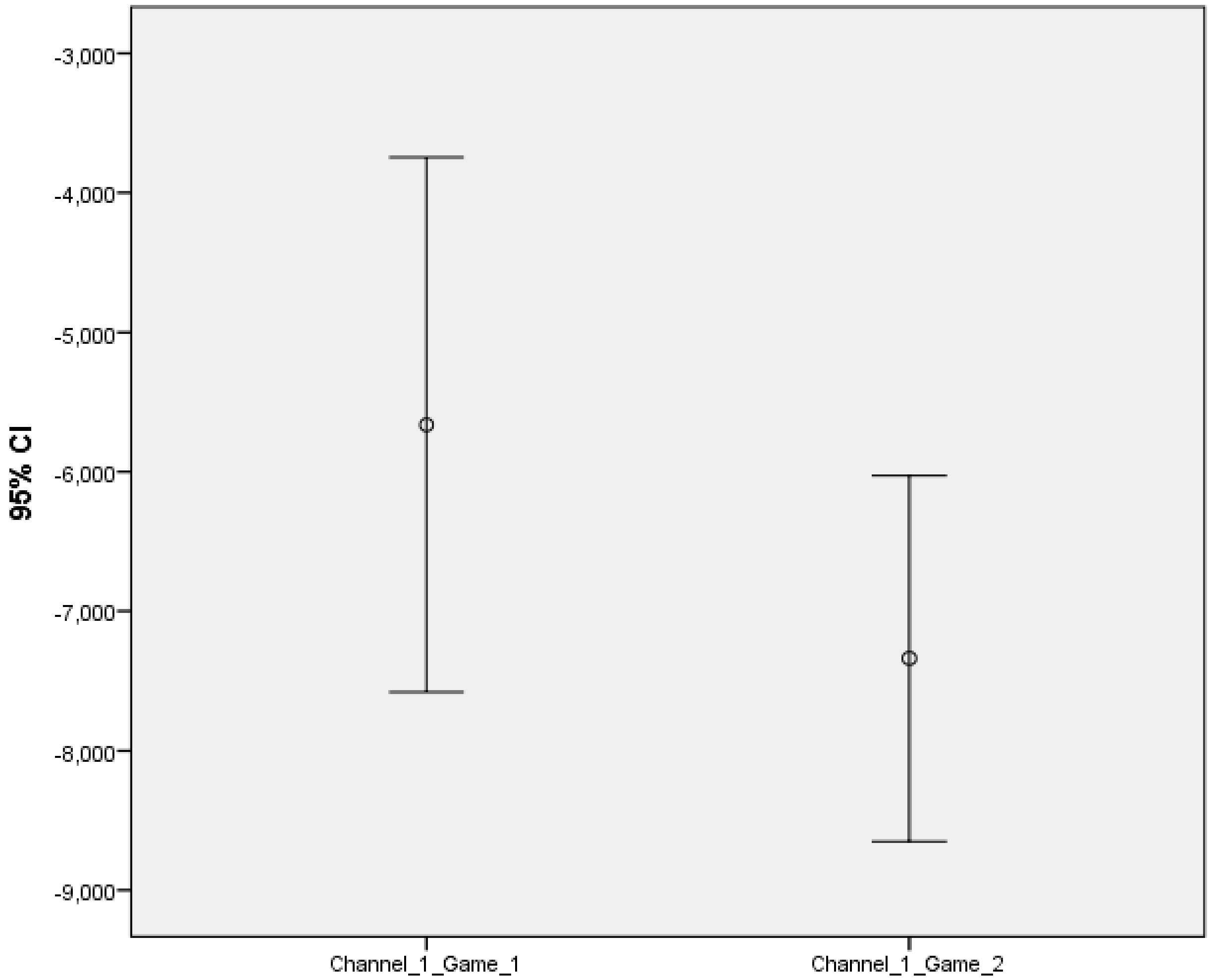
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_1	Sphericity Assumed	16853454.600	1	16853454.600	4.087	.068	.271	4.087	.454
	Greenhouse-Geisser	16853454.600	1.000	16853454.600	4.087	.068	.271	4.087	.454
	Huynh-Feldt	16853454.600	1.000	16853454.600	4.087	.068	.271	4.087	.454
	Lower-bound	16853454.600	1.000	16853454.600	4.087	.068	.271	4.087	.454
Error(Channel_1)	Sphericity Assumed	45355855.010	11	4123259.547					
	Greenhouse-Geisser	45355855.010	11.000	4123259.547					
	Huynh-Feldt	45355855.010	11.000	4123259.547					
	Lower-bound	45355855.010	11.000	4123259.547					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_2_Game_1	-5632.1577	3178.92781	12
Channel_2_Game_2	-7091.1638	2613.26935	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_2	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_2

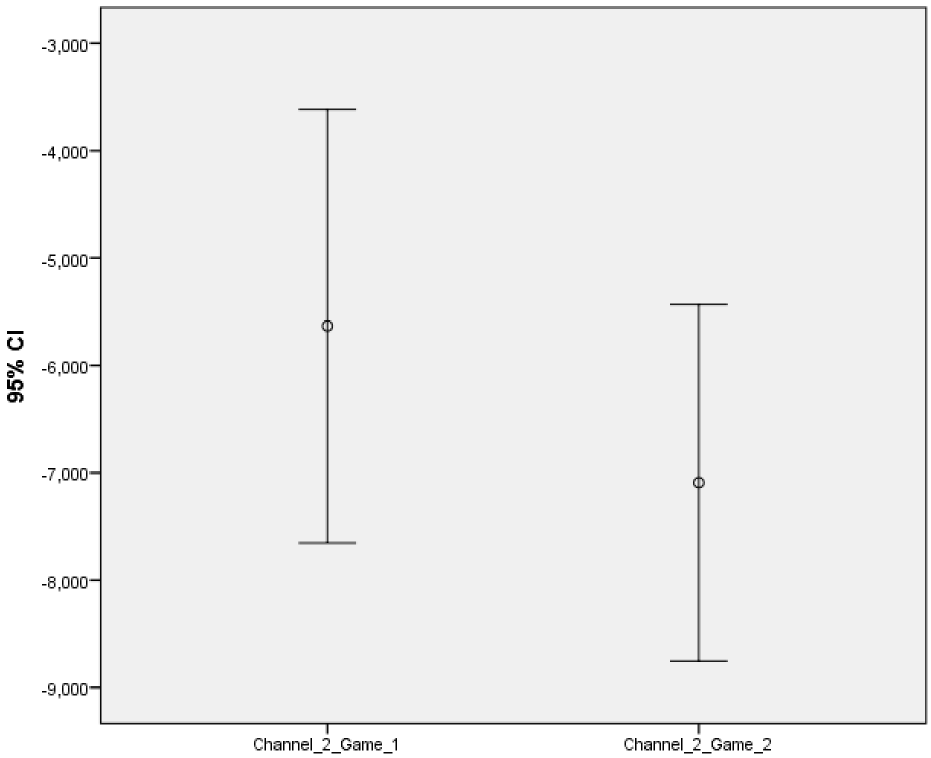
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_2	Sphericity Assumed	12772191.780	1	12772191.780	2.665	.131	.195	2.665	.320
	Greenhouse-Geisser	12772191.780	1.000	12772191.780	2.665	.131	.195	2.665	.320
	Huynh-Feldt	12772191.780	1.000	12772191.780	2.665	.131	.195	2.665	.320
	Lower-bound	12772191.780	1.000	12772191.780	2.665	.131	.195	2.665	.320
Error(Channel_2)	Sphericity Assumed	52722785.870	11	4792980.534					
	Greenhouse-Geisser	52722785.870	11.000	4792980.534					
	Huynh-Feldt	52722785.870	11.000	4792980.534					
	Lower-bound	52722785.870	11.000	4792980.534					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_3_Game_1	-5606.8451	2293.56286	12
Channel_3_Game_2	-5949.9387	1603.77411	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_3	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_3

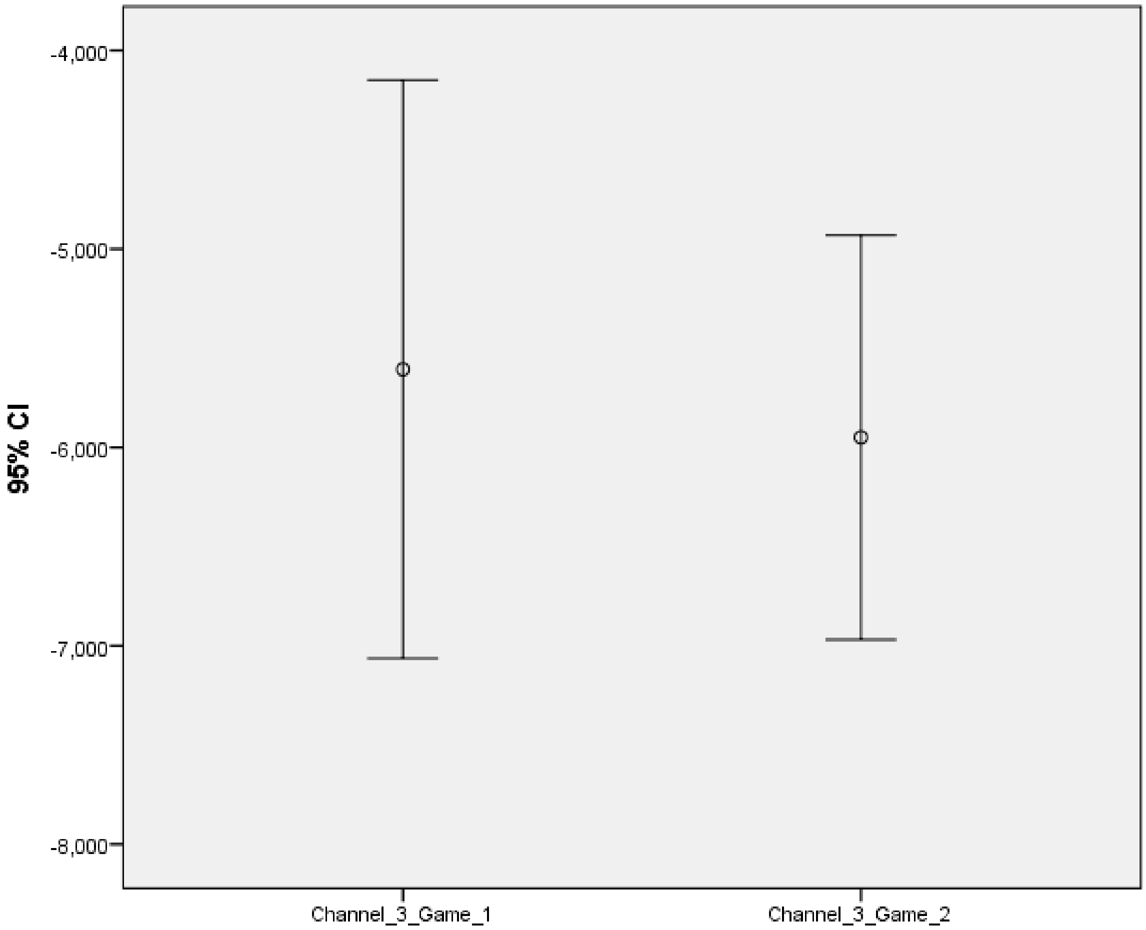
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_3	Sphericity Assumed	706279.207	1	706279.207	.332	.576	.029	.332	.082
	Greenhouse-Geisser	706279.207	1.000	706279.207	.332	.576	.029	.332	.082
	Huynh-Feldt	706279.207	1.000	706279.207	.332	.576	.029	.332	.082
	Lower-bound	706279.207	1.000	706279.207	.332	.576	.029	.332	.082
Error(Channel_3)	Sphericity Assumed	23379448.890	11	2125404.444					
	Greenhouse-Geisser	23379448.890	11.000	2125404.444					
	Huynh-Feldt	23379448.890	11.000	2125404.444					
	Lower-bound	23379448.890	11.000	2125404.444					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_4_Game_1	3149.7677	4775.48067	12
Channel_4_Game_2	2928.5019	5799.79404	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_4	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_4

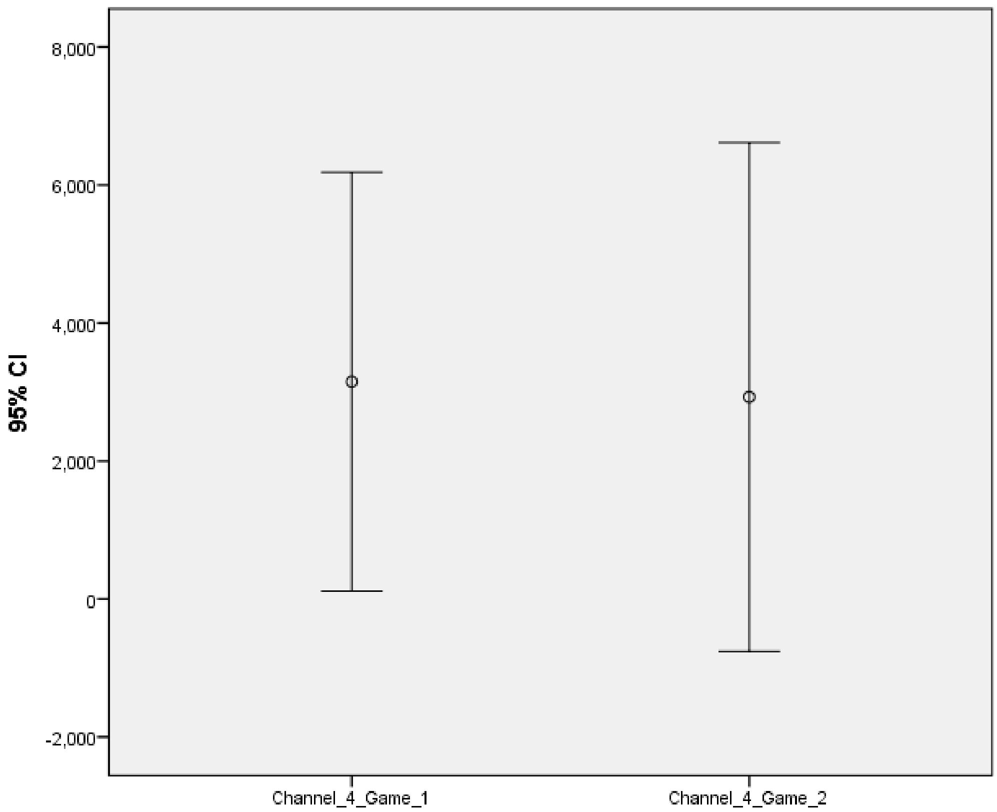
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_4	Sphericity Assumed	293751.414	1	293751.414	.036	.854	.003	.036	.053
	Greenhouse-Geisser	293751.414	1.000	293751.414	.036	.854	.003	.036	.053
	Huynh-Feldt	293751.414	1.000	293751.414	.036	.854	.003	.036	.053
	Lower-bound	293751.414	1.000	293751.414	.036	.854	.003	.036	.053
Error(Channel_4)	Sphericity Assumed	90630036.680	11	8239094.244					
	Greenhouse-Geisser	90630036.680	11.000	8239094.244					
	Huynh-Feldt	90630036.680	11.000	8239094.244					
	Lower-bound	90630036.680	11.000	8239094.244					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_5_Game_1	5178.5216	3084.91978	12
Channel_5_Game_2	5747.0610	3175.67566	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_5	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
 Within Subjects Design: Channel_5

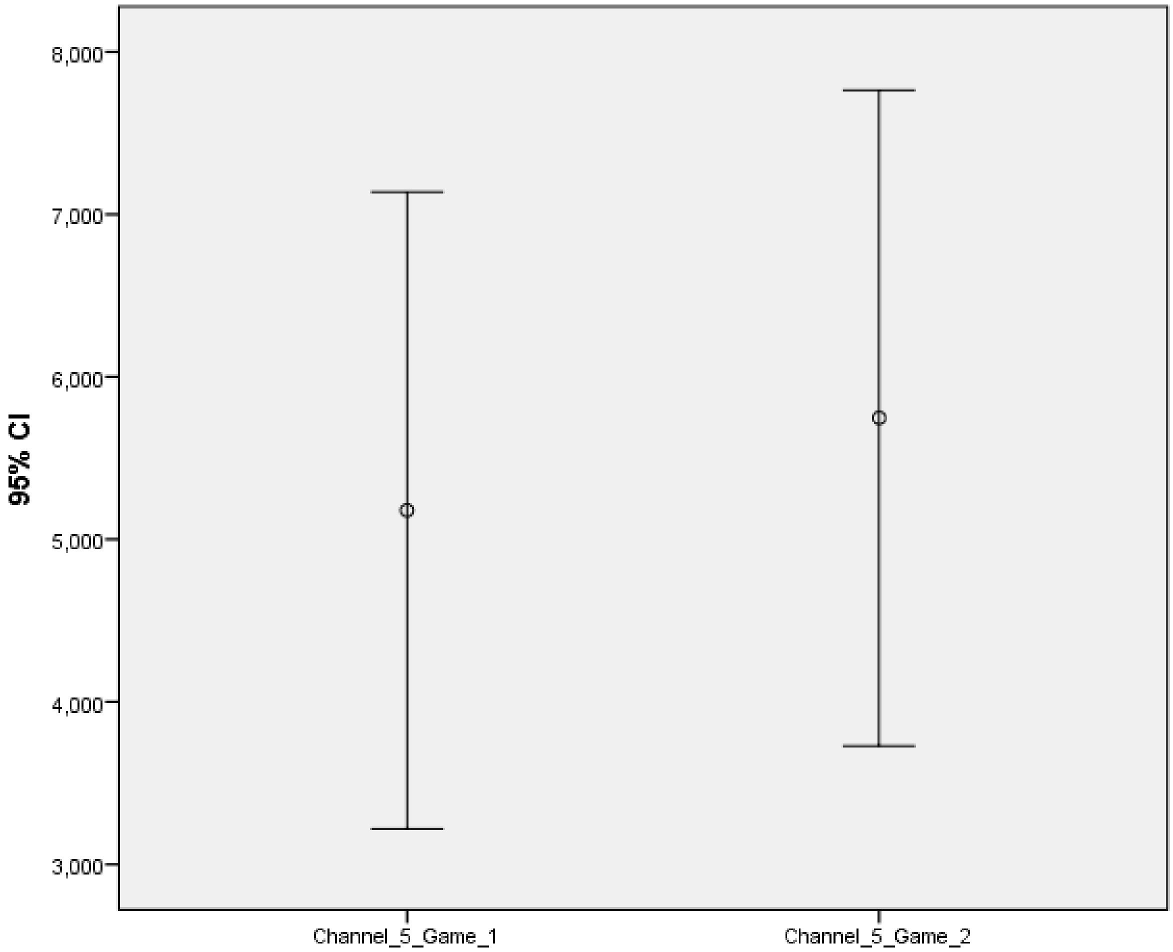
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_5	Sphericity Assumed	1939422.012	1	1939422.012	.176	.683	.016	.176	.067
	Greenhouse-Geisser	1939422.012	1.000	1939422.012	.176	.683	.016	.176	.067
	Huynh-Feldt	1939422.012	1.000	1939422.012	.176	.683	.016	.176	.067
	Lower-bound	1939422.012	1.000	1939422.012	.176	.683	.016	.176	.067
Error(Channel_5)	Sphericity Assumed	121149041.700	11	11013549.250					
	Greenhouse-Geisser	121149041.700	11.000	11013549.250					
	Huynh-Feldt	121149041.700	11.000	11013549.250					
	Lower-bound	121149041.700	11.000	11013549.250					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_6_Game_1	-224.9110	3224.41973	12
Channel_6_Game_2	341.1761	4668.82001	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_6	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_6

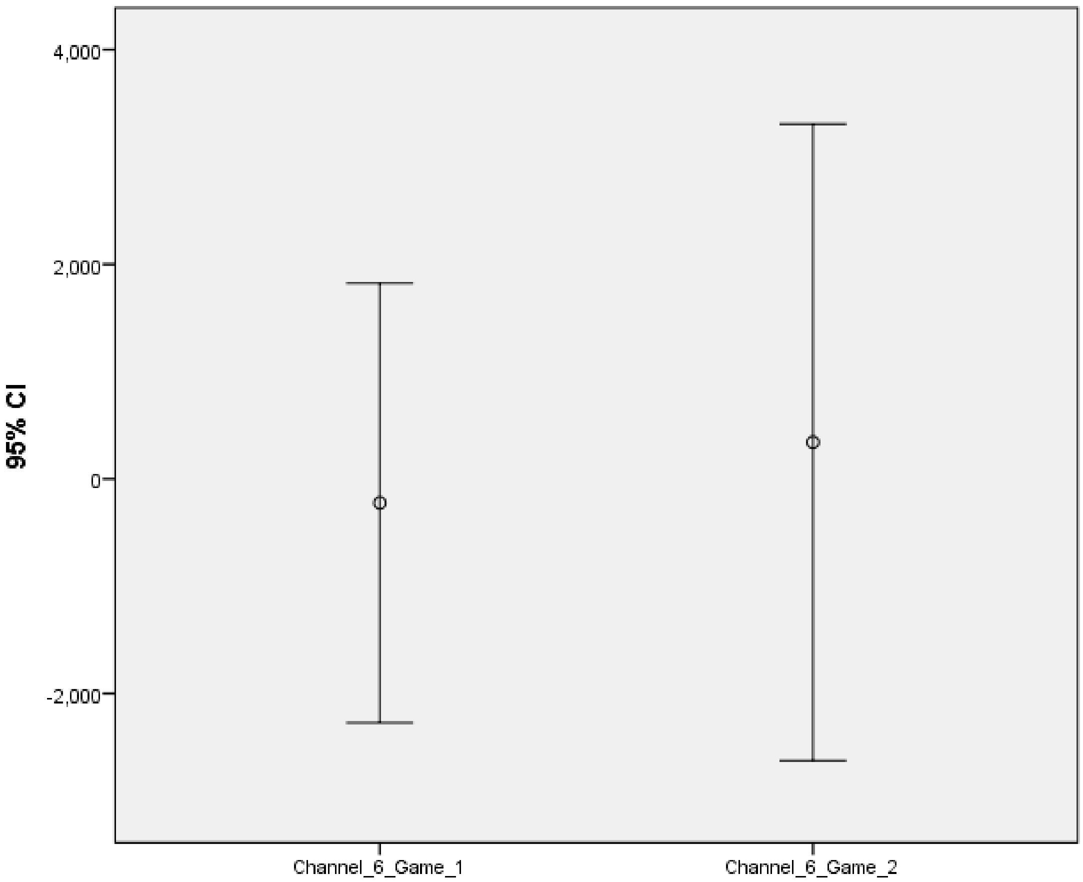
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_6	Sphericity Assumed	1922727.855	1	1922727.855	.182	.678	.016	.182	.068
	Greenhouse-Geisser	1922727.855	1.000	1922727.855	.182	.678	.016	.182	.068
	Huynh-Feldt	1922727.855	1.000	1922727.855	.182	.678	.016	.182	.068
	Lower-bound	1922727.855	1.000	1922727.855	.182	.678	.016	.182	.068
Error(Channel_6)	Sphericity Assumed	116058982.900	11	10550816.630					
	Greenhouse-Geisser	116058982.900	11.000	10550816.630					
	Huynh-Feldt	116058982.900	11.000	10550816.630					
	Lower-bound	116058982.900	11.000	10550816.630					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_7_Game_1	-6306.6931	2887.22137	12
Channel_7_Game_2	-7311.8263	1379.00364	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_7	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: Channel_7

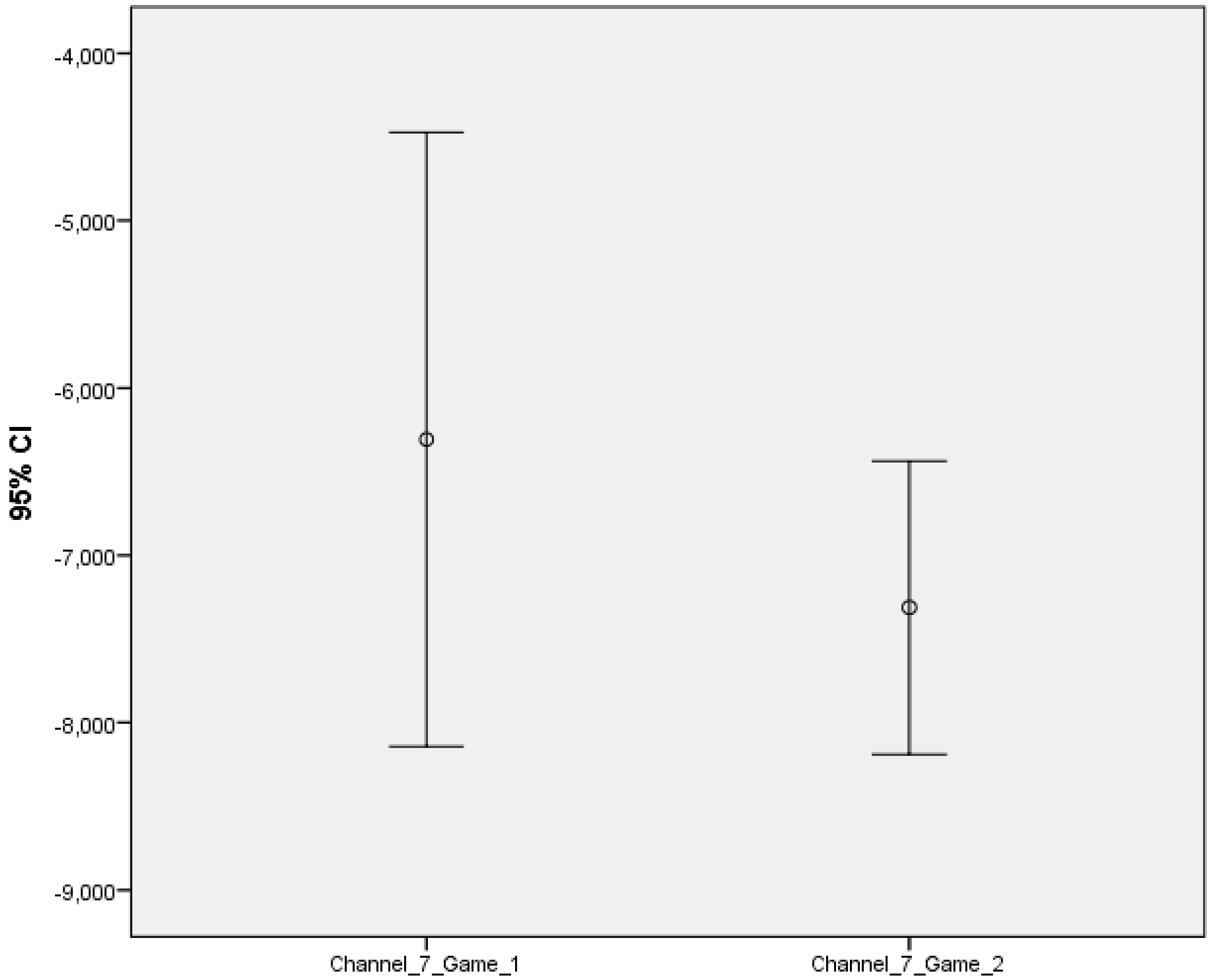
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_7	Sphericity Assumed	6061757.202	1	6061757.202	1.907	.195	.148	1.907	.243
	Greenhouse-Geisser	6061757.202	1.000	6061757.202	1.907	.195	.148	1.907	.243
	Huynh-Feldt	6061757.202	1.000	6061757.202	1.907	.195	.148	1.907	.243
	Lower-bound	6061757.202	1.000	6061757.202	1.907	.195	.148	1.907	.243
Error(Channel_7)	Sphericity Assumed	34965184.030	11	3178653.094					
	Greenhouse-Geisser	34965184.030	11.000	3178653.094					
	Huynh-Feldt	34965184.030	11.000	3178653.094					
	Lower-bound	34965184.030	11.000	3178653.094					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_9_Game_1	7019.3963	4069.86394	12
Channel_9_Game_2	6211.8036	4949.05627	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_9	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_9

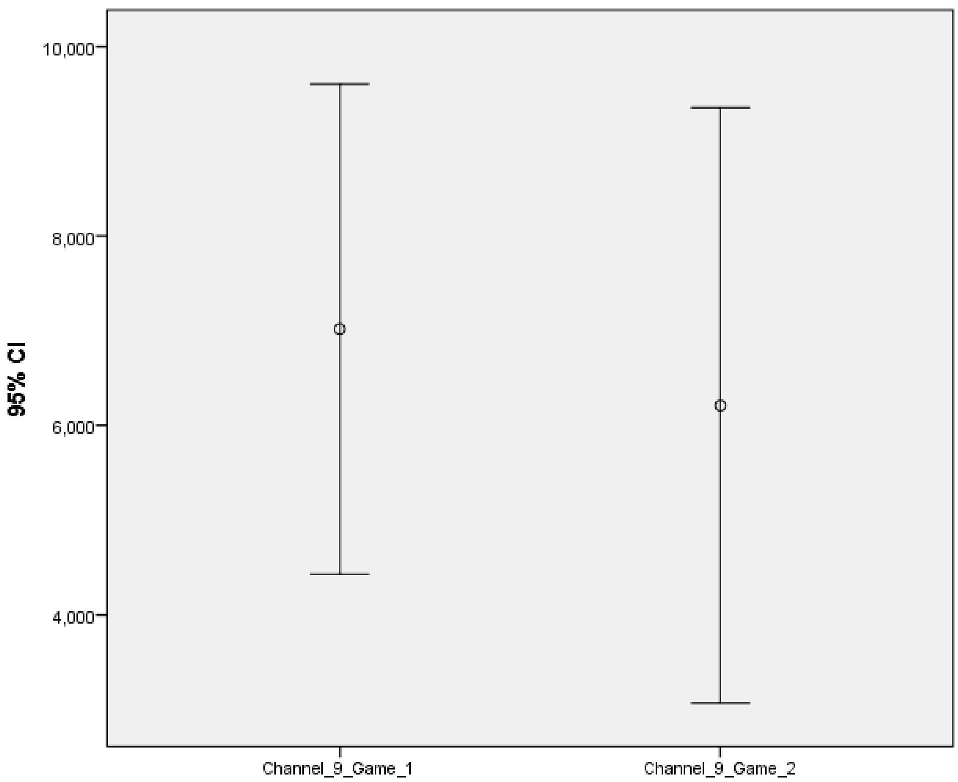
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_9	Sphericity Assumed	3913236.218	1	3913236.218	.491	.498	.043	.491	.098
	Greenhouse-Geisser	3913236.218	1.000	3913236.218	.491	.498	.043	.491	.098
	Huynh-Feldt	3913236.218	1.000	3913236.218	.491	.498	.043	.491	.098
	Lower-bound	3913236.218	1.000	3913236.218	.491	.498	.043	.491	.098
Error(Channel_9)	Sphericity Assumed	87619616.930	11	7965419.720					
	Greenhouse-Geisser	87619616.930	11.000	7965419.720					
	Huynh-Feldt	87619616.930	11.000	7965419.720					
	Lower-bound	87619616.930	11.000	7965419.720					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_10_Game_1	5844.2004	3425.89054	12
Channel_10_Game_2	6356.9473	3758.23555	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_10	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_10

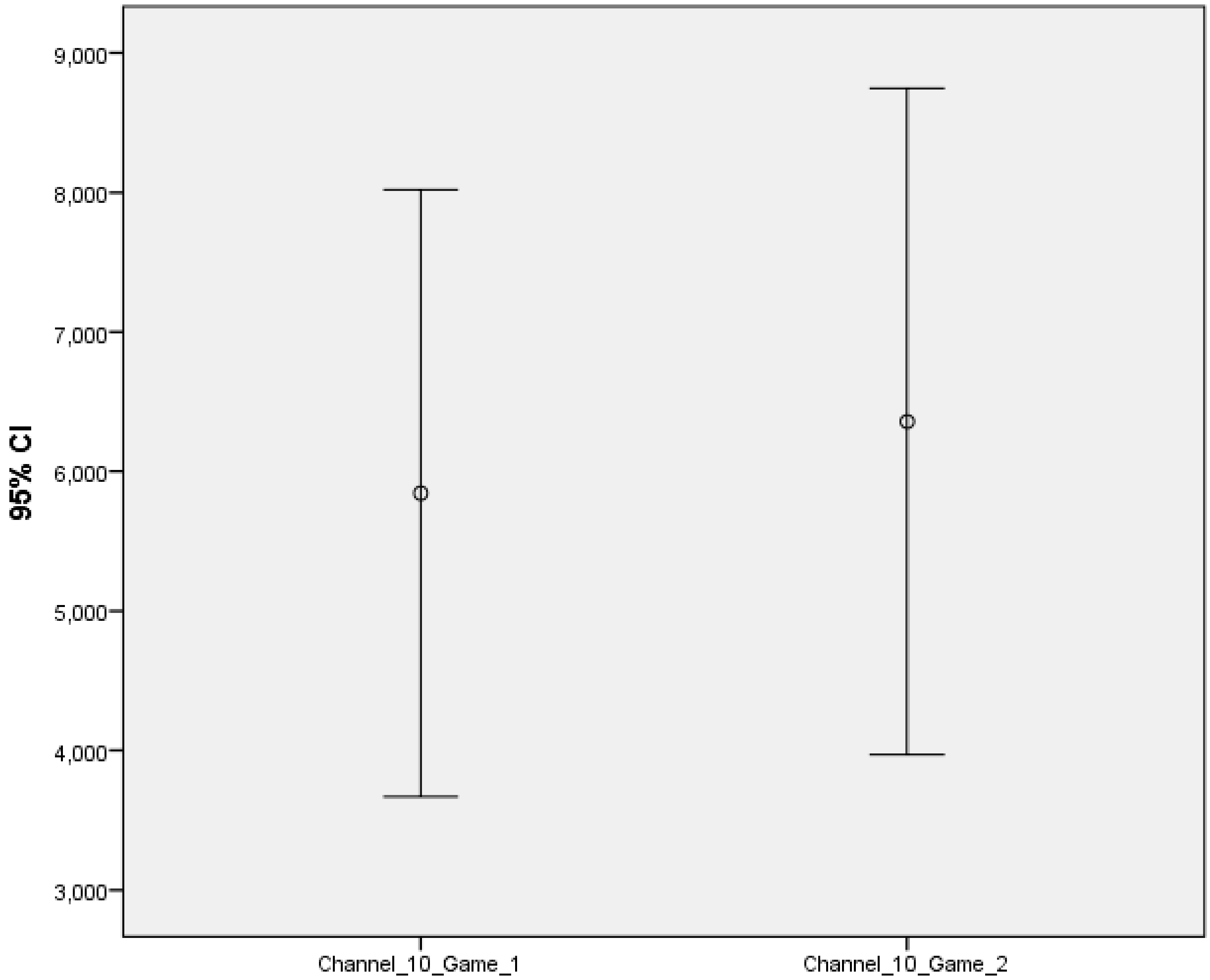
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_10	Sphericity Assumed	1577456.147	1	1577456.147	.091	.769	.008	.091	.059
	Greenhouse-Geisser	1577456.147	1.000	1577456.147	.091	.769	.008	.091	.059
	Huynh-Feldt	1577456.147	1.000	1577456.147	.091	.769	.008	.091	.059
	Lower-bound	1577456.147	1.000	1577456.147	.091	.769	.008	.091	.059
Error(Channel_10)	Sphericity Assumed	191483060.900	11	17407550.990					
	Greenhouse-Geisser	191483060.900	11.000	17407550.990					
	Huynh-Feldt	191483060.900	11.000	17407550.990					
	Lower-bound	191483060.900	11.000	17407550.990					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_11_Game_1	1122.7174	3487.13974	12
Channel_11_Game_2	3844.8717	3490.10434	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_11	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_11

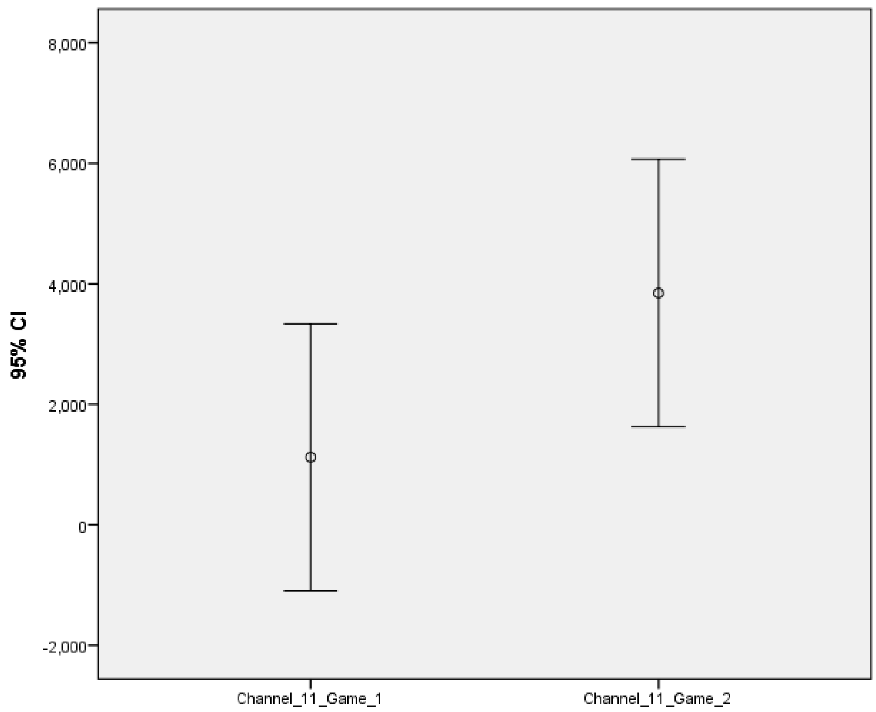
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_11	Sphericity Assumed	44460741.480	1	44460741.480	6.721	.025	.379	6.721	.656
	Greenhouse-Geisser	44460741.480	1.000	44460741.480	6.721	.025	.379	6.721	.656
	Huynh-Feldt	44460741.480	1.000	44460741.480	6.721	.025	.379	6.721	.656
	Lower-bound	44460741.480	1.000	44460741.480	6.721	.025	.379	6.721	.656
Error(Channel_11)	Sphericity Assumed	72772147.840	11	6615649.804					
	Greenhouse-Geisser	72772147.840	11.000	6615649.804					
	Huynh-Feldt	72772147.840	11.000	6615649.804					
	Lower-bound	72772147.840	11.000	6615649.804					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_8_Game_1	-6496.8682	2278.30101	12
Channel_8_Game_2	-6654.0232	1204.75707	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_8	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_8

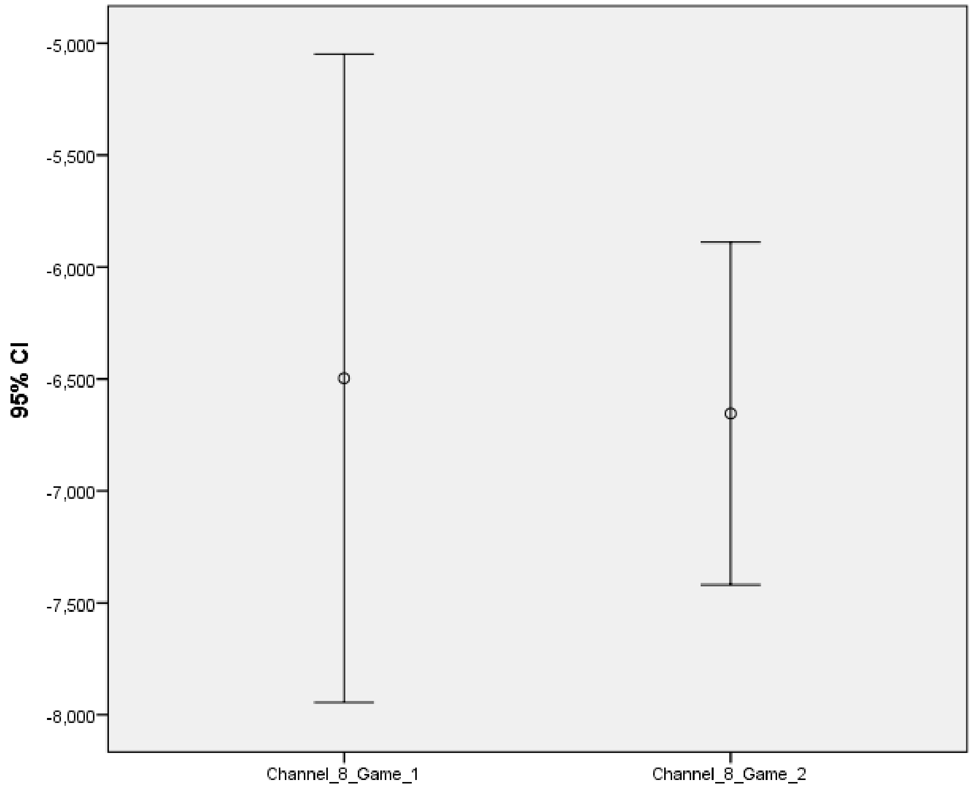
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_8	Sphericity Assumed	148186.101	1	148186.101	.070	.796	.006	.070	.057
	Greenhouse-Geisser	148186.101	1.000	148186.101	.070	.796	.006	.070	.057
	Huynh-Feldt	148186.101	1.000	148186.101	.070	.796	.006	.070	.057
	Lower-bound	148186.101	1.000	148186.101	.070	.796	.006	.070	.057
Error(Channel_8)	Sphericity Assumed	23174704.030	11	2106791.275					
	Greenhouse-Geisser	23174704.030	11.000	2106791.275					
	Huynh-Feldt	23174704.030	11.000	2106791.275					
	Lower-bound	23174704.030	11.000	2106791.275					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_12_Game_1	704.5966	2862.66164	12
Channel_12_Game_2	506.1842	4476.76459	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_12	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_12

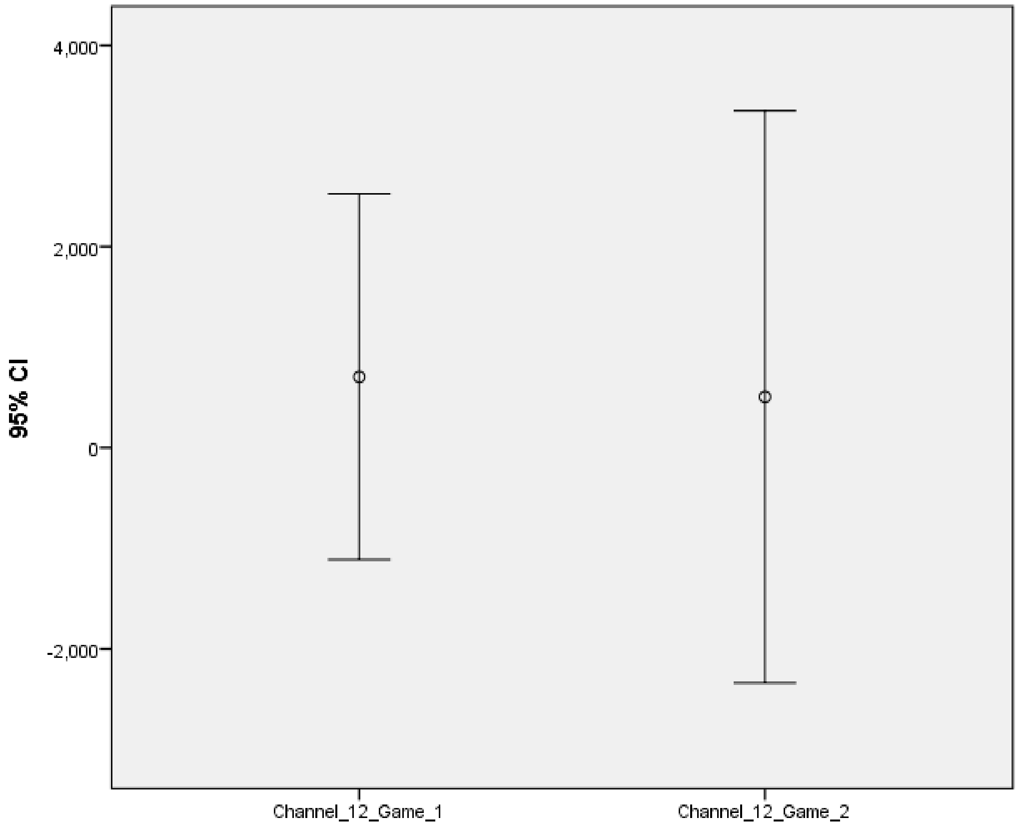
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_12	Sphericity Assumed	236204.942	1	236204.942	.056	.816	.005	.056	.055
	Greenhouse-Geisser	236204.942	1.000	236204.942	.056	.816	.005	.056	.055
	Huynh-Feldt	236204.942	1.000	236204.942	.056	.816	.005	.056	.055
	Lower-bound	236204.942	1.000	236204.942	.056	.816	.005	.056	.055
Error(Channel_12)	Sphericity Assumed	45987795.800	11	4180708.709					
	Greenhouse-Geisser	45987795.800	11.000	4180708.709					
	Huynh-Feldt	45987795.800	11.000	4180708.709					
	Lower-bound	45987795.800	11.000	4180708.709					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_13_Game_1	-3806.7711	2023.99196	12
Channel_13_Game_2	-3717.8229	2022.14287	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_13	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_13

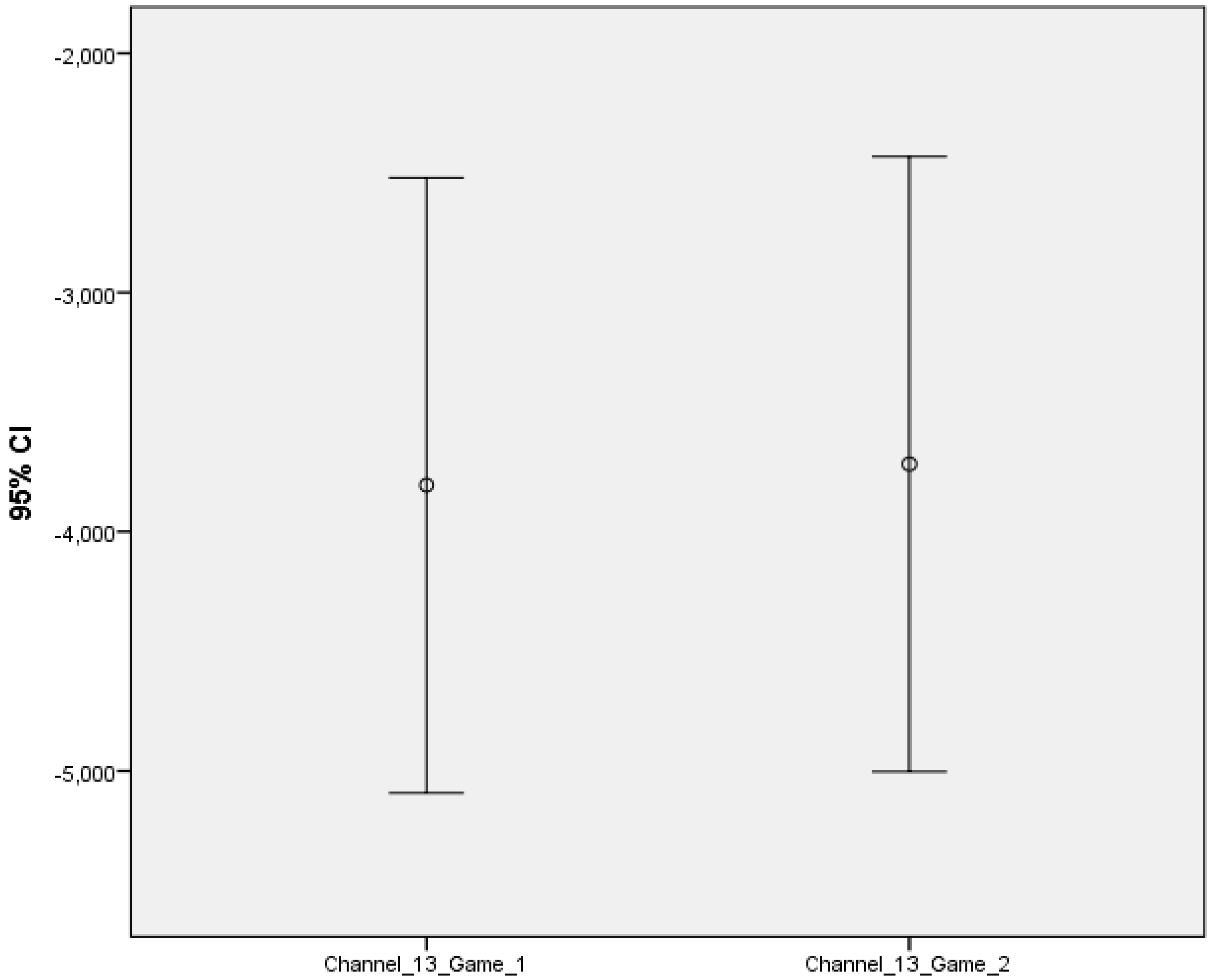
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_13	Sphericity Assumed	47470.711	1	47470.711	.013	.911	.001	.013	.051
	Greenhouse-Geisser	47470.711	1.000	47470.711	.013	.911	.001	.013	.051
	Huynh-Feldt	47470.711	1.000	47470.711	.013	.911	.001	.013	.051
	Lower-bound	47470.711	1.000	47470.711	.013	.911	.001	.013	.051
Error(Channel_13)	Sphericity Assumed	40182047.920	11	3652913.447					
	Greenhouse-Geisser	40182047.920	11.000	3652913.447					
	Huynh-Feldt	40182047.920	11.000	3652913.447					
	Lower-bound	40182047.920	11.000	3652913.447					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_17_Game_1	-4927.1924	5200.47489	12
Channel_17_Game_2	52.6855	9890.00422	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_17	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: Channel_17

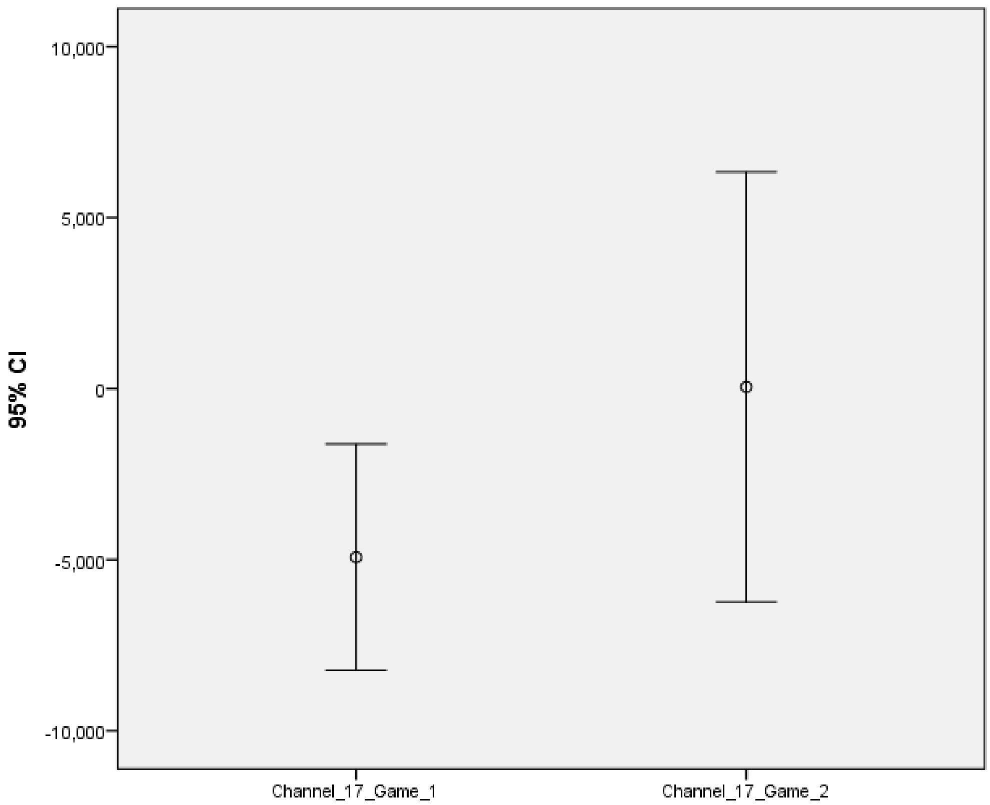
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_17	Sphericity Assumed	148795101.900	1	148795101.900	5.254	.043	.323	5.254	.552
	Greenhouse-Geisser	148795101.900	1.000	148795101.900	5.254	.043	.323	5.254	.552
	Huynh-Feldt	148795101.900	1.000	148795101.900	5.254	.043	.323	5.254	.552
	Lower-bound	148795101.900	1.000	148795101.900	5.254	.043	.323	5.254	.552
Error(Channel_17)	Sphericity Assumed	311521840.200	11	28320167.290					
	Greenhouse-Geisser	311521840.200	11.000	28320167.290					
	Huynh-Feldt	311521840.200	11.000	28320167.290					
	Lower-bound	311521840.200	11.000	28320167.290					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_14_Game_1	2984.4162	3267.83238	12
Channel_14_Game_2	3837.0070	4614.97334	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_14	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_14

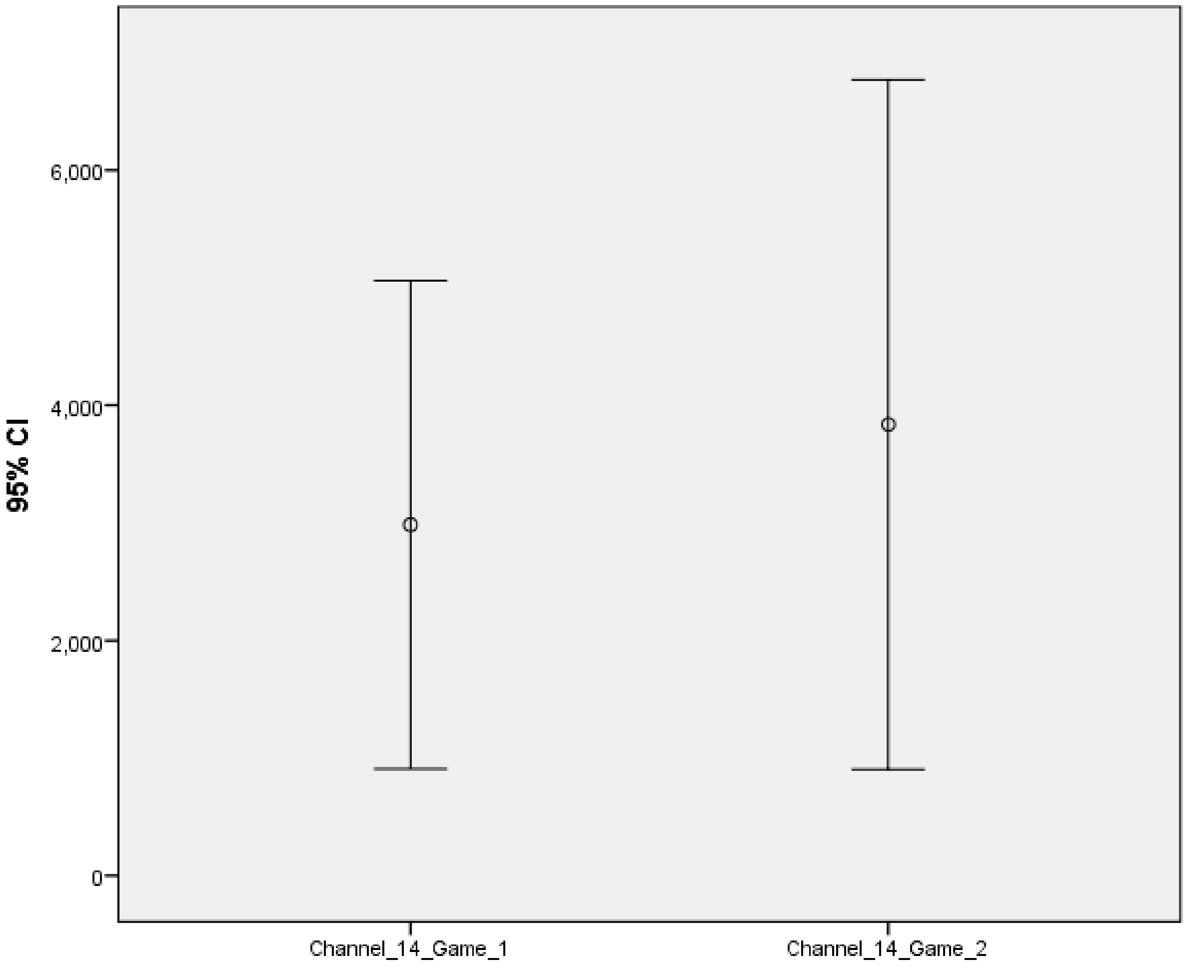
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_14	Sphericity Assumed	4361466.092	1	4361466.092	.209	.657	.019	.209	.070
	Greenhouse-Geisser	4361466.092	1.000	4361466.092	.209	.657	.019	.209	.070
	Huynh-Feldt	4361466.092	1.000	4361466.092	.209	.657	.019	.209	.070
	Lower-bound	4361466.092	1.000	4361466.092	.209	.657	.019	.209	.070
Error(Channel_14)	Sphericity Assumed	229753283.000	11	20886662.090					
	Greenhouse-Geisser	229753283.000	11.000	20886662.090					
	Huynh-Feldt	229753283.000	11.000	20886662.090					
	Lower-bound	229753283.000	11.000	20886662.090					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_15_Game_1	-827.2808	5294.97606	12
Channel_15_Game_2	1465.1432	5151.39902	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_15	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: Channel_15

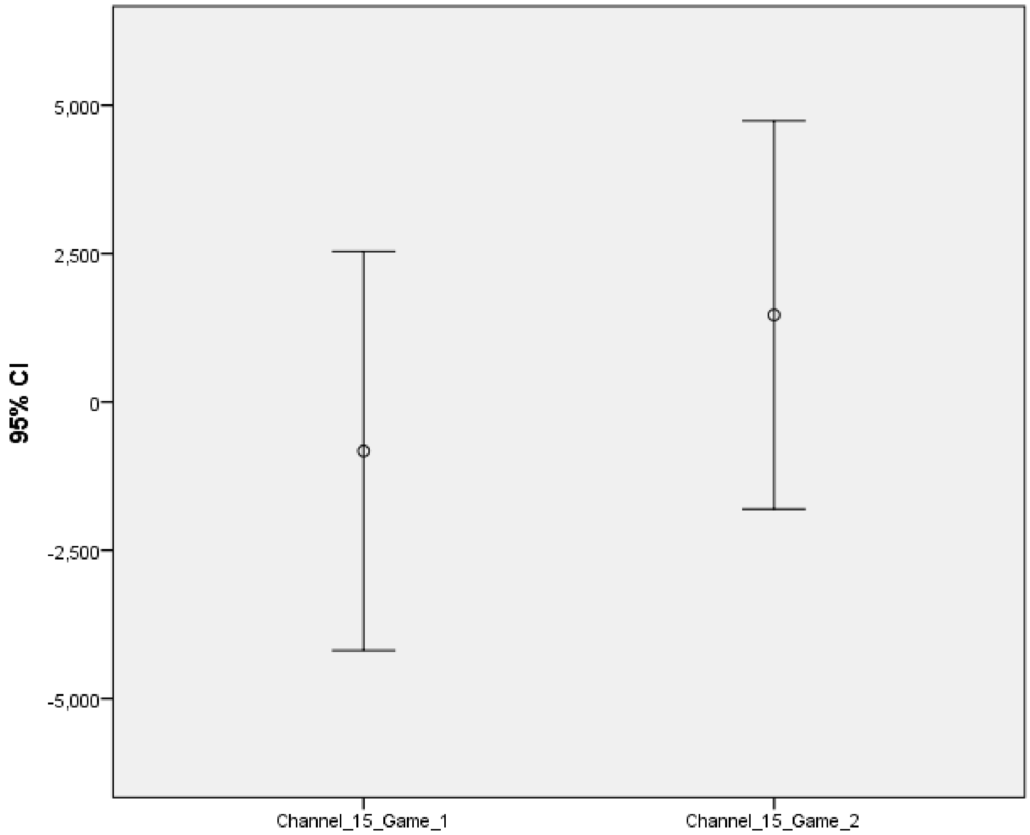
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_15	Sphericity Assumed	31531246.770	1	31531246.770	6.016	.032	.354	6.016	.609
	Greenhouse-Geisser	31531246.770	1.000	31531246.770	6.016	.032	.354	6.016	.609
	Huynh-Feldt	31531246.770	1.000	31531246.770	6.016	.032	.354	6.016	.609
	Lower-bound	31531246.770	1.000	31531246.770	6.016	.032	.354	6.016	.609
Error(Channel_15)	Sphericity Assumed	57649050.820	11	5240822.801					
	Greenhouse-Geisser	57649050.820	11.000	5240822.801					
	Huynh-Feldt	57649050.820	11.000	5240822.801					
	Lower-bound	57649050.820	11.000	5240822.801					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_16_Game_1	552.7596	6753.53770	12
Channel_16_Game_2	2533.1076	4916.76313	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_16	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_16

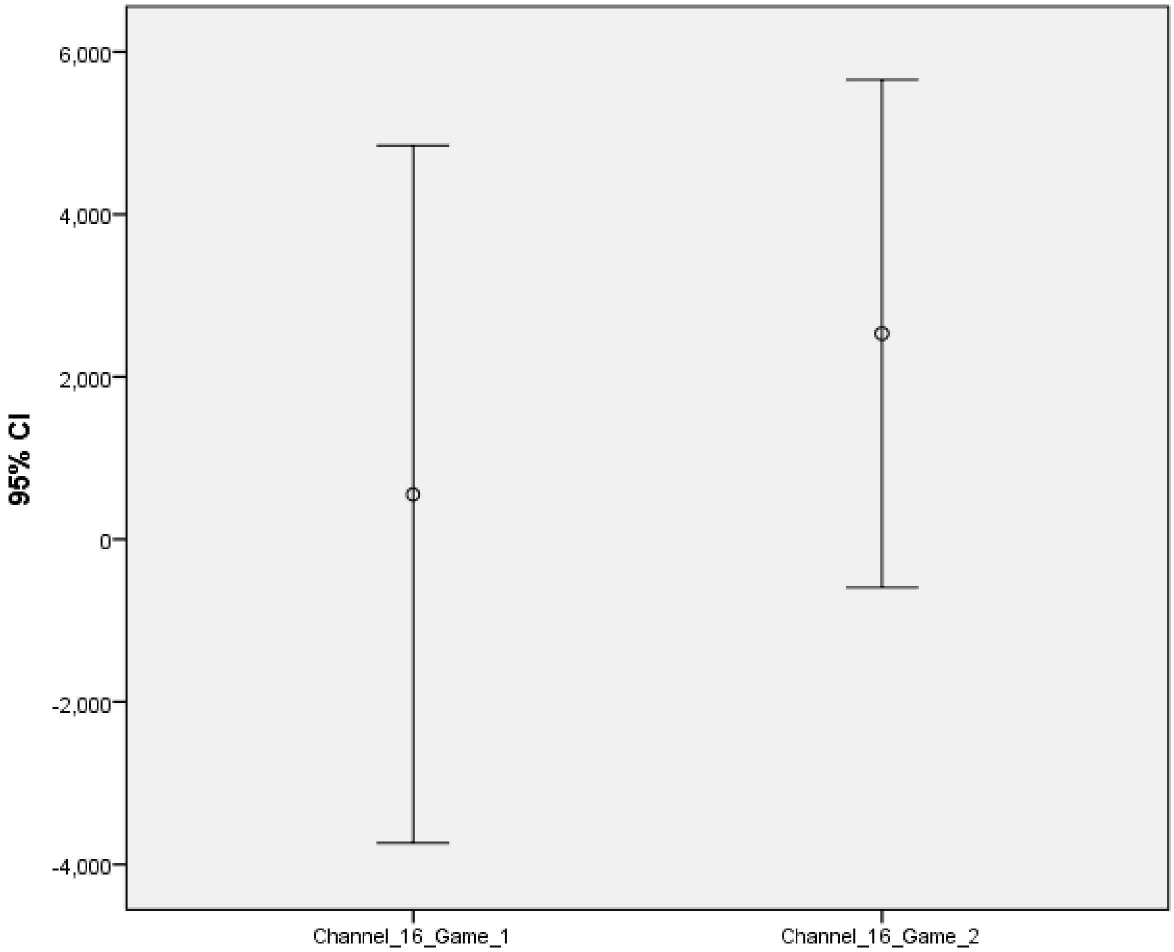
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_16	Sphericity Assumed	23530667.420	1	23530667.420	1.580	.235	.126	1.580	.210
	Greenhouse-Geisser	23530667.420	1.000	23530667.420	1.580	.235	.126	1.580	.210
	Huynh-Feldt	23530667.420	1.000	23530667.420	1.580	.235	.126	1.580	.210
	Lower-bound	23530667.420	1.000	23530667.420	1.580	.235	.126	1.580	.210
Error(Channel_16)	Sphericity Assumed	163852219.300	11	14895656.300					
	Greenhouse-Geisser	163852219.300	11.000	14895656.300					
	Huynh-Feldt	163852219.300	11.000	14895656.300					
	Lower-bound	163852219.300	11.000	14895656.300					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_18_Game_1	-252.4801	4273.55785	12
Channel_18_Game_2	1403.4253	4378.95728	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_18	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
 Within Subjects Design: Channel_18

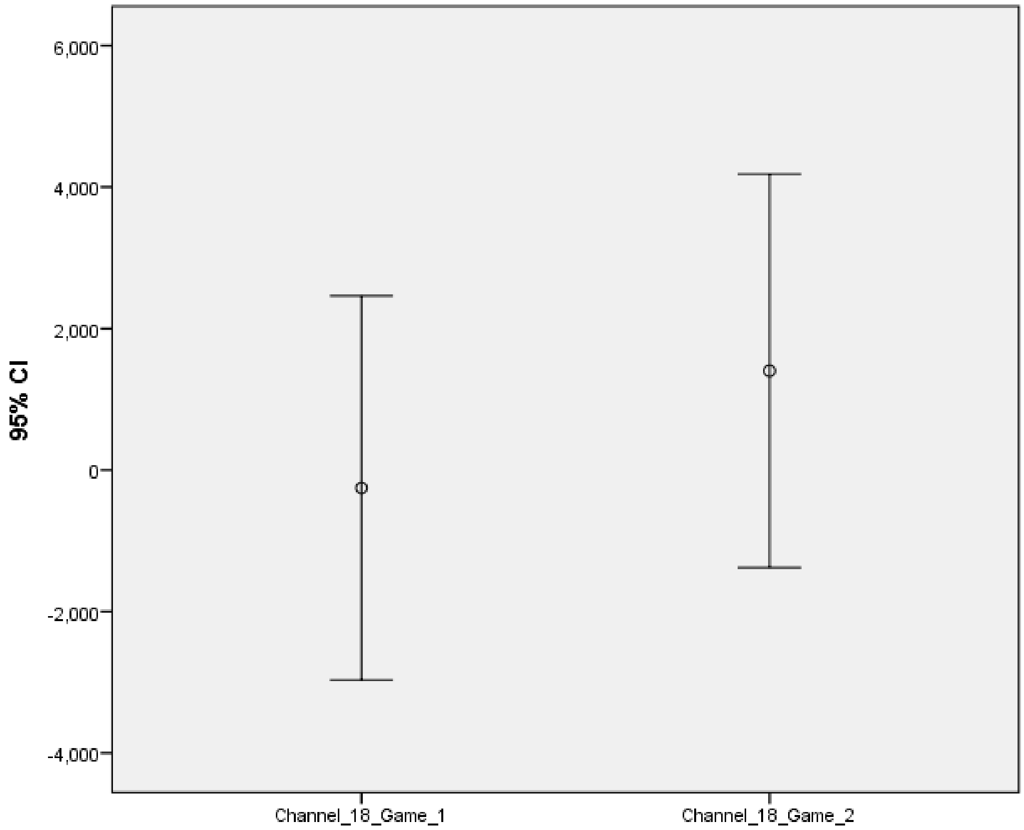
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_18	Sphericity Assumed	16452134.840	1	16452134.840	4.481	.058	.289	4.481	.489
	Greenhouse-Geisser	16452134.840	1.000	16452134.840	4.481	.058	.289	4.481	.489
	Huynh-Feldt	16452134.840	1.000	16452134.840	4.481	.058	.289	4.481	.489
	Lower-bound	16452134.840	1.000	16452134.840	4.481	.058	.289	4.481	.489
Error(Channel_18)	Sphericity Assumed	40386715.080	11	3671519.553					
	Greenhouse-Geisser	40386715.080	11.000	3671519.553					
	Huynh-Feldt	40386715.080	11.000	3671519.553					
	Lower-bound	40386715.080	11.000	3671519.553					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_19_Game_1	602.9006	5495.06633	12
Channel_19_Game_2	2335.7845	4687.47834	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_19	1.000	.000	0	.	1.000	1.000	1.000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_19

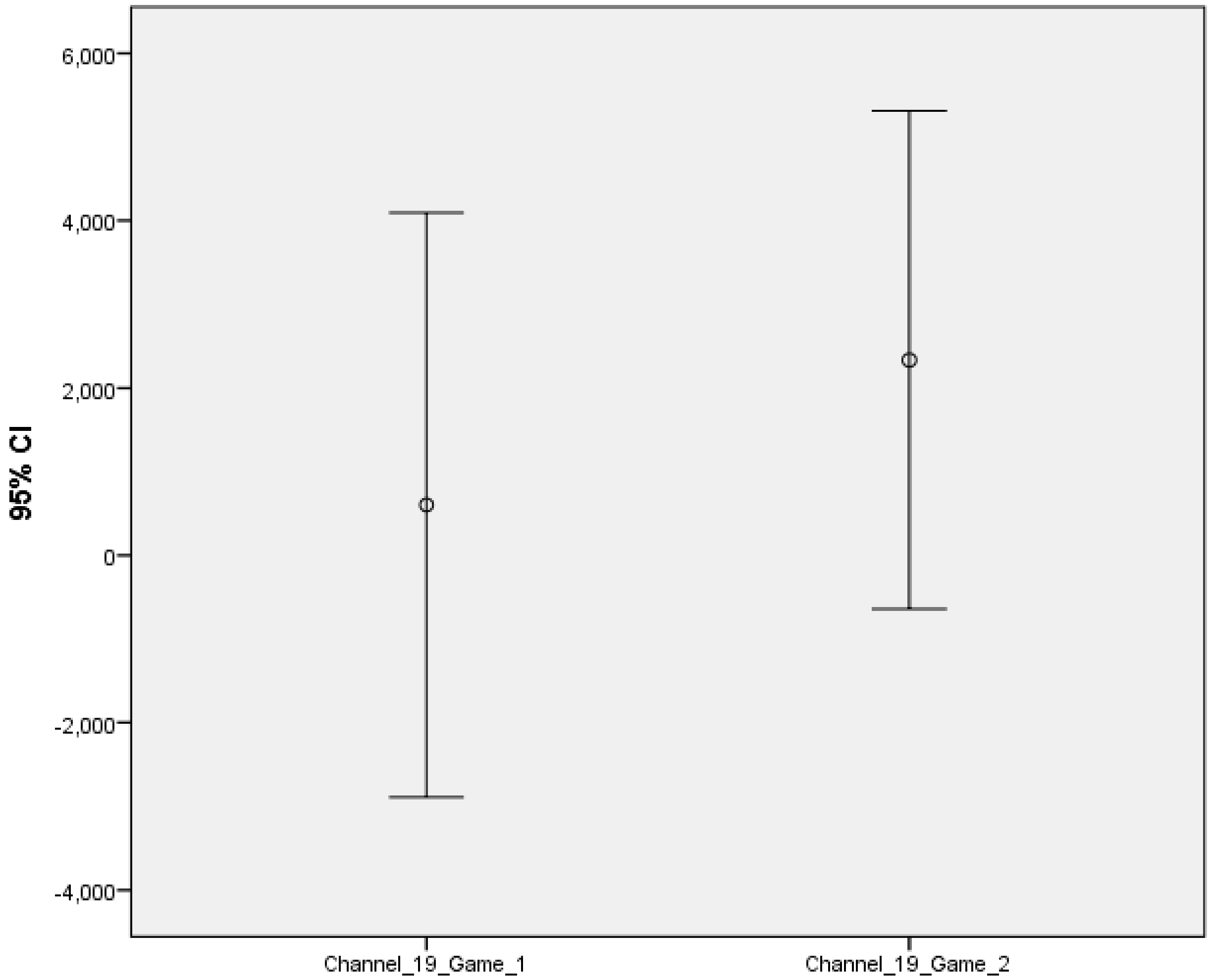
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_19	Sphericity Assumed	18017321.400	1	18017321.400	2.087	.176	.159	2.087	.262
	Greenhouse-Geisser	18017321.400	1.000	18017321.400	2.087	.176	.159	2.087	.262
	Huynh-Feldt	18017321.400	1.000	18017321.400	2.087	.176	.159	2.087	.262
	Lower-bound	18017321.400	1.000	18017321.400	2.087	.176	.159	2.087	.262
Error(Channel_19)	Sphericity Assumed	94964996.460	11	8633181.496					
	Greenhouse-Geisser	94964996.460	11.000	8633181.496					
	Huynh-Feldt	94964996.460	11.000	8633181.496					
	Lower-bound	94964996.460	11.000	8633181.496					

a. Computed using alpha = .05


6,000
4,000
2,000
0
-2,000
-4,000
95% CI
Channel_19_Game_1
Channel_19_Game_2

Appendix 3 – Results Study 2

Appendices 3A

Match Performance Data SPSS Outputs; Total Points, Goal Difference, Ball Possession and Number of Fouls

Descriptive Statistics

	Mean	Std. Deviation	N
Game_Points	1.6667	1.43548	12
Game2_Points	2.0000	1.27920	12
Game3_Points	2.0833	1.16450	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Points	.833	1.830	2	.401	.857	.999	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Points

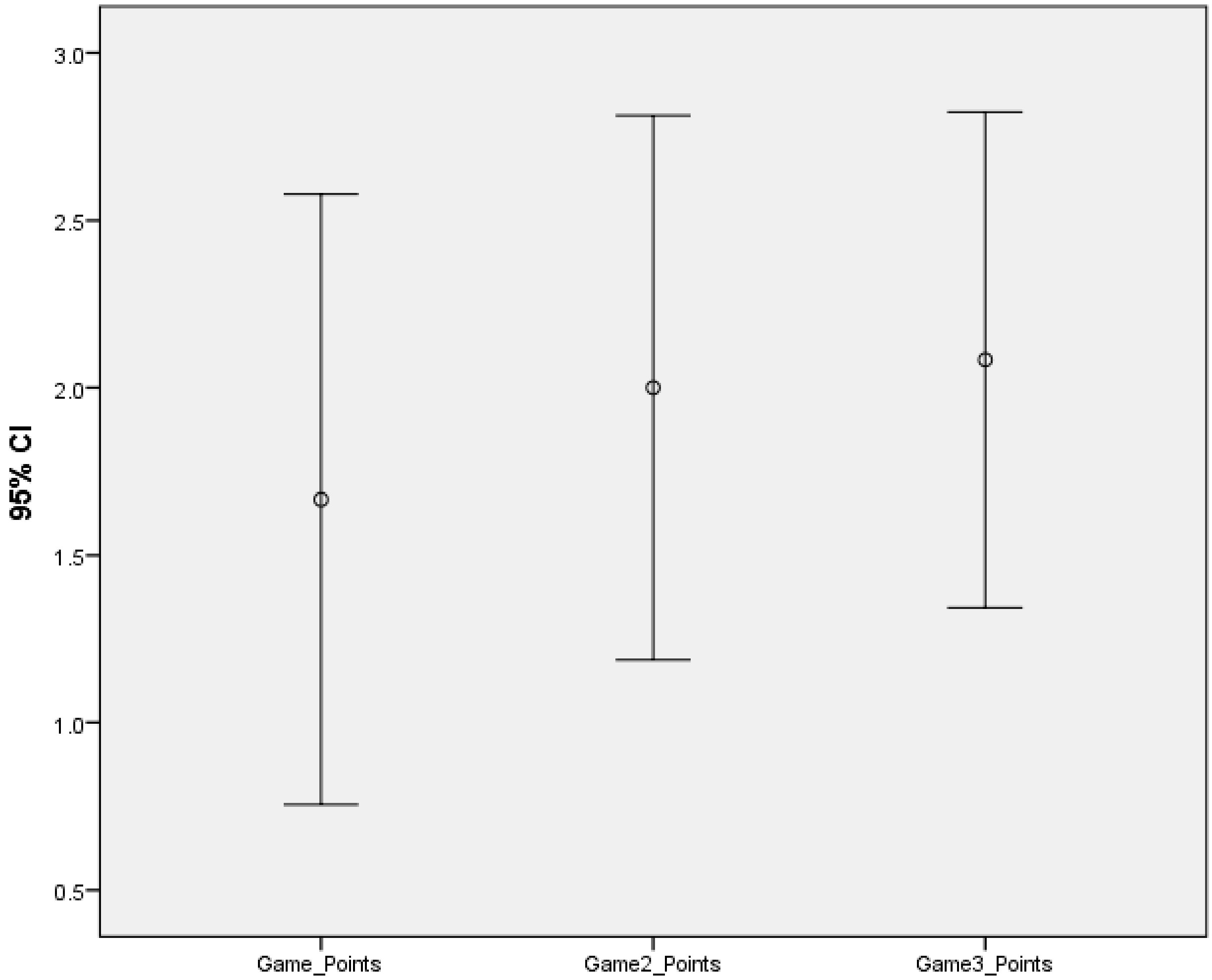
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Points	Sphericity Assumed	1.167	2	.583	.336	.718	.030	.672	.097
	Greenhouse-Geisser	1.167	1.713	.681	.336	.686	.030	.576	.093
	Huynh-Feldt	1.167	1.999	.584	.336	.718	.030	.672	.097
	Lower-bound	1.167	1.000	1.167	.336	.574	.030	.336	.083
Error(Points)	Sphericity Assumed	38.167	22	1.735					
	Greenhouse-Geisser	38.167	18.848	2.025					
	Huynh-Feldt	38.167	21.987	1.736					
	Lower-bound	38.167	11.000	3.470					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Game1_Goal_Diff	.6667	1.87487	12
Game2_Goal_Diff	.7500	1.21543	12
Game3_Goal_Diff	.9167	1.44338	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Goal_Diff	.832	1.840	2	.398	.856	.998	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Goal_Diff

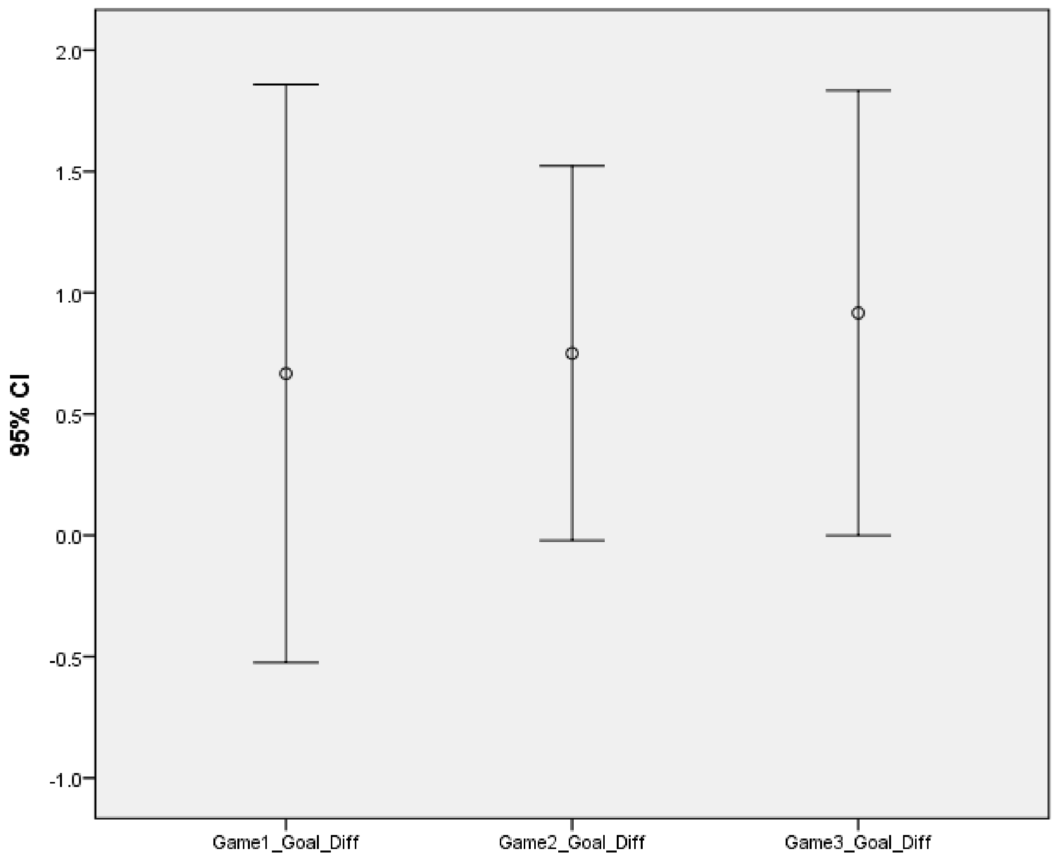
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Goal_Diff	Sphericity Assumed	.389	2	.194	.084	.920	.008	.168	.061
	Greenhouse-Geisser	.389	1.712	.227	.084	.894	.008	.144	.060
	Huynh-Feldt	.389	1.997	.195	.084	.920	.008	.168	.061
	Lower-bound	.389	1.000	.389	.084	.777	.008	.084	.058
Error(Goal_Diff)	Sphericity Assumed	50.944	22	2.316					
	Greenhouse-Geisser	50.944	18.834	2.705					
	Huynh-Feldt	50.944	21.966	2.319					
	Lower-bound	50.944	11.000	4.631					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Game1_Ball_Possesion	51.3333	1.89896	12
Game2_Ball_Possesion	52.0000	3.58659	12
Game3_Ball_Possesion	51.5417	3.18704	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Ball_Possesion	.927	.755	2	.686	.932	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: Ball_Possesion

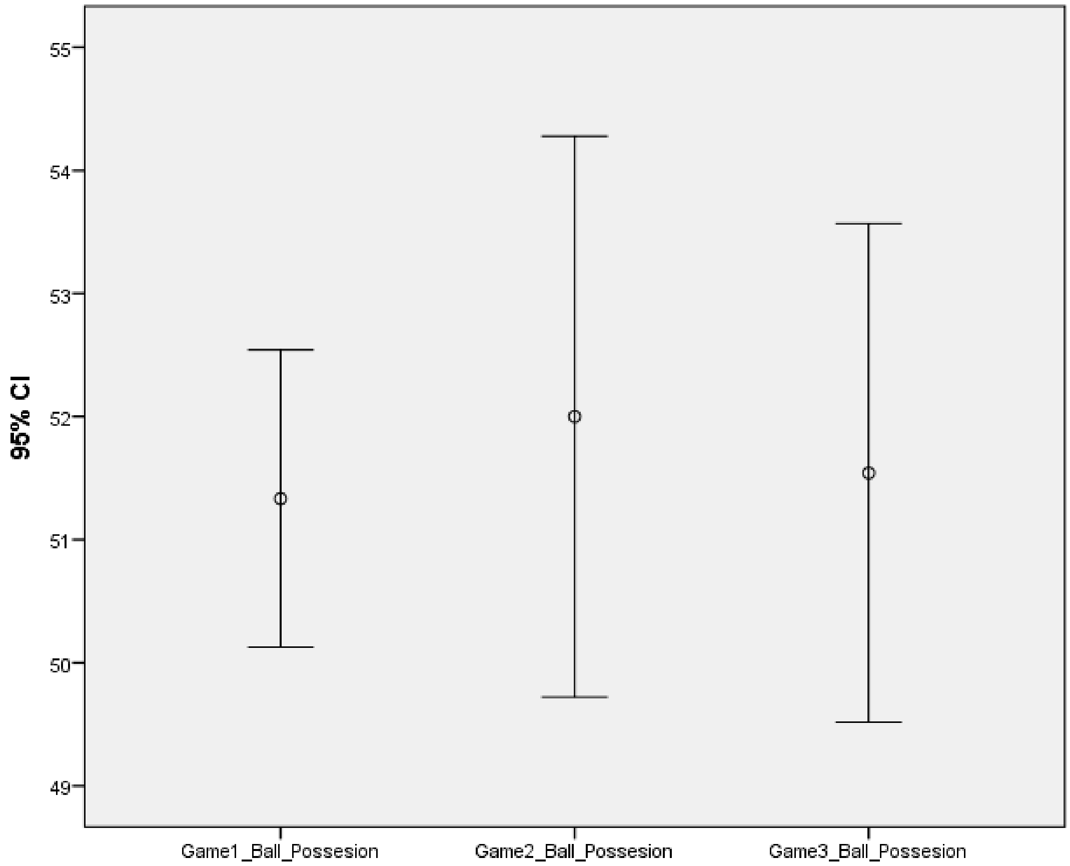
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Ball_Possesion	Sphericity Assumed	2.792	2	1.396	.185	.832	.017	.370	.075
	Greenhouse-Geisser	2.792	1.864	1.497	.185	.818	.017	.345	.074
	Huynh-Feldt	2.792	2.000	1.396	.185	.832	.017	.370	.075
	Lower-bound	2.792	1.000	2.792	.185	.675	.017	.185	.068
Error(Ball_Possesion)	Sphericity Assumed	166.042	22	7.547					
	Greenhouse-Geisser	166.042	20.509	8.096					
	Huynh-Feldt	166.042	22.000	7.547					
	Lower-bound	166.042	11.000	15.095					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Game1_Fouls	4.4167	1.78164	12
Game2_Fouls	8.3333	2.26969	12
Game3_Fouls	9.9167	2.39159	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Foul	.864	1.461	2	.482	.880	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
 Within Subjects Design: Foul

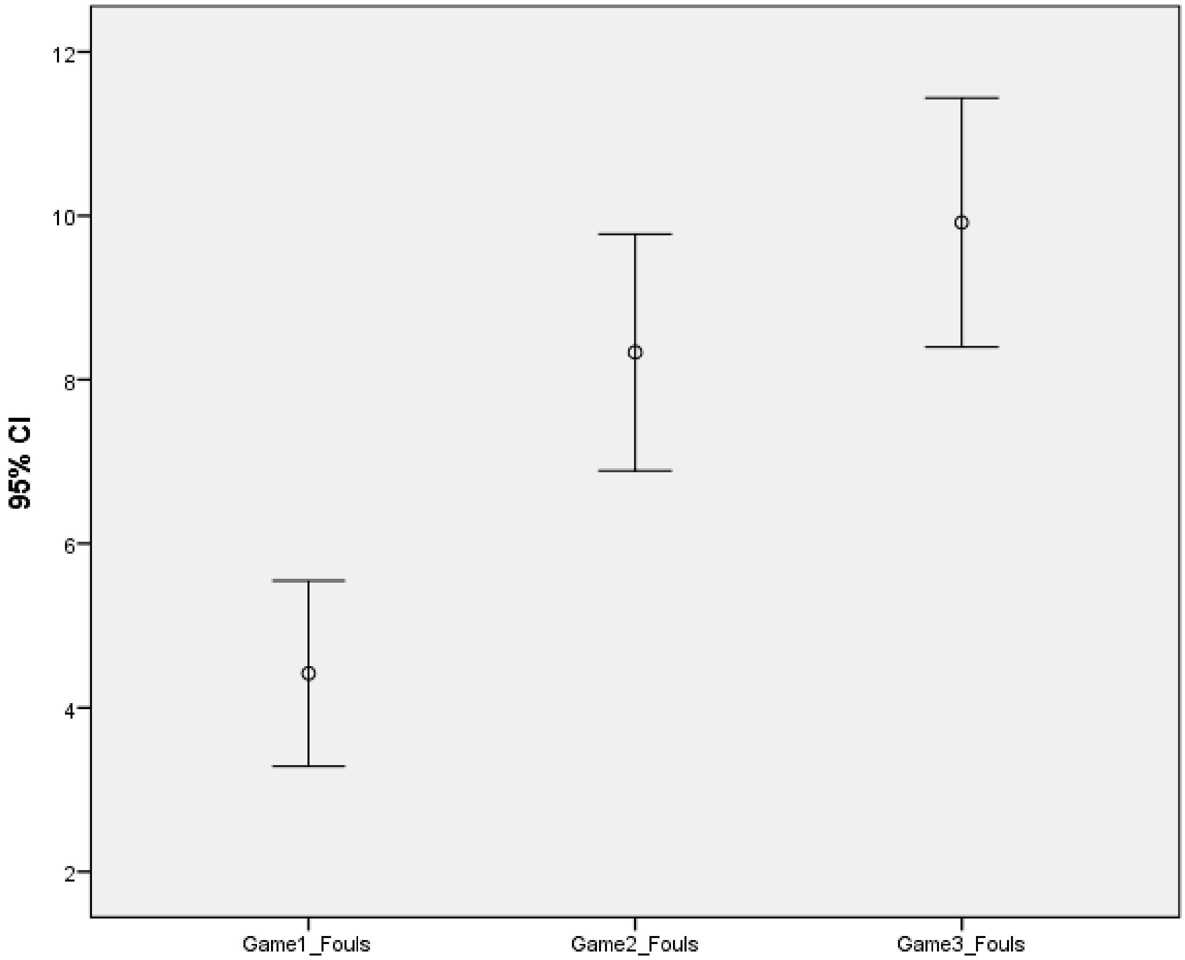
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Foul	Sphericity Assumed	192.389	2	96.194	18.411	.000	.626	36.823	1.000
	Greenhouse-Geisser	192.389	1.761	109.267	18.411	.000	.626	32.417	.999
	Huynh-Feldt	192.389	2.000	96.194	18.411	.000	.626	36.823	1.000
	Lower-bound	192.389	1.000	192.389	18.411	.001	.626	18.411	.973
Error(Foul)	Sphericity Assumed	114.944	22	5.225					
	Greenhouse-Geisser	114.944	19.368	5.935					
	Huynh-Feldt	114.944	22.000	5.225					
	Lower-bound	114.944	11.000	10.449					

a. Computed using alpha = .05



Appendices 3B

Subjective Self-report SPSS outputs; Arousal, Pleasantness, Attention Self-Efficacy, Others' Efficacy and Likability

Descriptive Statistics

	Mean	Std. Deviation	N
Arousal_Game1	7.8472	.96298	24
Arousal_Game2	7.7639	.81933	24
Arousal_Game3	7.6806	.92980	24

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Epsilon[b] Huynh-Feldt	Epsilon[b] Lower-bound
Arousal	.945	1.251	2	.535	.948	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: Arousal

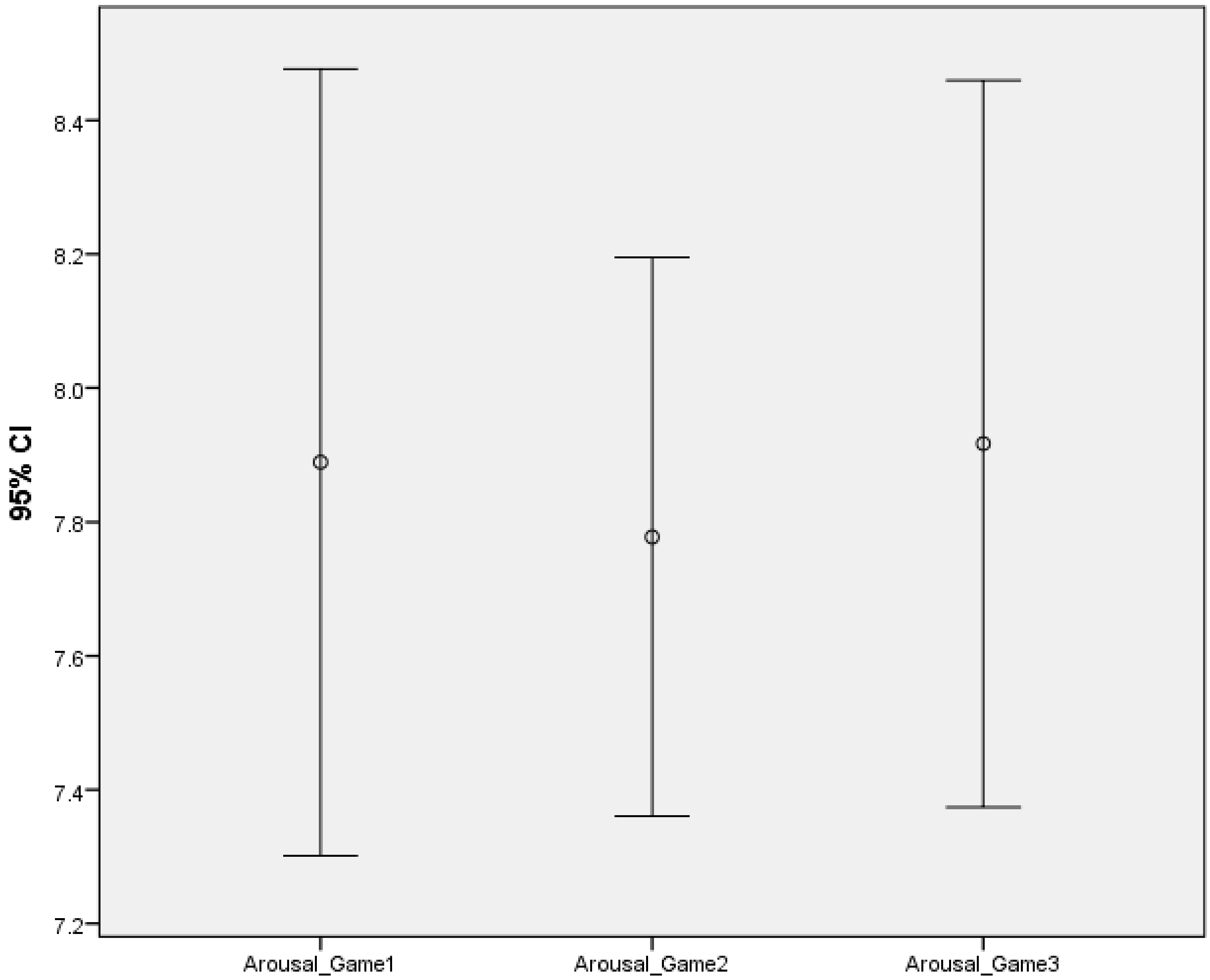
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Arousal	Sphericity Assumed	.333	2	.167	.232	.794	.010	.465	.084
	Greenhouse-Geisser	.333	1.895	.176	.232	.782	.010	.440	.083
	Huynh-Feldt	.333	2.000	.167	.232	.794	.010	.465	.084
	Lower-bound	.333	1.000	.333	.232	.634	.010	.232	.075
Error(Arousal)	Sphericity Assumed	33.000	46	.717					
	Greenhouse-Geisser	33.000	43.591	.757					
	Huynh-Feldt	33.000	46.000	.717					
	Lower-bound	33.000	23.000	1.435					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Pleasantness_Game1	7.9583	.92372	24
Pleasantness_Game2	7.6667	.81650	24
Pleasantness_Game3	8.0000	.80458	24

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Pleasantness	.954	1.028	2	.598	.956	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Pleasantness

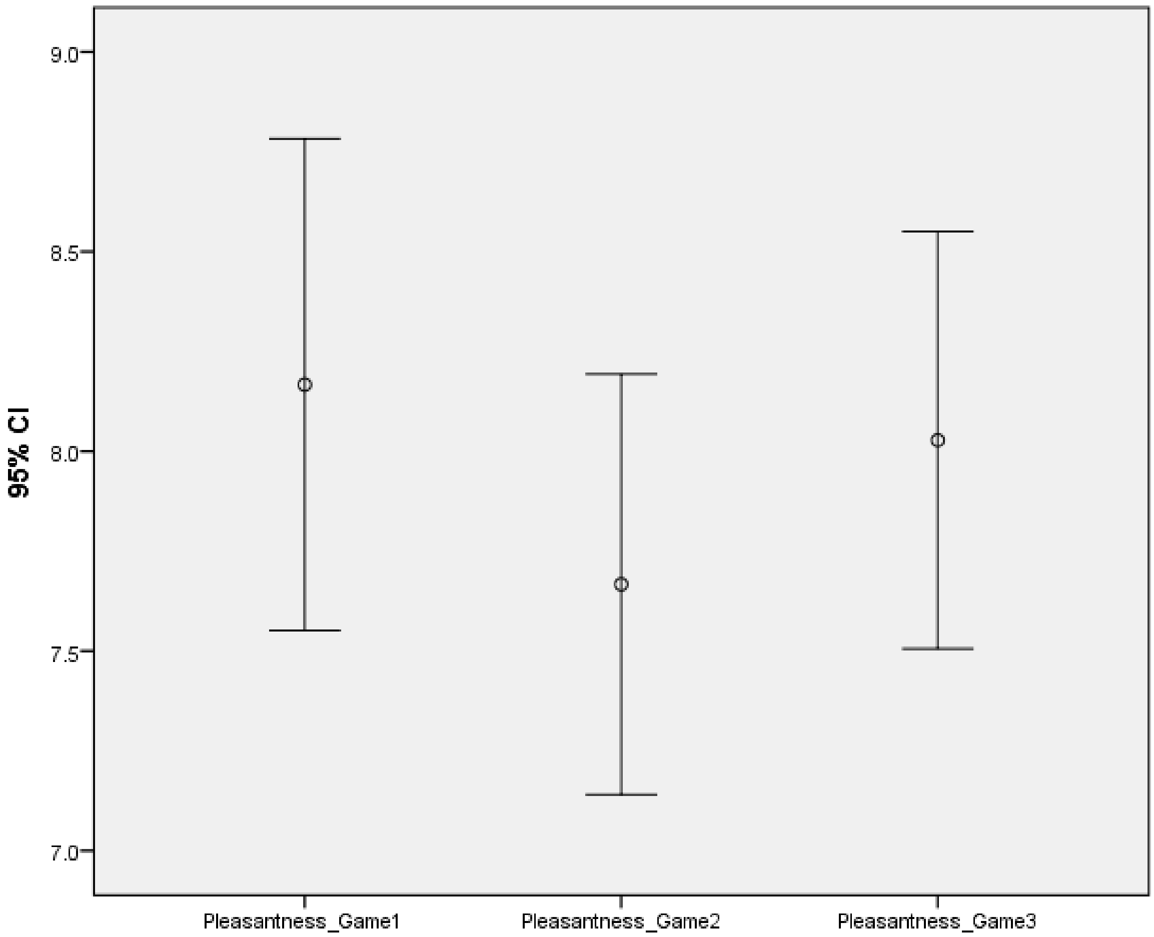
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Pleasantness	Sphericity Assumed	1.583	2	.792	1.319	.277	.054	2.639	.271
	Greenhouse-Geisser	1.583	1.913	.828	1.319	.277	.054	2.523	.265
	Huynh-Feldt	1.583	2.000	.792	1.319	.277	.054	2.639	.271
	Lower-bound	1.583	1.000	1.583	1.319	.263	.054	1.319	.196
Error(Pleasantness)	Sphericity Assumed	27.602	46	.600					
	Greenhouse-Geisser	27.602	43.991	.627					
	Huynh-Feldt	27.602	46.000	.600					
	Lower-bound	27.602	23.000	1.200					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Attention_Game1	7.9167	.87504	24
Attention_Game2	8.0000	.98295	24
Attention_Game3	7.9861	.73871	24

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Attention	.886	2.660	2	.264	.898	.969	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Attention

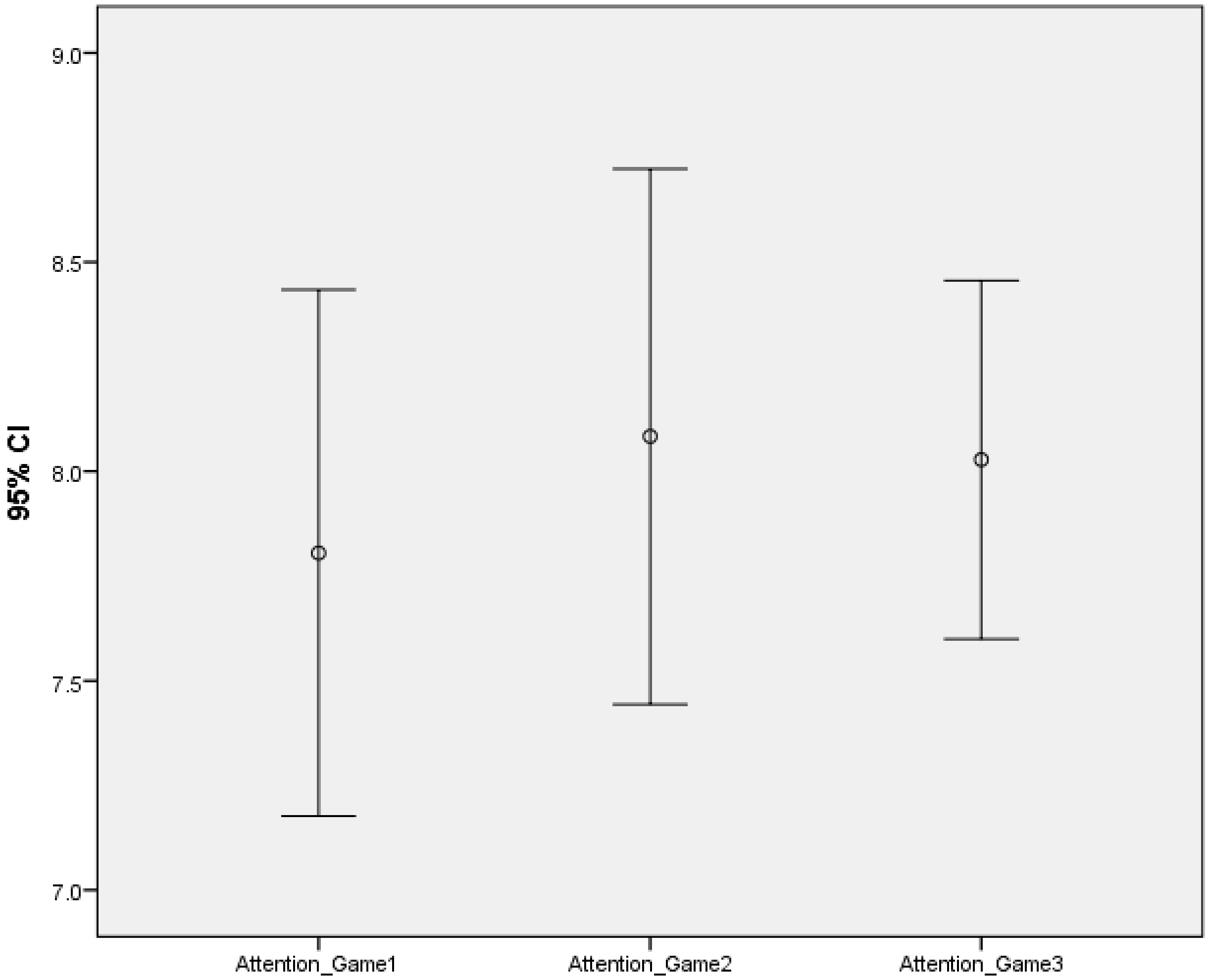
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Attention	Sphericity Assumed	.096	2	.048	.074	.928	.003	.149	.061
	Greenhouse-Geisser	.096	1.795	.053	.074	.912	.003	.133	.060
	Huynh-Feldt	.096	1.938	.049	.074	.924	.003	.144	.060
	Lower-bound	.096	1.000	.096	.074	.788	.003	.074	.058
Error(Attention)	Sphericity Assumed	29.608	46	.644					
	Greenhouse-Geisser	29.608	41.296	.717					
	Huynh-Feldt	29.608	44.571	.664					
	Lower-bound	29.608	23.000	1.287					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
SE_Game1	7.9167	.95479	12
SE_Game2	8.1111	.65649	12
SE_Game3	7.6389	.93699	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Epsilon[b] Huynh-Feldt	Epsilon[b] Lower-bound
SE	.800	2.228	2	.328	.834	.965	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: SE

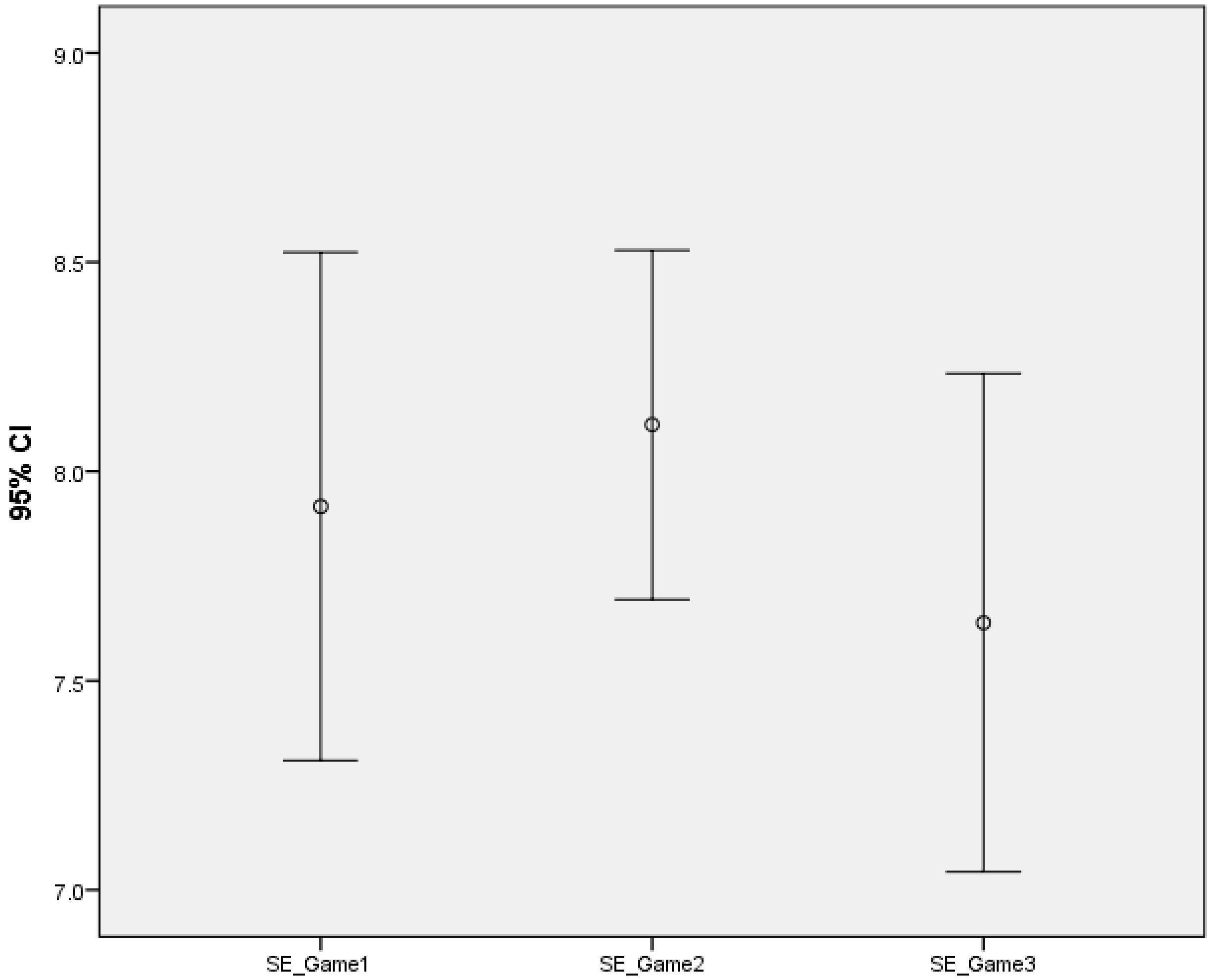
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
SE	Sphericity Assumed	1.352	2	.676	.855	.439	.072	1.710	.178
	Greenhouse-Geisser	1.352	1.667	.811	.855	.423	.072	1.426	.164
	Huynh-Feldt	1.352	1.929	.701	.855	.436	.072	1.650	.175
	Lower-bound	1.352	1.000	1.352	.855	.375	.072	.855	.135
Error(SE)	Sphericity Assumed	17.389	22	.790					
	Greenhouse-Geisser	17.389	18.338	.948					
	Huynh-Feldt	17.389	21.221	.819					
	Lower-bound	17.389	11.000	1.581					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
OE_Game1	7.8056	.77144	12
OE_Game2	7.6667	.75210	12
OE_Game3	7.3611	1.22646	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
OE	.712	3.392	2	.183	.777	.881	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: OE

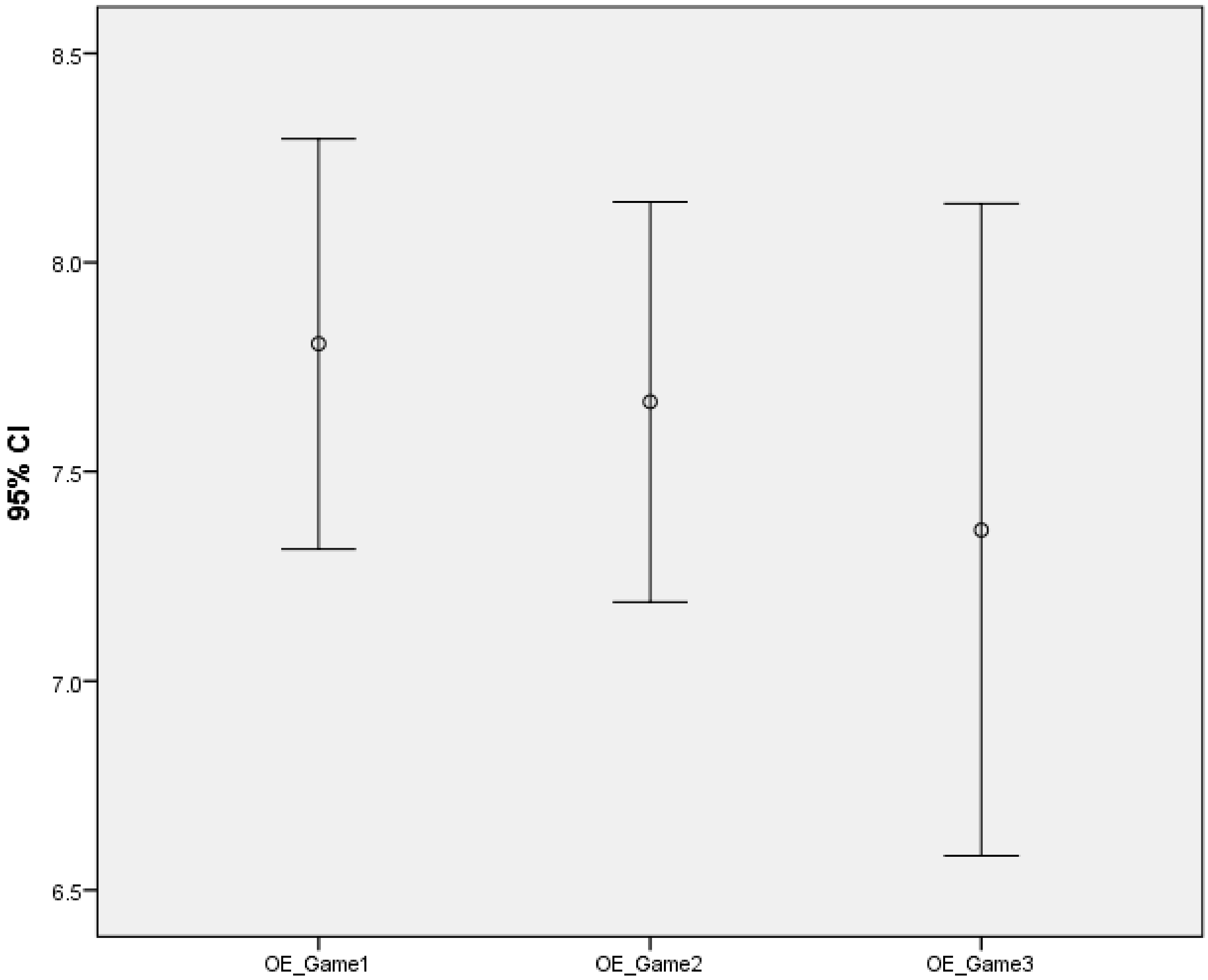
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
OE	Sphericity Assumed	1.241	2	.620	1.057	.364	.088	2.115	.211
	Greenhouse-Geisser	1.241	1.553	.799	1.057	.352	.088	1.642	.188
	Huynh-Feldt	1.241	1.761	.704	1.057	.358	.088	1.862	.199
	Lower-bound	1.241	1.000	1.241	1.057	.326	.088	1.057	.156
Error(OE)	Sphericity Assumed	12.907	22	.587					
	Greenhouse-Geisser	12.907	17.086	.755					
	Huynh-Feldt	12.907	19.375	.666					
	Lower-bound	12.907	11.000	1.173					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Likability_Game1	8.2639	.93756	24
Likability_Game2	7.7639	.84830	24
Likability_Game3	7.6806	.88180	24

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Likability	.992	.173	2	.917	.992	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
 Within Subjects Design: Likability

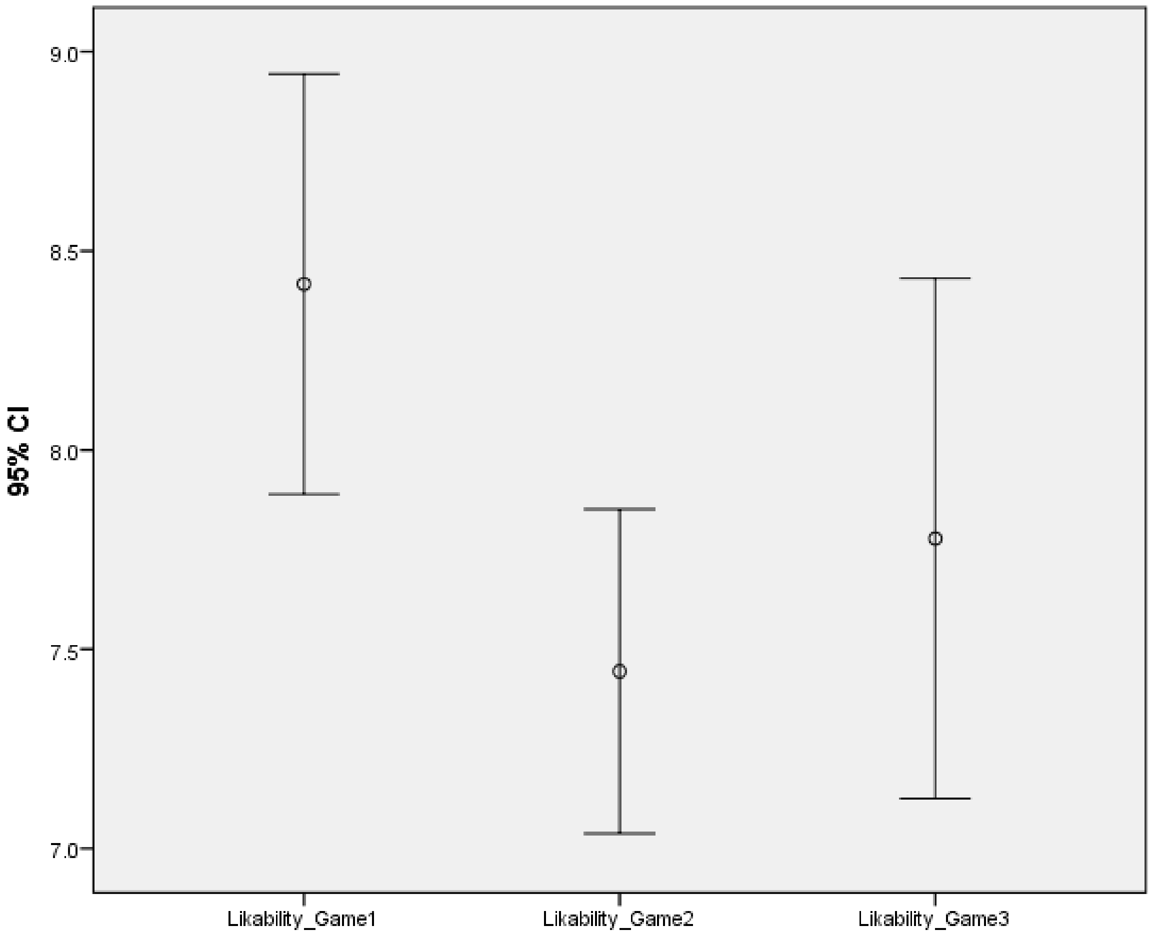
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Likability	Sphericity Assumed	4.778	2	2.389	2.818	.070	.109	5.635	.527
	Greenhouse-Geisser	4.778	1.984	2.408	2.818	.071	.109	5.592	.525
	Huynh-Feldt	4.778	2.000	2.389	2.818	.070	.109	5.635	.527
	Lower-bound	4.778	1.000	4.778	2.818	.107	.109	2.818	.363
Error(Likability)	Sphericity Assumed	39.000	46	.848					
	Greenhouse-Geisser	39.000	45.643	.854					
	Huynh-Feldt	39.000	46.000	.848					
	Lower-bound	39.000	23.000	1.696					

a. Computed using alpha = .05



Appendices 3C

Psychophysiological data SPSS Outputs; Heart Rate, Heart Rate Varaiability, Alpha Peak and Theta/Beta Ratio

Descriptive Statistics

	Mean	Std. Deviation	N
HR_P1_Game1	81.0542	5.39989	120
HR_P1_Game2	82.4875	5.85557	120
HR_P1_Game3	80.9208	6.51630	120

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
HR	.951	5.897	2	.052	.954	.969	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: HR

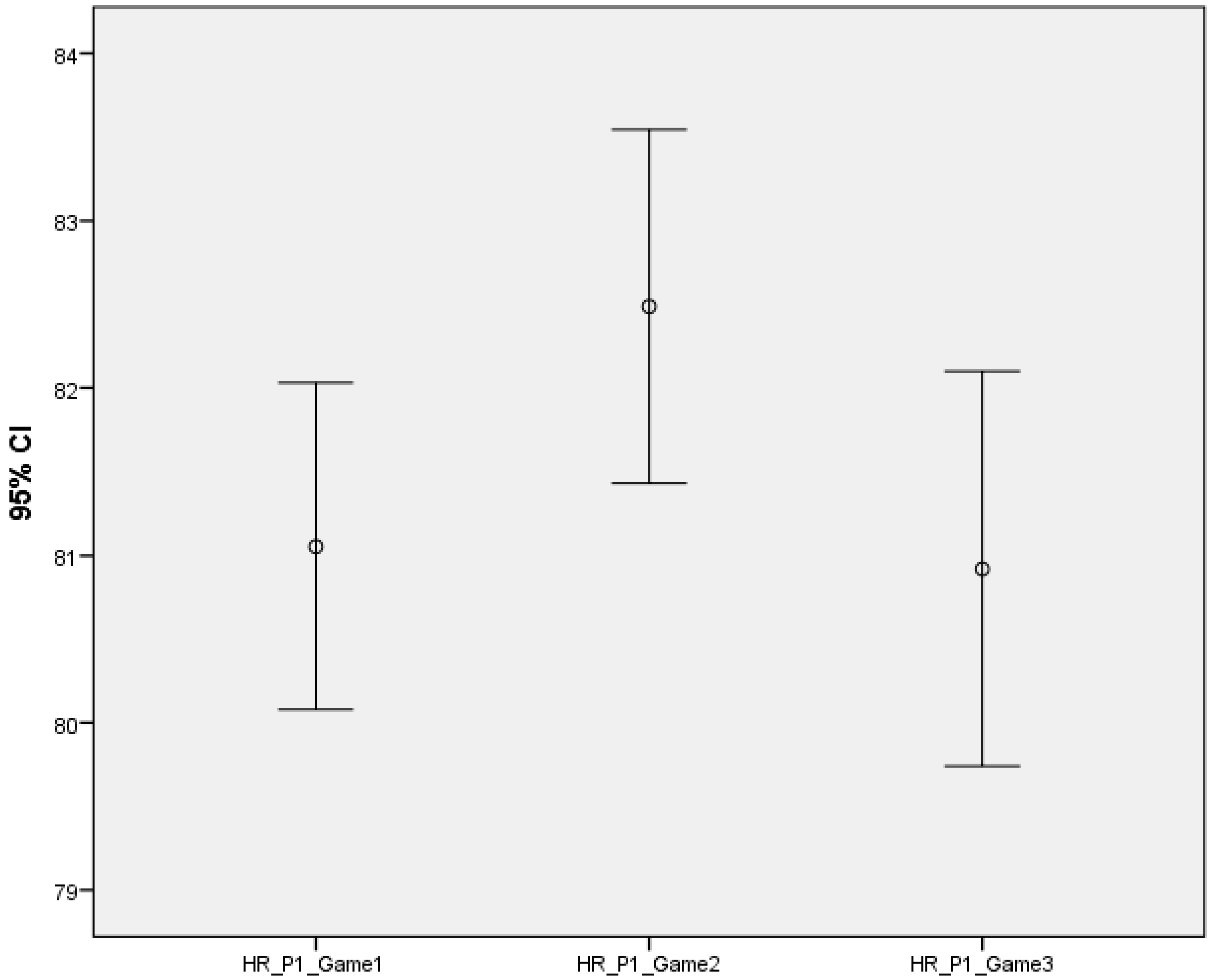
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
HR	Sphericity Assumed	181.067	2	90.533	3.872	.022	.032	7.743	.697
	Greenhouse-Geisser	181.067	1.907	94.947	3.872	.024	.032	7.383	.682
	Huynh-Feldt	181.067	1.937	93.464	3.872	.023	.032	7.501	.687
	Lower-bound	181.067	1.000	181.067	3.872	.051	.032	3.872	.497
Error(HR)	Sphericity Assumed	5565.267	238	23.383					
	Greenhouse-Geisser	5565.267	226.937	24.523					
	Huynh-Feldt	5565.267	230.538	24.140					
	Lower-bound	5565.267	119.000	46.767					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Game1_RMSSD	50.7750	7.11663	120
Game2_RMSSD_P1	50.4833	8.88108	120
Game3_RMSSD_P1	55.2083	8.70612	120

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
HRV	.940	7.274	2	.026	.944	.958	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: HRV

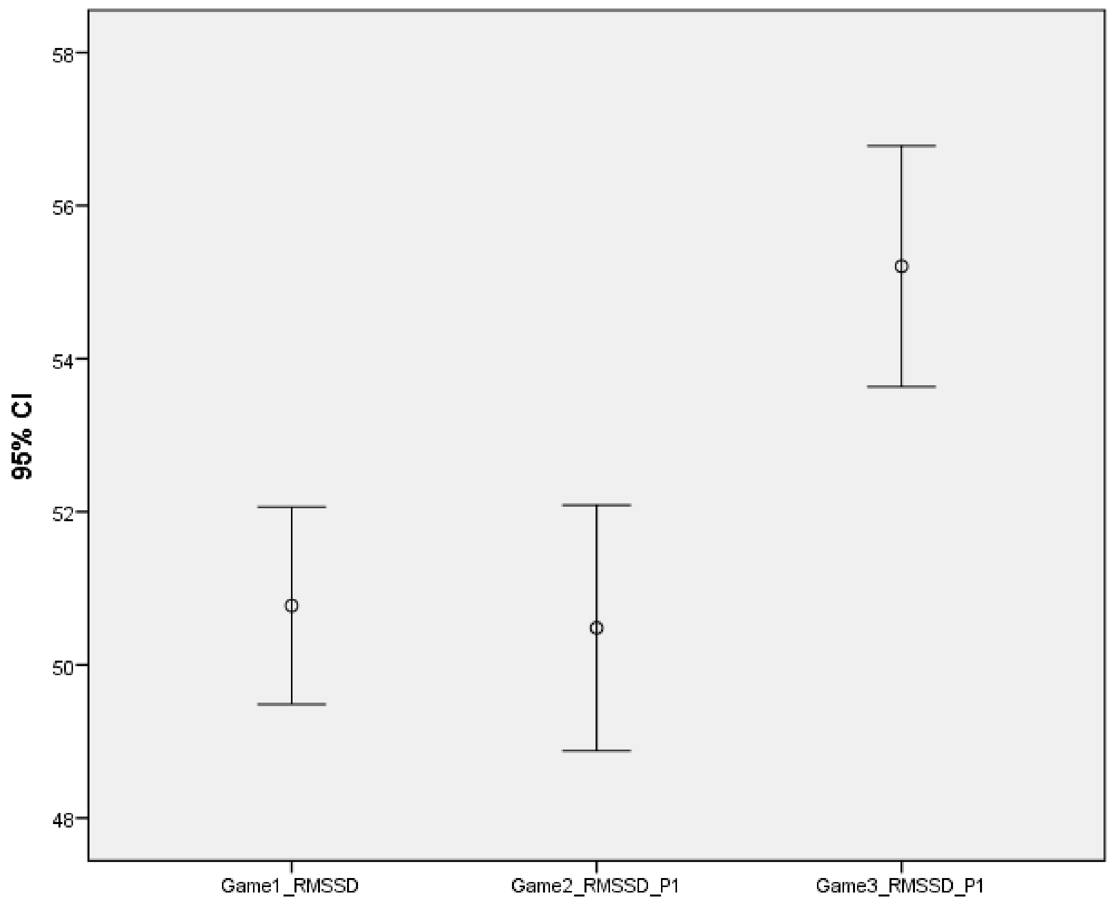
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
HRV	Sphericity Assumed	1682.606	2	841.303	12.959	.000	.098	25.919	.997
	Greenhouse-Geisser	1682.606	1.887	891.598	12.959	.000	.098	24.456	.996
	Huynh-Feldt	1682.606	1.917	877.900	12.959	.000	.098	24.838	.996
	Lower-bound	1682.606	1.000	1682.606	12.959	.000	.098	12.959	.946
Error(HRV)	Sphericity Assumed	15450.728	238	64.919					
	Greenhouse-Geisser	15450.728	224.574	68.800					
	Huynh-Feldt	15450.728	228.078	67.743					
	Lower-bound	15450.728	119.000	129.838					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Alpha_Peak_Game1	9.9767	.19109	12
Alpha_Peak_Game2	9.9308	.16876	12
Alpha_Peak_Game3	10.0758	.20571	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
alpha	.966	.349	2	.840	.967	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: alpha

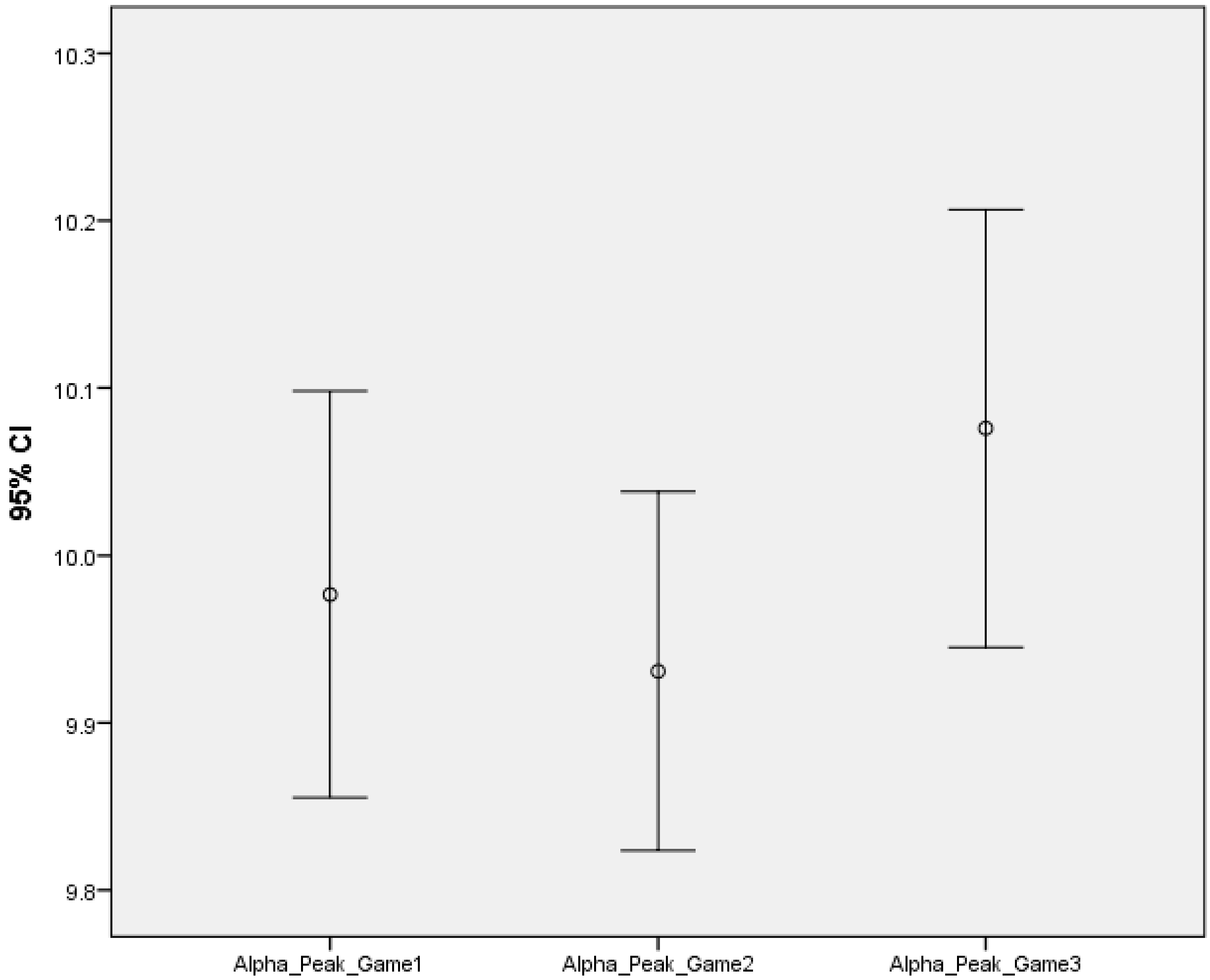
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
alpha	Sphericity Assumed	.132	2	.066	2.005	.158	.154	4.011	.369
	Greenhouse-Geisser	.132	1.934	.068	2.005	.160	.154	3.878	.362
	Huynh-Feldt	.132	2.000	.066	2.005	.158	.154	4.011	.369
	Lower-bound	.132	1.000	.132	2.005	.184	.154	2.005	.253
Error(alpha)	Sphericity Assumed	.723	22	.033					
	Greenhouse-Geisser	.723	21.271	.034					
	Huynh-Feldt	.723	22.000	.033					
	Lower-bound	.723	11.000	.066					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Beta_Theta_Game1	.6242	.25347	12
Beta_Theta_Game2	.6017	.26426	12
Beta_Theta_Game3	.6525	.17551	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Beta_Theta	.791	2.344	2	.310	.827	.955	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: Beta_Theta

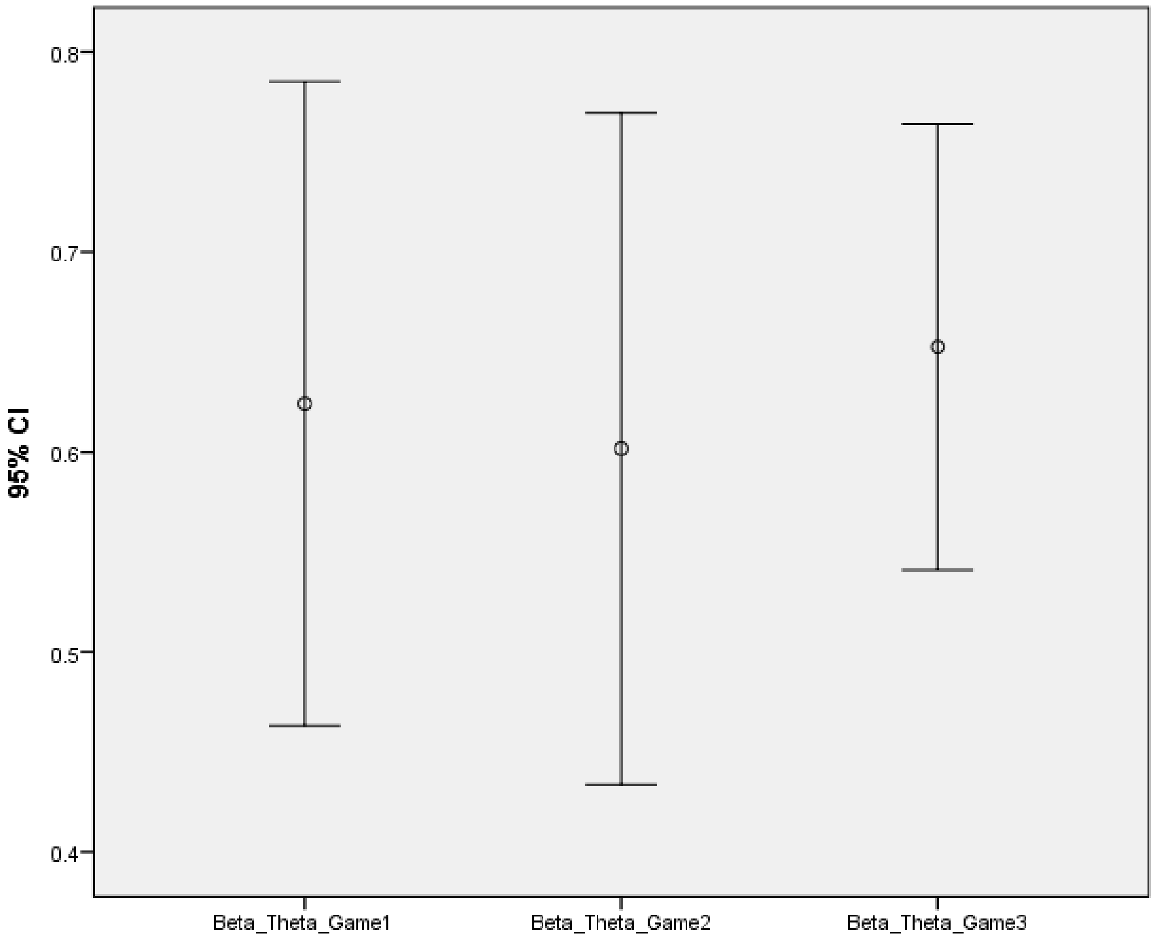
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Beta_Theta	Sphericity Assumed	.016	2	.008	.177	.839	.016	.354	.074
	Greenhouse-Geisser	.016	1.654	.009	.177	.799	.016	.293	.072
	Huynh-Feldt	.016	1.910	.008	.177	.830	.016	.338	.074
	Lower-bound	.016	1.000	.016	.177	.682	.016	.177	.067
Error(Beta_Theta)	Sphericity Assumed	.968	22	.044					
	Greenhouse-Geisser	.968	18.198	.053					
	Huynh-Feldt	.968	21.013	.046					
	Lower-bound	.968	11.000	.088					

a. Computed using alpha = .05



Appendices 3D

Channel Power SPSS Outputs; Fp1, Fp2, Fp7, F3, Fz, F4, F8, C3, Cz, C4, T3, T4, T5, T6, P3, Pz, P4, O1 and O2

Descriptive Statistics

	Mean	Std. Deviation	N
Channel_1_Game1	-6353.9958	3063.50625	12
Channel_1_Game2	-9001.8268	2354.40997	12
Channel_1_Game3	-7262.6130	2325.28271	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_1	.823	1.953	2	.377	.849	.988	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
 Within Subjects Design: Channel_1

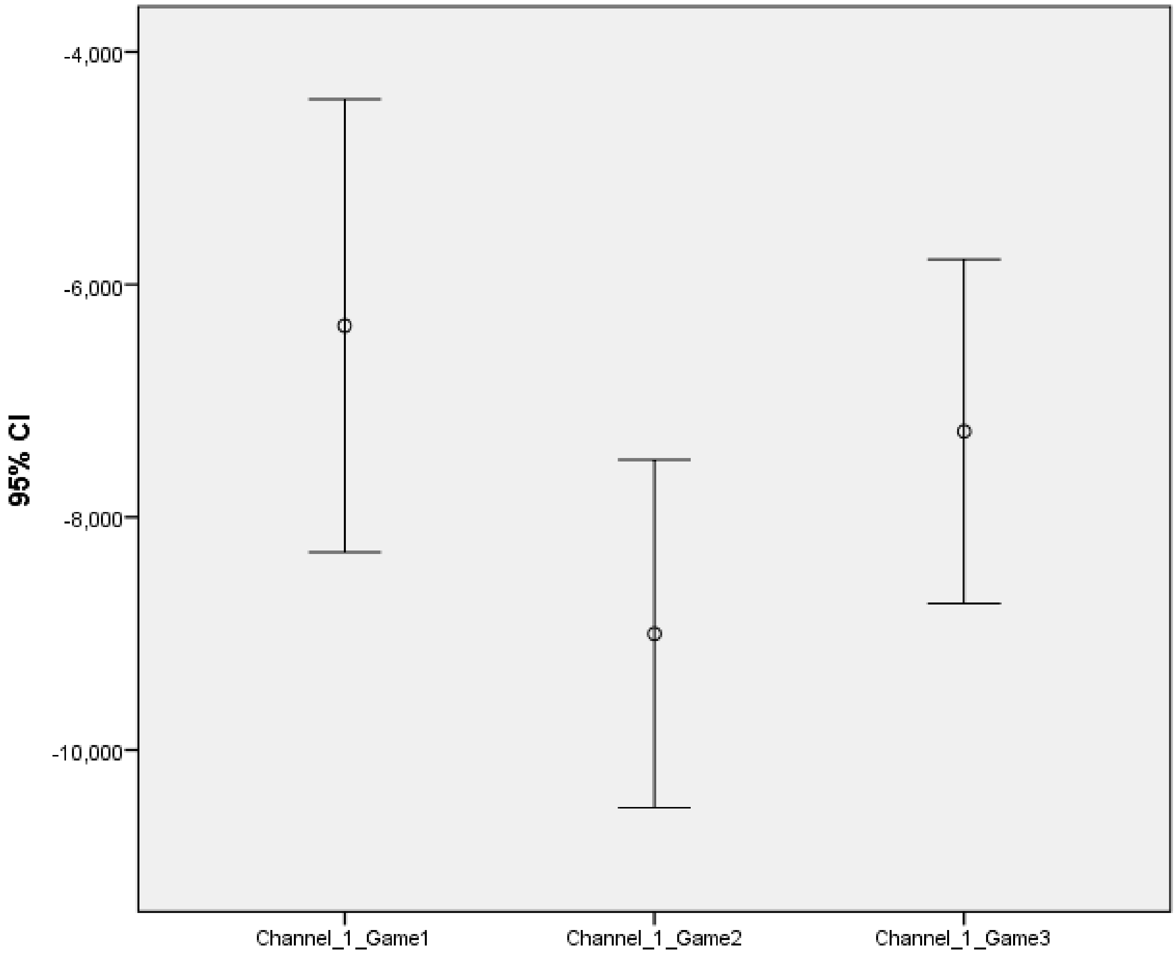
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_1	Sphericity Assumed	43445835.480	2	21722917.740	3.377	.053	.235	6.753	.575
	Greenhouse-Geisser	43445835.480	1.699	25575952.610	3.377	.063	.235	5.736	.525
	Huynh-Feldt	43445835.480	1.977	21980764.810	3.377	.053	.235	6.674	.571
	Lower-bound	43445835.480	1.000	43445835.480	3.377	.093	.235	3.377	.389
Error(Channel_1)	Sphericity Assumed	141534621.900	22	6433391.905					
	Greenhouse-Geisser	141534621.900	18.686	7574494.754					
	Huynh-Feldt	141534621.900	21.742	6509755.092					
	Lower-bound	141534621.900	11.000	12866783.810					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_2_Game1	-6495.5883	3368.96709	12
Channel_2_Game2	-9570.4536	3323.08018	12
Channel_2_Game3	-7677.9374	3474.58402	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_2	.751	2.857	2	.240	.801	.916	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: Channel_2

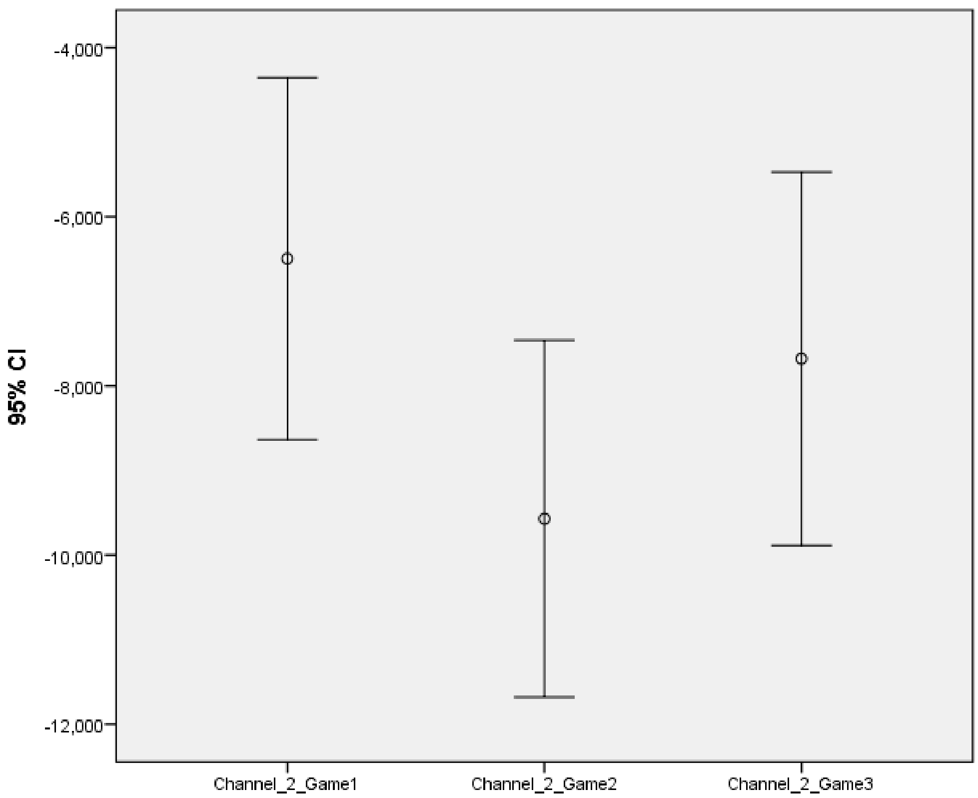
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_2	Sphericity Assumed	57737452.450	2	28868726.230	3.376	.053	.235	6.752	.575
	Greenhouse-Geisser	57737452.450	1.602	36042779.860	3.376	.066	.235	5.408	.508
	Huynh-Feldt	57737452.450	1.833	31505679.880	3.376	.058	.235	6.187	.548
	Lower-bound	57737452.450	1.000	57737452.450	3.376	.093	.235	3.376	.389
Error(Channel_2)	Sphericity Assumed	188132211.500	22	8551464.160					
	Greenhouse-Geisser	188132211.500	17.621	10676554.890					
	Huynh-Feldt	188132211.500	20.159	9332579.836					
	Lower-bound	188132211.500	11.000	17102928.320					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_3_Game1	-5736.7078	2189.77331	12
Channel_3_Game2	-7131.6146	1912.32918	12
Channel_3_Game3	-6280.7000	1688.08329	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_3	.892	1.139	2	.566	.903	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_3

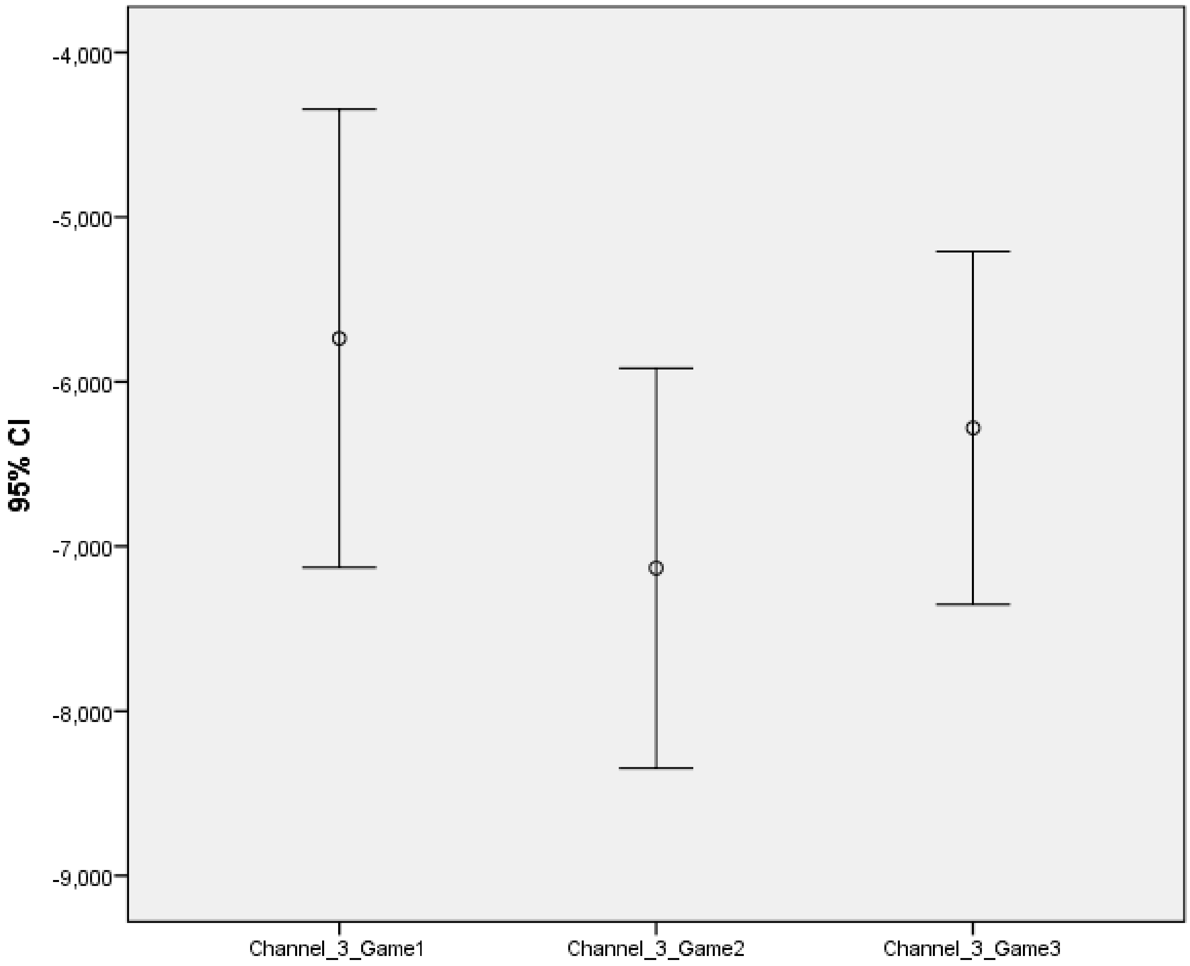
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_3	Sphericity Assumed	11862992.560	2	5931496.281	2.564	.100	.189	5.127	.458
	Greenhouse-Geisser	11862992.560	1.806	6570175.335	2.564	.107	.189	4.629	.431
	Huynh-Feldt	11862992.560	2.000	5931496.281	2.564	.100	.189	5.127	.458
	Lower-bound	11862992.560	1.000	11862992.560	2.564	.138	.189	2.564	.310
Error(Channel_3)	Sphericity Assumed	50902688.850	22	2313758.584					
	Greenhouse-Geisser	50902688.850	19.861	2562894.565					
	Huynh-Feldt	50902688.850	22.000	2313758.584					
	Lower-bound	50902688.850	11.000	4627517.168					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_4_Game1	3971.6775	5277.07323	12
Channel_4_Game2	5744.6060	3084.58103	12
Channel_4_Game3	5837.3892	2253.33608	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_4	.166	17.934	2	.000	.545	.560	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_4

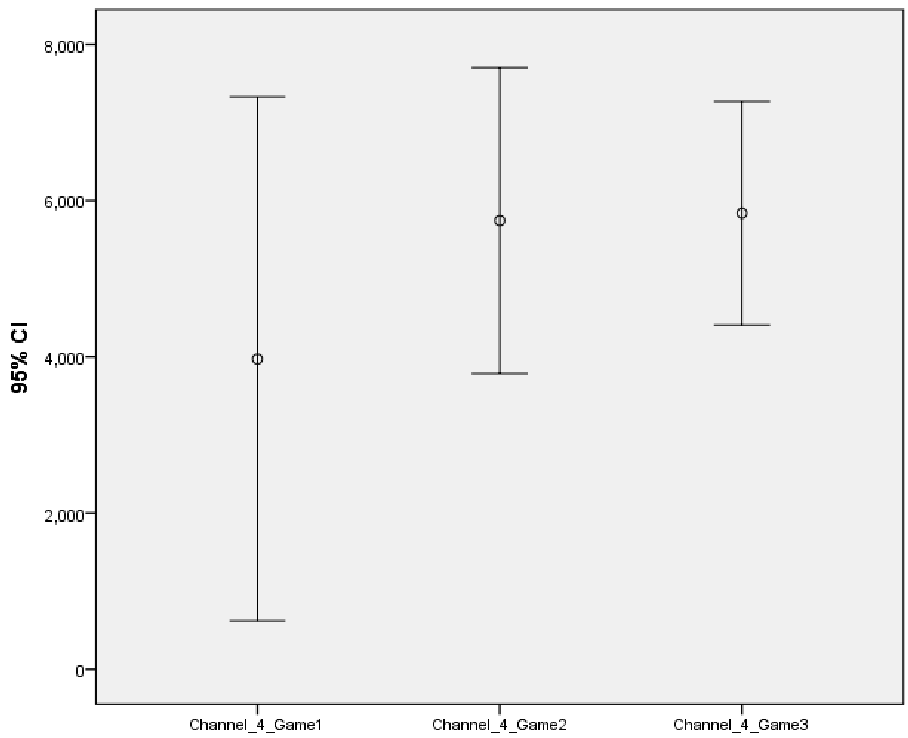
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_4	Sphericity Assumed	26531059.190	2	13265529.600	1.830	.184	.143	3.659	.340
	Greenhouse-Geisser	26531059.190	1.091	24323842.240	1.830	.202	.143	1.996	.246
	Huynh-Feldt	26531059.190	1.119	23708638.680	1.830	.202	.143	2.048	.249
	Lower-bound	26531059.190	1.000	26531059.190	1.830	.203	.143	1.830	.235
Error(Channel_4)	Sphericity Assumed	159498260.000	22	7249920.910					
	Greenhouse-Geisser	159498260.000	11.998	13293546.350					
	Huynh-Feldt	159498260.000	12.310	12957323.270					
	Lower-bound	159498260.000	11.000	14499841.820					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_5_Game1	4710.3345	2622.81904	12
Channel_5_Game2	5811.3847	4069.09518	12
Channel_5_Game3	6880.1277	3337.92813	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_5	.867	1.428	2	.490	.883	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_5

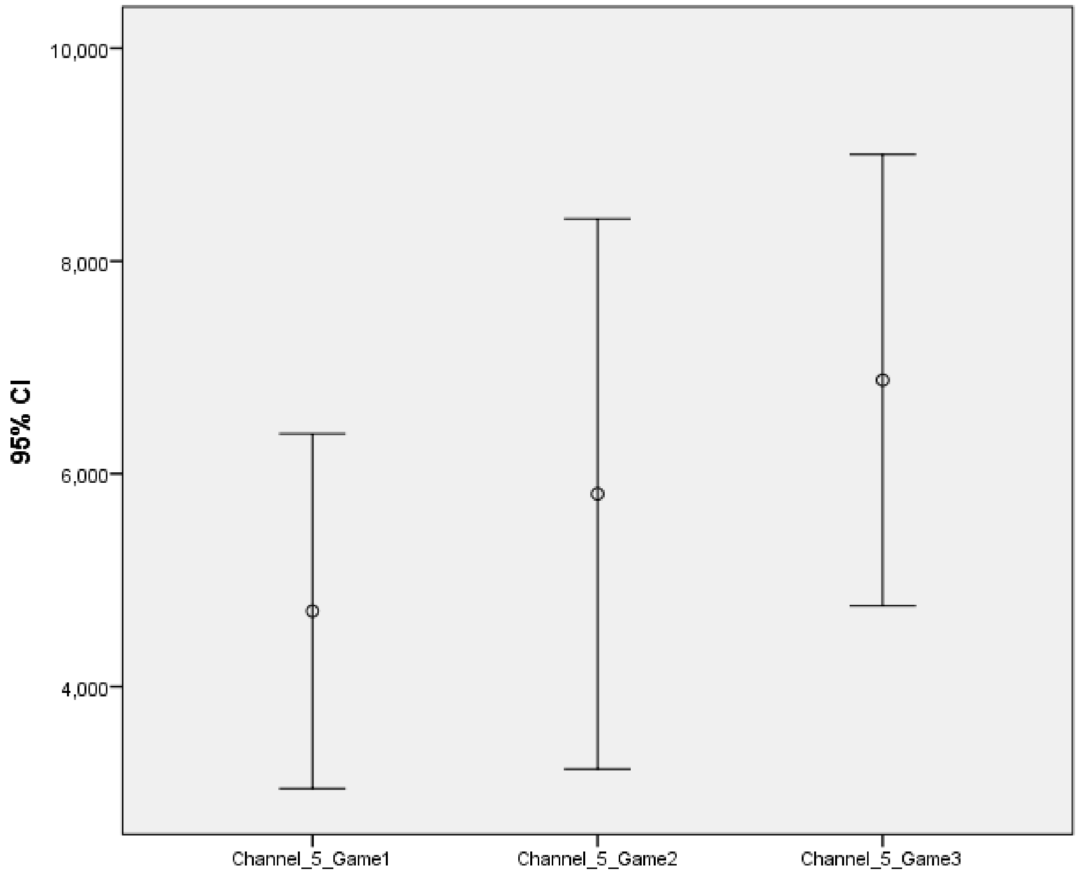
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_5	Sphericity Assumed	28250102.460	2	14125051.230	2.316	.122	.174	4.632	.419
	Greenhouse-Geisser	28250102.460	1.765	16004227.520	2.316	.130	.174	4.088	.390
	Huynh-Feldt	28250102.460	2.000	14125051.230	2.316	.122	.174	4.632	.419
	Lower-bound	28250102.460	1.000	28250102.460	2.316	.156	.174	2.316	.285
Error(Channel_5)	Sphericity Assumed	134190255.900	22	6099557.085					
	Greenhouse-Geisser	134190255.900	19.417	6911033.296					
	Huynh-Feldt	134190255.900	22.000	6099557.085					
	Lower-bound	134190255.900	11.000	12199114.170					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_6_Game1	1316.1856	4287.58285	12
Channel_6_Game2	1175.3618	6703.61634	12
Channel_6_Game3	-342.3708	5284.05812	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_6	.909	.956	2	.620	.916	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_6

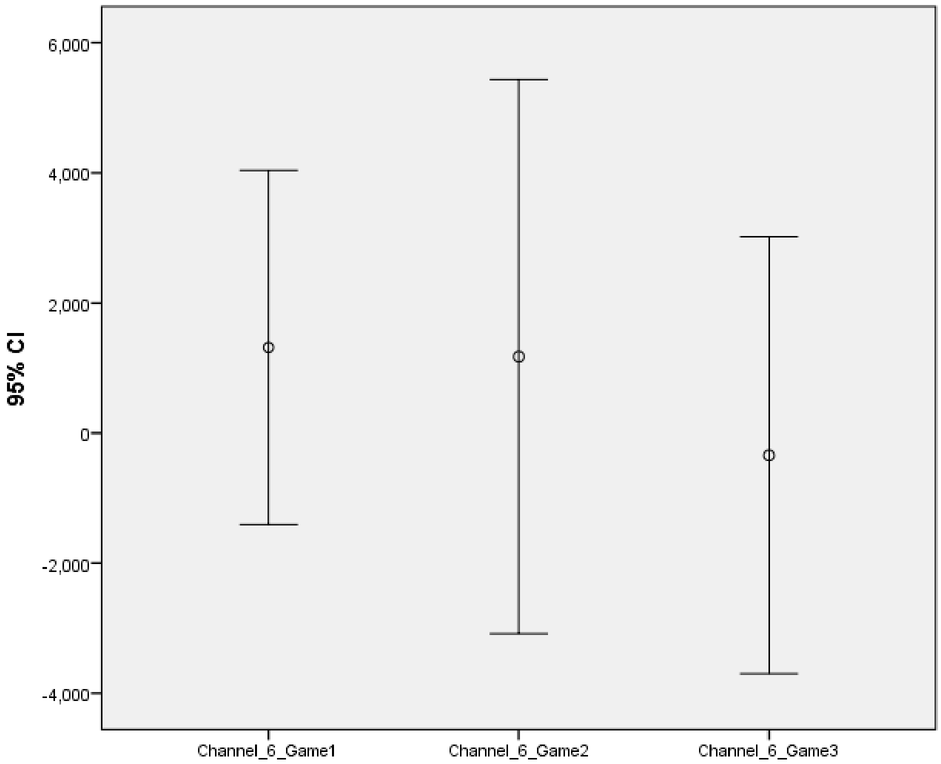
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_6	Sphericity Assumed	20296610.410	2	10148305.200	.799	.462	.068	1.599	.169
	Greenhouse-Geisser	20296610.410	1.833	11073640.440	.799	.453	.068	1.465	.163
	Huynh-Feldt	20296610.410	2.000	10148305.200	.799	.462	.068	1.599	.169
	Lower-bound	20296610.410	1.000	20296610.410	.799	.390	.068	.799	.129
Error(Channel_6)	Sphericity Assumed	279323744.900	22	12696533.860					
	Greenhouse-Geisser	279323744.900	20.162	13854219.790					
	Huynh-Feldt	279323744.900	22.000	12696533.860					
	Lower-bound	279323744.900	11.000	25393067.720					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_7_Game1	-6602.6331	2672.70925	12
Channel_7_Game2	-8155.7223	952.33787	12
Channel_7_Game3	-6758.7048	1690.99514	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_7	.667	4.045	2	.132	.750	.843	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_7

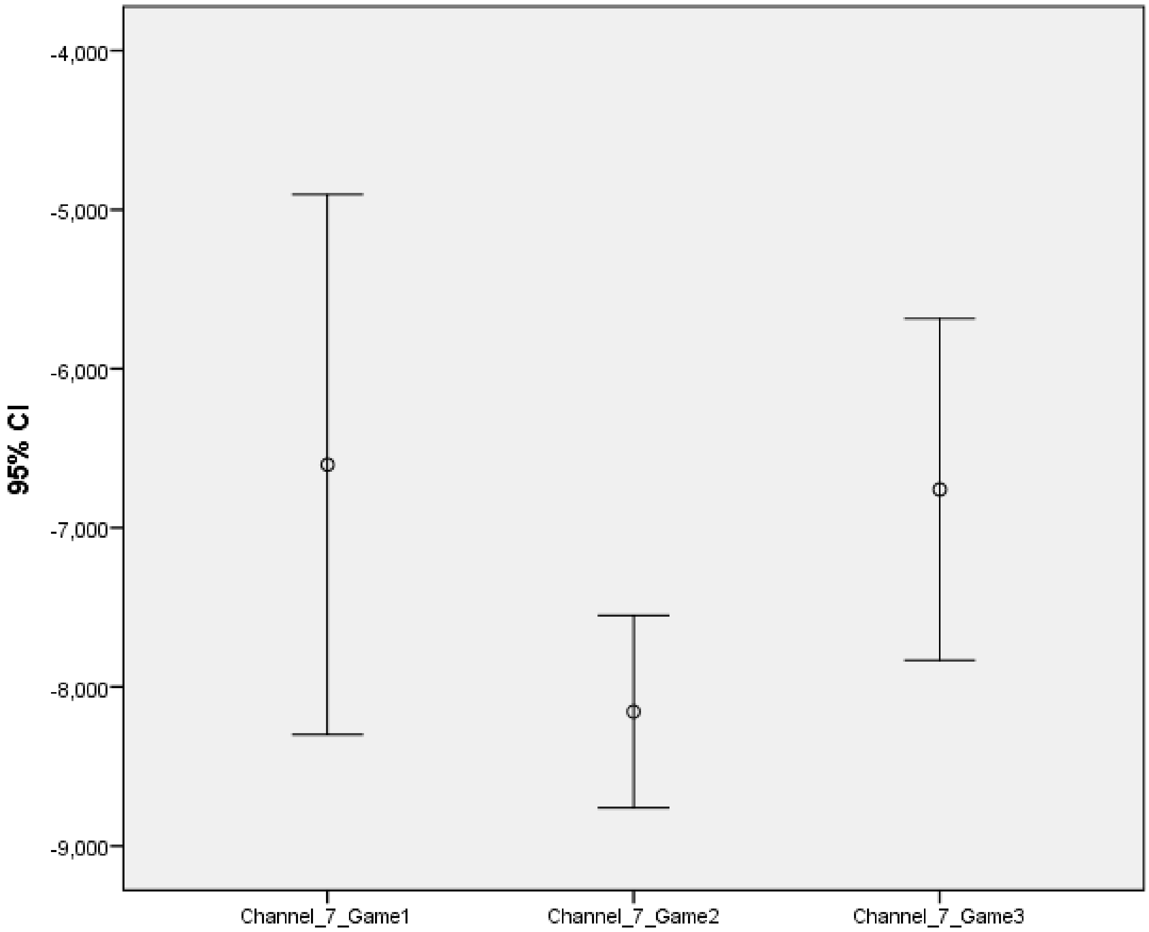
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_7	Sphericity Assumed	17552410.230	2	8776205.113	2.541	.102	.188	5.083	.454
	Greenhouse-Geisser	17552410.230	1.501	11695712.600	2.541	.120	.188	3.814	.385
	Huynh-Feldt	17552410.230	1.685	10415009.390	2.541	.113	.188	4.283	.411
	Lower-bound	17552410.230	1.000	17552410.230	2.541	.139	.188	2.541	.308
Error(Channel_7)	Sphericity Assumed	75976197.840	22	3453463.538					
	Greenhouse-Geisser	75976197.840	16.508	4602298.657					
	Huynh-Feldt	75976197.840	18.538	4098338.030					
	Lower-bound	75976197.840	11.000	6906927.077					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_9_Game1	6969.2993	4289.83592	12
Channel_9_Game2	9126.2536	3584.25544	12
Channel_9_Game3	8620.0931	1447.41506	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_9	.755	2.816	2	.245	.803	.919	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_9

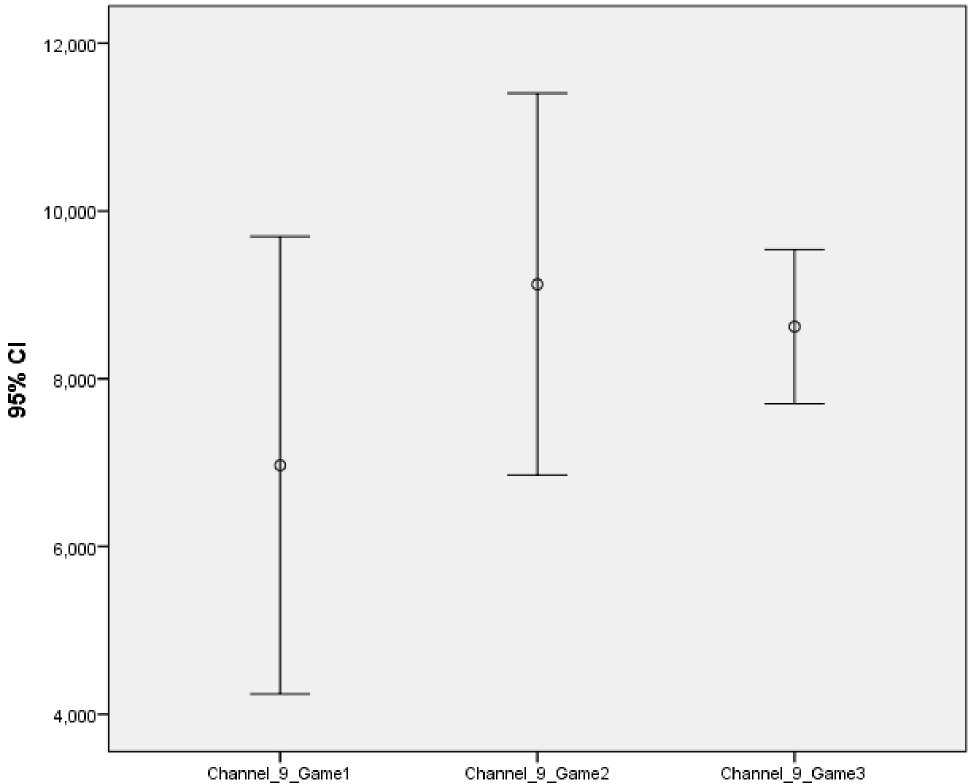
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_9	Sphericity Assumed	30535081.160	2	15267540.580	3.004	.070	.215	6.009	.524
	Greenhouse-Geisser	30535081.160	1.606	19015111.880	3.004	.084	.215	4.825	.462
	Huynh-Feldt	30535081.160	1.838	16609836.440	3.004	.076	.215	5.523	.499
	Lower-bound	30535081.160	1.000	30535081.160	3.004	.111	.215	3.004	.353
Error(Channel_9)	Sphericity Assumed	111798304.500	22	5081741.115					
	Greenhouse-Geisser	111798304.500	17.664	6329105.551					
	Huynh-Feldt	111798304.500	20.222	5528519.036					
	Lower-bound	111798304.500	11.000	10163482.230					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_10_Game1	5413.6977	2639.97919	12
Channel_10_Game2	7866.6198	3802.48390	12
Channel_10_Game3	7648.4017	3885.67074	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_10	.950	.508	2	.776	.953	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_10

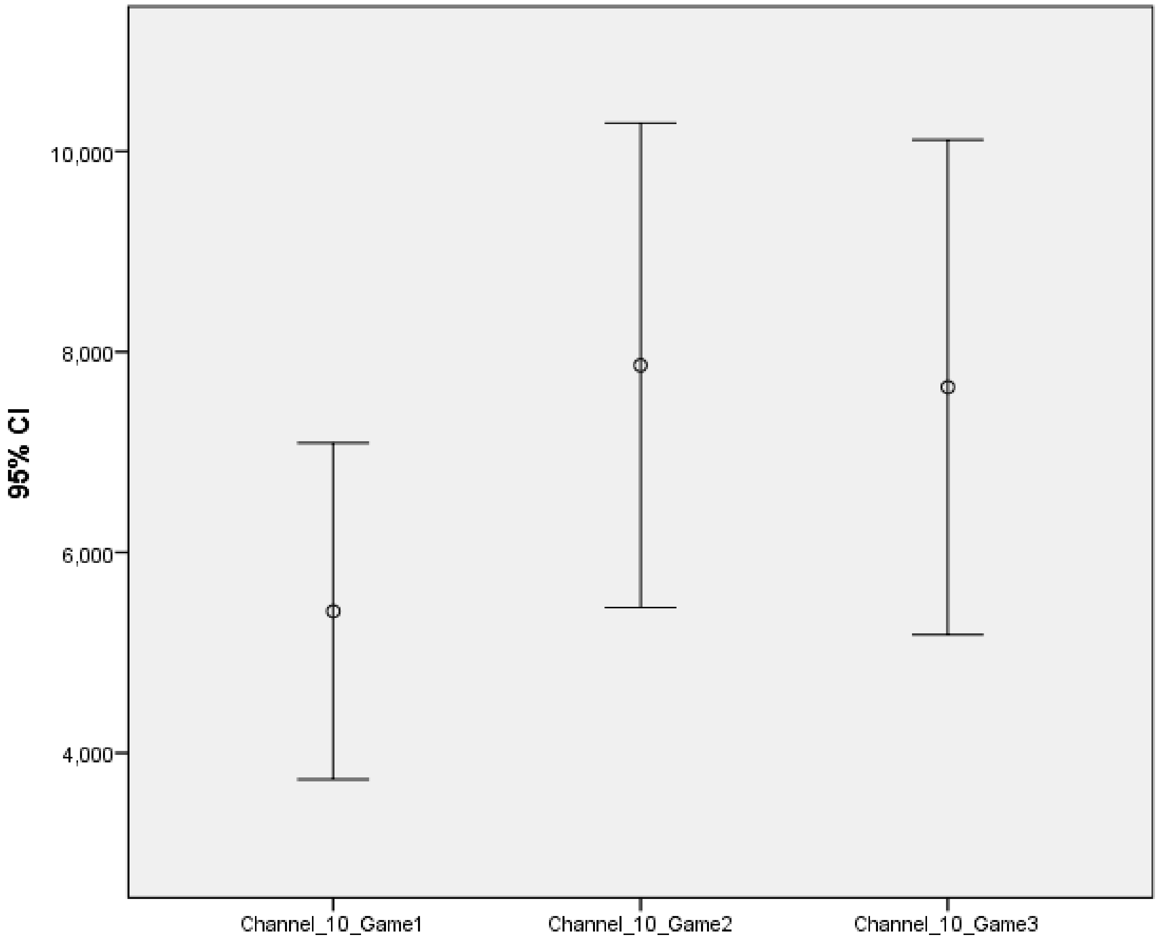
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_10	Sphericity Assumed	44233392.280	2	22116696.140	2.793	.083	.203	5.586	.493
	Greenhouse-Geisser	44233392.280	1.906	23212077.800	2.793	.086	.203	5.323	.479
	Huynh-Feldt	44233392.280	2.000	22116696.140	2.793	.083	.203	5.586	.493
	Lower-bound	44233392.280	1.000	44233392.280	2.793	.123	.203	2.793	.333
Error(Channel_10)	Sphericity Assumed	174194478.100	22	7917930.824					
	Greenhouse-Geisser	174194478.100	20.962	8310085.066					
	Huynh-Feldt	174194478.100	22.000	7917930.824					
	Lower-bound	174194478.100	11.000	15835861.650					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_11_Game1	2455.5190	4084.39837	12
Channel_11_Game2	4853.4985	3223.87929	12
Channel_11_Game3	2955.2672	3566.27213	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_11	.565	5.711	2	.058	.697	.766	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_11

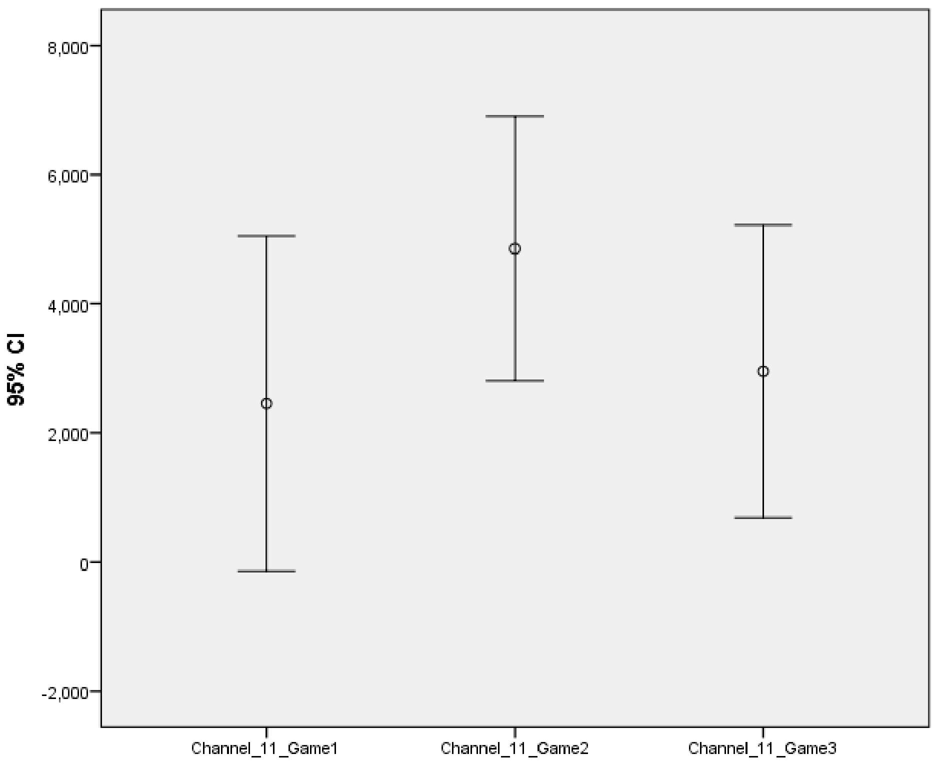
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_11	Sphericity Assumed	38413345.300	2	19206672.650	1.407	.266	.113	2.814	.269
	Greenhouse-Geisser	38413345.300	1.394	27563806.650	1.407	.266	.113	1.961	.224
	Huynh-Feldt	38413345.300	1.533	25063079.950	1.407	.267	.113	2.156	.235
	Lower-bound	38413345.300	1.000	38413345.300	1.407	.261	.113	1.407	.192
Error(Channel_11)	Sphericity Assumed	300327710.600	22	13651259.570					
	Greenhouse-Geisser	300327710.600	15.330	19591143.470					
	Huynh-Feldt	300327710.600	16.859	17813736.730					
	Lower-bound	300327710.600	11.000	27302519.140					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_8_Game1	-6361.2045	2085.22528	12
Channel_8_Game2	-6917.2068	1192.79348	12
Channel_8_Game3	-6536.3674	918.42962	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_8	.951	.501	2	.778	.953	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_8

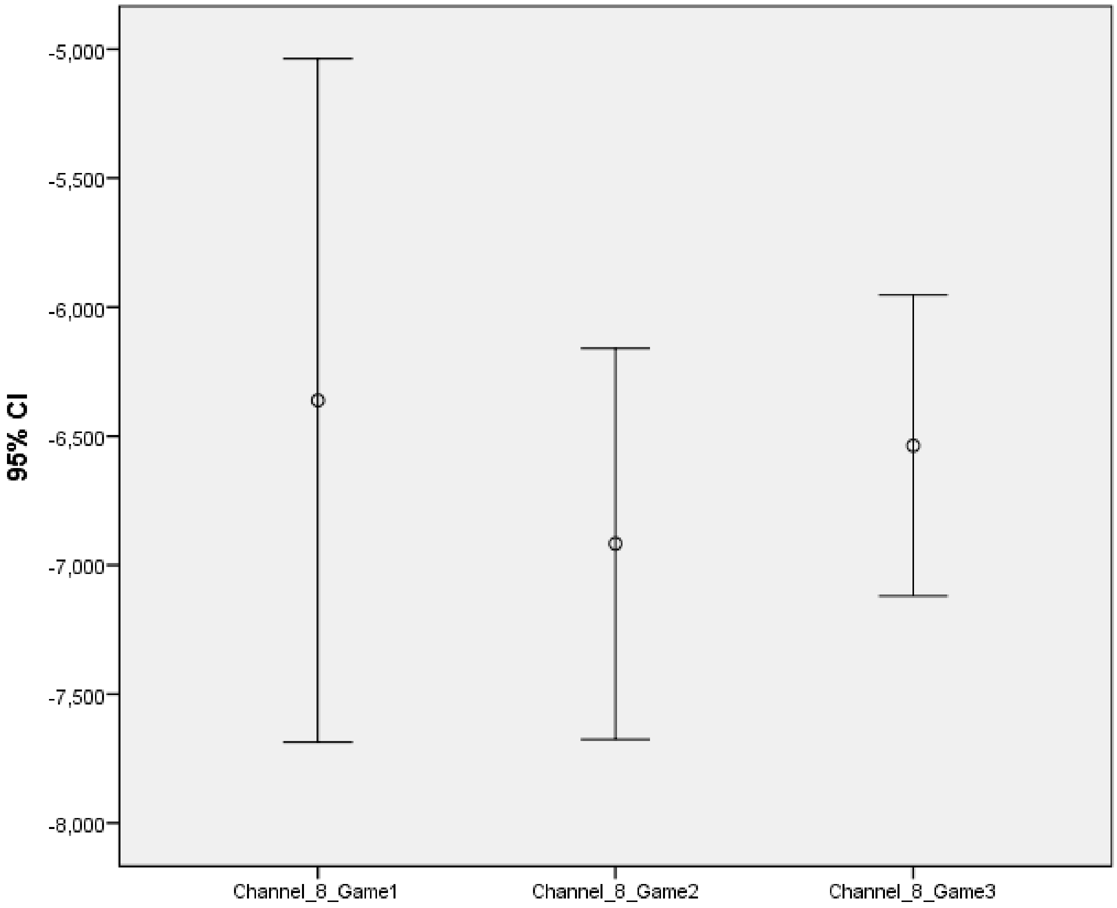
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_8	Sphericity Assumed	1939436.747	2	969718.374	.504	.611	.044	1.008	.122
	Greenhouse-Geisser	1939436.747	1.907	1017113.724	.504	.603	.044	.961	.120
	Huynh-Feldt	1939436.747	2.000	969718.374	.504	.611	.044	1.008	.122
	Lower-bound	1939436.747	1.000	1939436.747	.504	.493	.044	.504	.100
Error(Channel_8)	Sphericity Assumed	42325157.320	22	1923870.787					
	Greenhouse-Geisser	42325157.320	20.975	2017900.696					
	Huynh-Feldt	42325157.320	22.000	1923870.787					
	Lower-bound	42325157.320	11.000	3847741.574					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_12_Game1	7.6202	3809.56033	12
Channel_12_Game2	-1585.3530	5534.14914	12
Channel_12_Game3	-1737.1789	4251.06074	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_12	.956	.445	2	.800	.958	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_12

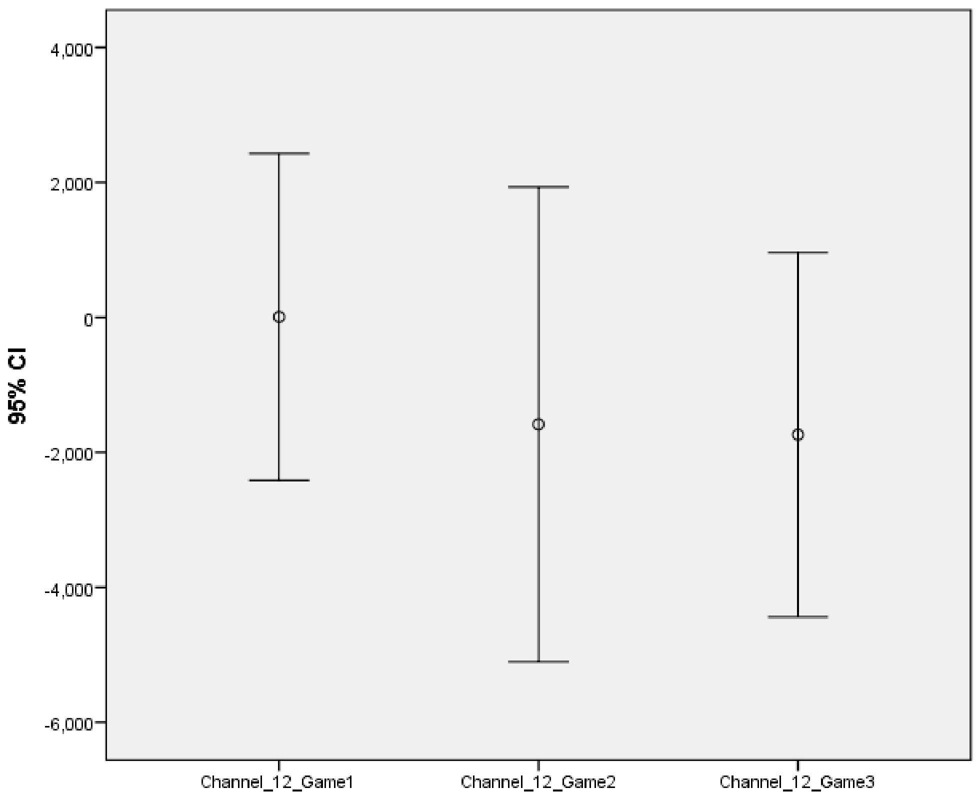
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_12	Sphericity Assumed	22419754.700	2	11209877.350	.728	.494	.062	1.455	.157
	Greenhouse-Geisser	22419754.700	1.917	11698020.500	.728	.489	.062	1.394	.155
	Huynh-Feldt	22419754.700	2.000	11209877.350	.728	.494	.062	1.455	.157
	Lower-bound	22419754.700	1.000	22419754.700	.728	.412	.062	.728	.122
Error(Channel_12)	Sphericity Assumed	338953688.200	22	15406985.830					
	Greenhouse-Geisser	338953688.200	21.082	16077895.450					
	Huynh-Feldt	338953688.200	22.000	15406985.830					
	Lower-bound	338953688.200	11.000	30813971.650					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_13_Game1	-4069.8655	1919.55176	12
Channel_13_Game2	-3650.5526	2342.57194	12
Channel_13_Game3	-3484.0088	2003.23182	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_13	.801	2.222	2	.329	.834	.965	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_13

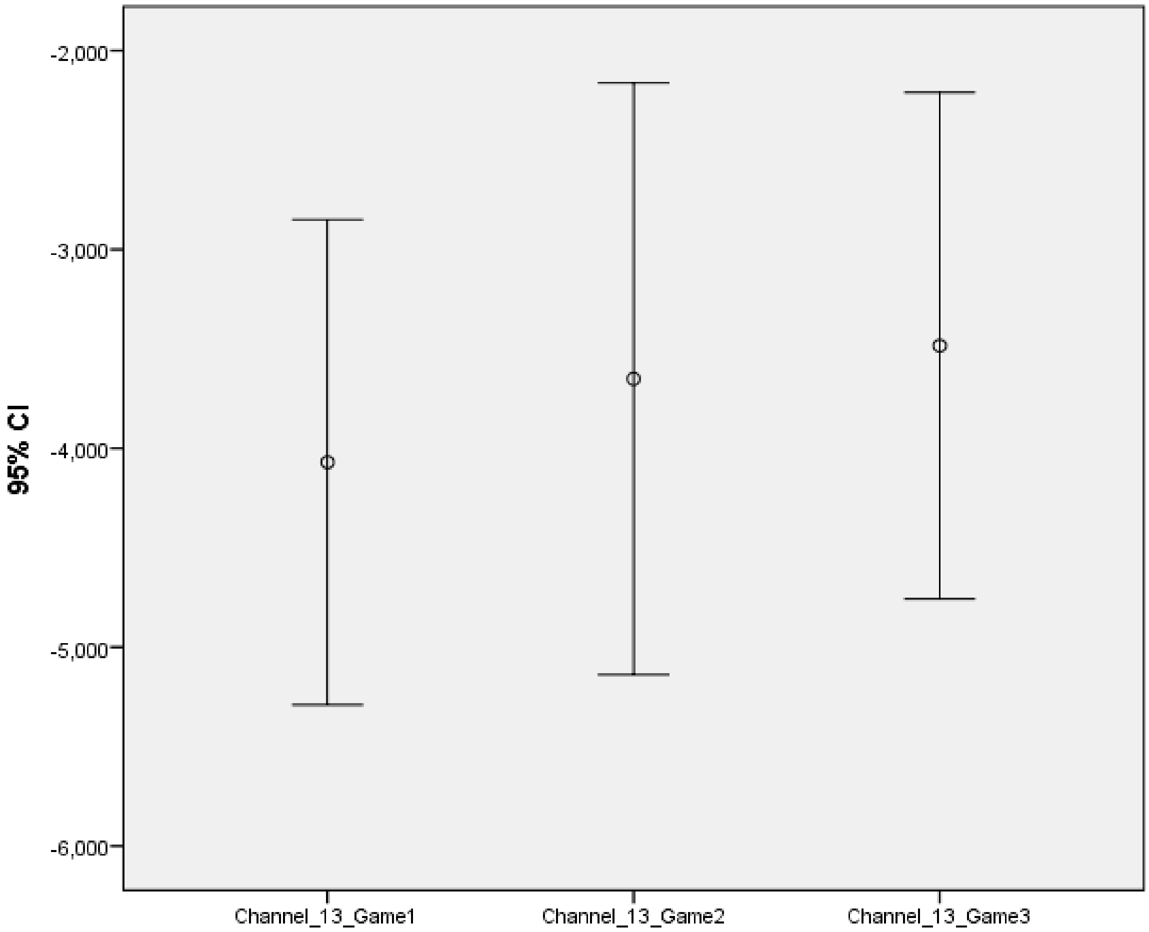
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_13	Sphericity Assumed	2187153.192	2	1093576.596	.498	.614	.043	.997	.121
	Greenhouse-Geisser	2187153.192	1.668	1311507.229	.498	.582	.043	.831	.115
	Huynh-Feldt	2187153.192	1.930	1133204.927	.498	.608	.043	.962	.120
	Lower-bound	2187153.192	1.000	2187153.192	.498	.495	.043	.498	.099
Error(Channel_13)	Sphericity Assumed	48264080.390	22	2193821.836					
	Greenhouse-Geisser	48264080.390	18.344	2631012.047					
	Huynh-Feldt	48264080.390	21.231	2273320.152					
	Lower-bound	48264080.390	11.000	4387643.672					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_17_Game1	-1849.6472	9039.40476	12
Channel_17_Game2	1623.7020	11282.28761	12
Channel_17_Game3	-384.1125	9892.05199	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_17	.929	.738	2	.691	.934	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_17

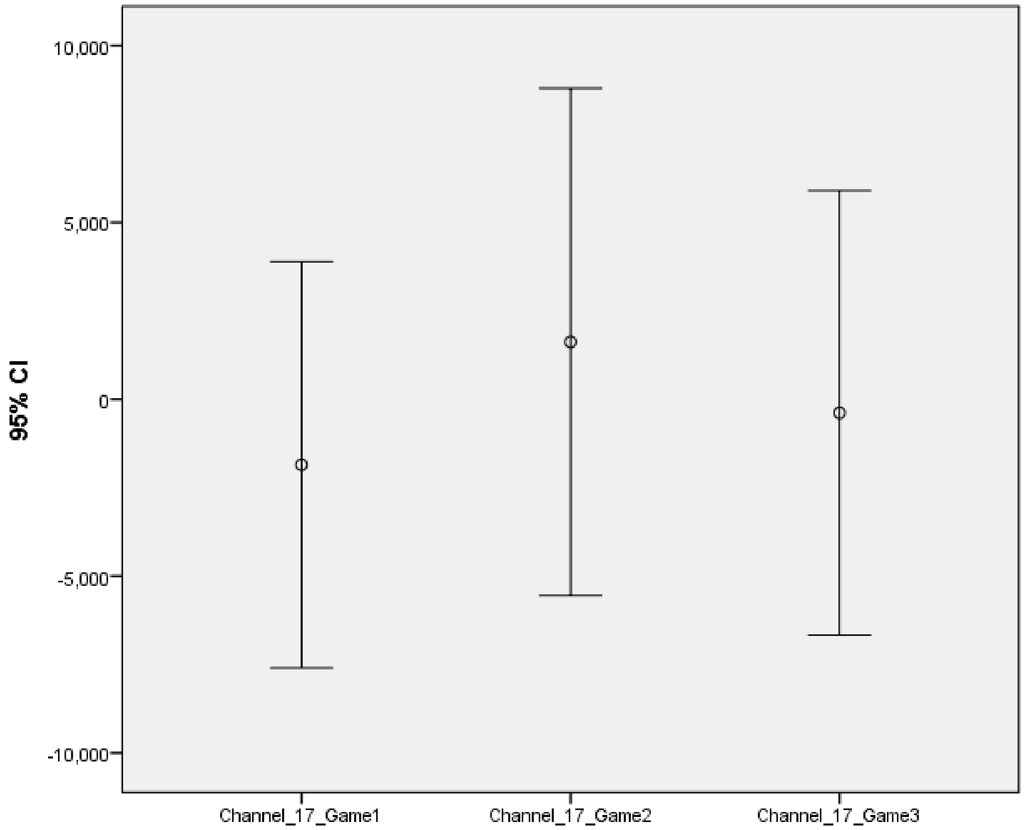
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_17	Sphericity Assumed	72973063.050	2	36486531.520	.327	.725	.029	.654	.096
	Greenhouse-Geisser	72973063.050	1.867	39082125.410	.327	.710	.029	.610	.094
	Huynh-Feldt	72973063.050	2.000	36486531.520	.327	.725	.029	.654	.096
	Lower-bound	72973063.050	1.000	72973063.050	.327	.579	.029	.327	.082
Error(Channel_17)	Sphericity Assumed	2455962125.000	22	111634642.000					
	Greenhouse-Geisser	2455962125.000	20.539	119576153.100					
	Huynh-Feldt	2455962125.000	22.000	111634642.000					
	Lower-bound	2455962125.000	11.000	223269284.100					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_14_Game1	1856.3713	4011.47654	12
Channel_14_Game2	3717.6508	5173.88136	12
Channel_14_Game3	2681.1407	5080.18194	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_14	.838	1.772	2	.412	.860	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_14

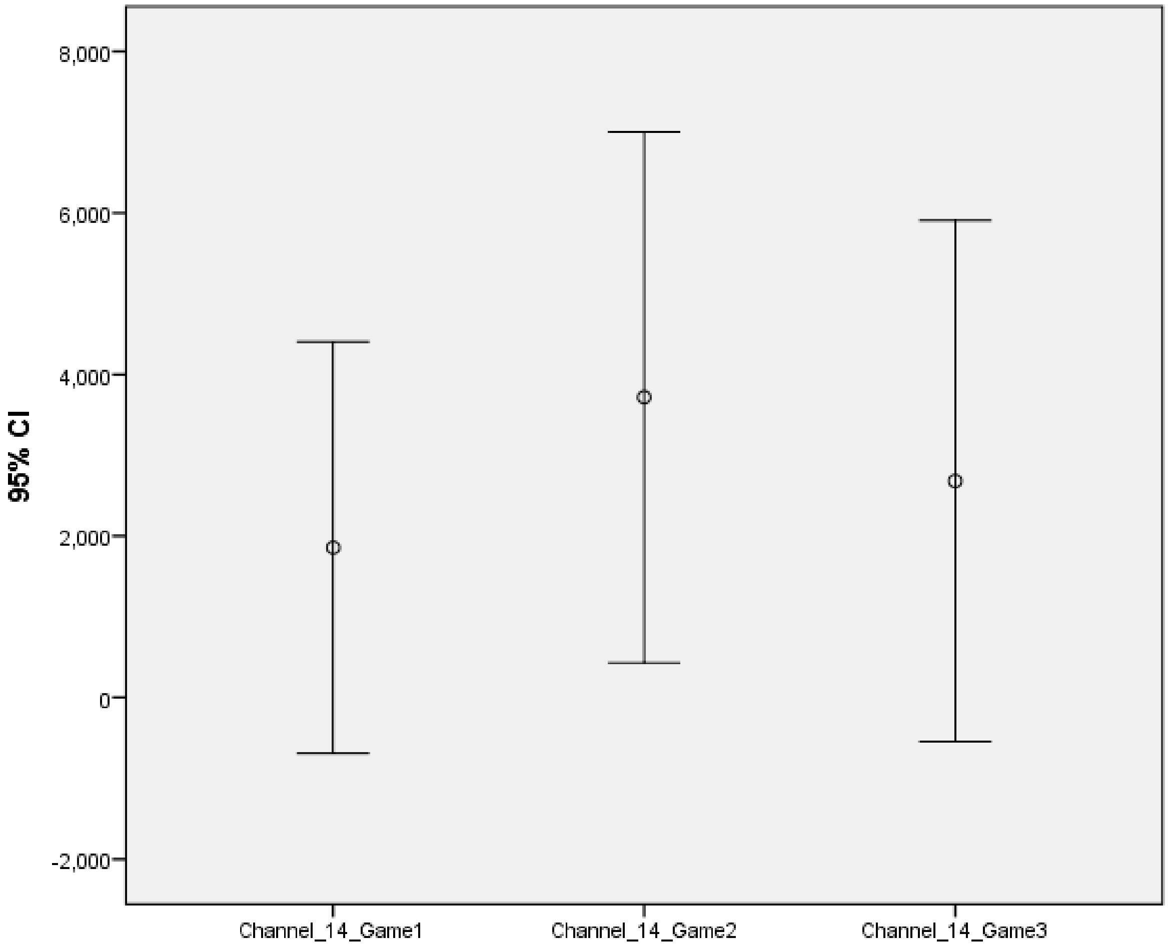
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_14	Sphericity Assumed	20875837.850	2	10437918.920	.809	.458	.069	1.618	.170
	Greenhouse-Geisser	20875837.850	1.721	12132828.500	.809	.443	.069	1.392	.160
	Huynh-Feldt	20875837.850	2.000	10437918.920	.809	.458	.069	1.618	.170
	Lower-bound	20875837.850	1.000	20875837.850	.809	.388	.069	.809	.130
Error(Channel_14)	Sphericity Assumed	283792750.800	22	12899670.490					
	Greenhouse-Geisser	283792750.800	18.927	14994319.350					
	Huynh-Feldt	283792750.800	22.000	12899670.490					
	Lower-bound	283792750.800	11.000	25799340.980					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_15_Game1	1863.8491	6550.56400	12
Channel_15_Game2	5300.7381	6530.29647	12
Channel_15_Game3	1499.1147	6213.71303	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_15	.516	6.618	2	.037	.674	.734	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_15

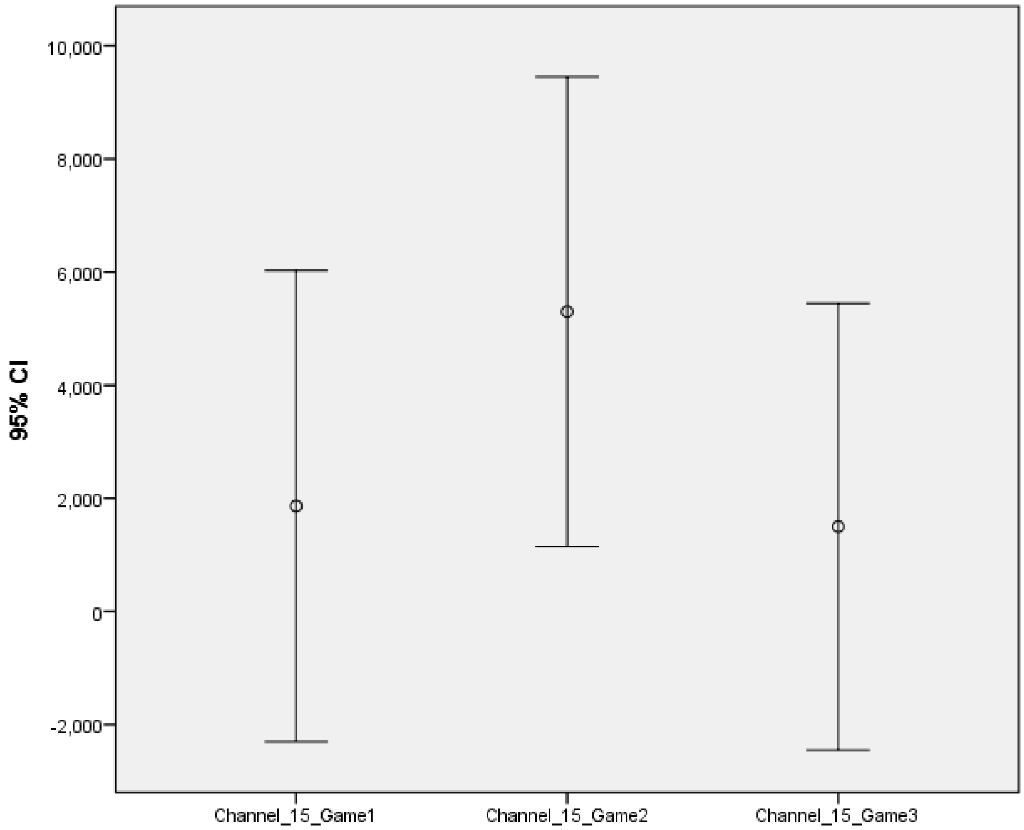
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_15	Sphericity Assumed	105590312.000	2	52795156.000	1.790	.190	.140	3.580	.333
	Greenhouse-Geisser	105590312.000	1.348	78350985.420	1.790	.204	.140	2.413	.269
	Huynh-Feldt	105590312.000	1.468	71916563.200	1.790	.201	.140	2.628	.281
	Lower-bound	105590312.000	1.000	105590312.000	1.790	.208	.140	1.790	.231
Error(Channel_15)	Sphericity Assumed	648821739.300	22	29491897.240					
	Greenhouse-Geisser	648821739.300	14.824	43767636.760					
	Huynh-Feldt	648821739.300	16.151	40173304.760					
	Lower-bound	648821739.300	11.000	58983794.480					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_16_Game1	455.8231	4957.44364	12
Channel_16_Game2	1884.3351	4144.54473	12
Channel_16_Game3	673.3748	3178.35854	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_16	.609	4.951	2	.084	.719	.798	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_16

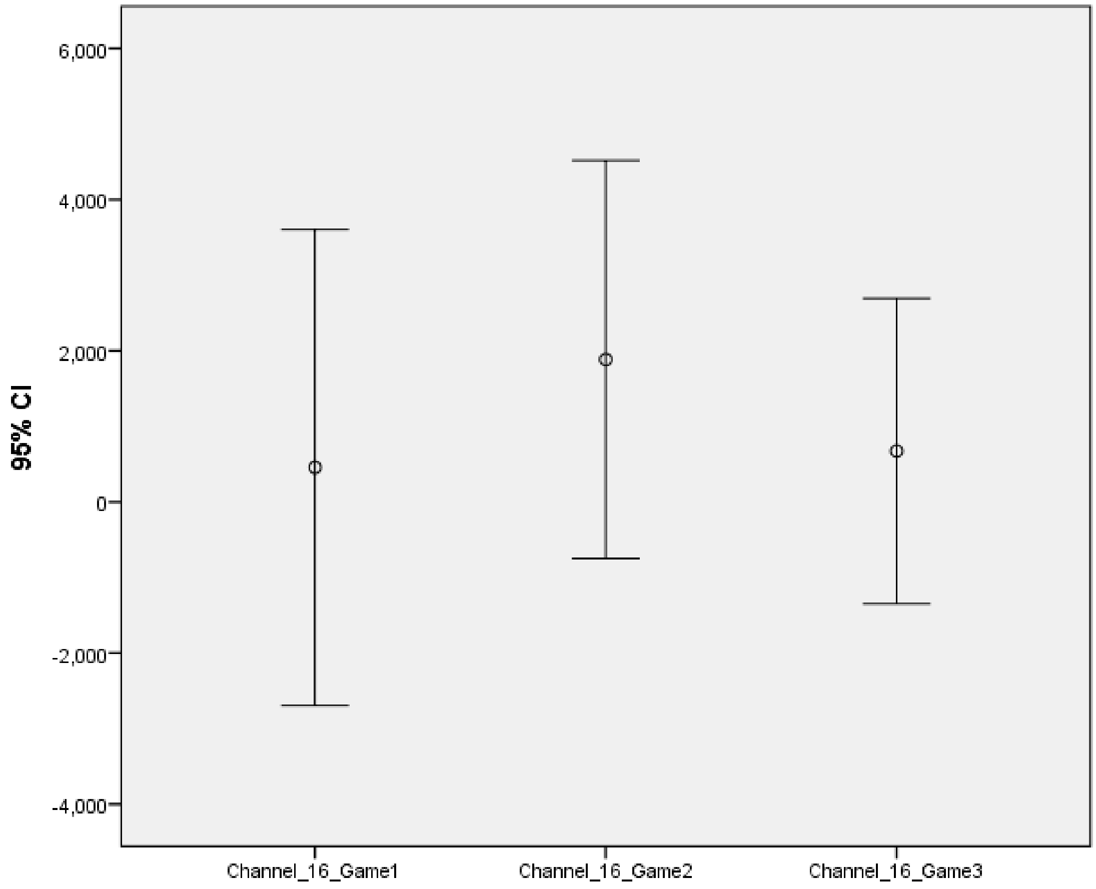
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_16	Sphericity Assumed	14217600.980	2	7108800.490	.516	.604	.045	1.032	.124
	Greenhouse-Geisser	14217600.980	1.438	9884912.292	.516	.548	.045	.743	.112
	Huynh-Feldt	14217600.980	1.596	8908675.352	.516	.565	.045	.824	.115
	Lower-bound	14217600.980	1.000	14217600.980	.516	.487	.045	.516	.101
Error(Channel_16)	Sphericity Assumed	302948459.800	22	13770384.530					
	Greenhouse-Geisser	302948459.800	15.821	19147962.240					
	Huynh-Feldt	302948459.800	17.555	17256903.670					
	Lower-bound	302948459.800	11.000	27540769.070					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_18_Game1	1126.5976	4750.18226	12
Channel_18_Game2	1976.1365	4533.63543	12
Channel_18_Game3	226.9972	4102.71107	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_18	.546	6.042	2	.049	.688	.754	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: Channel_18

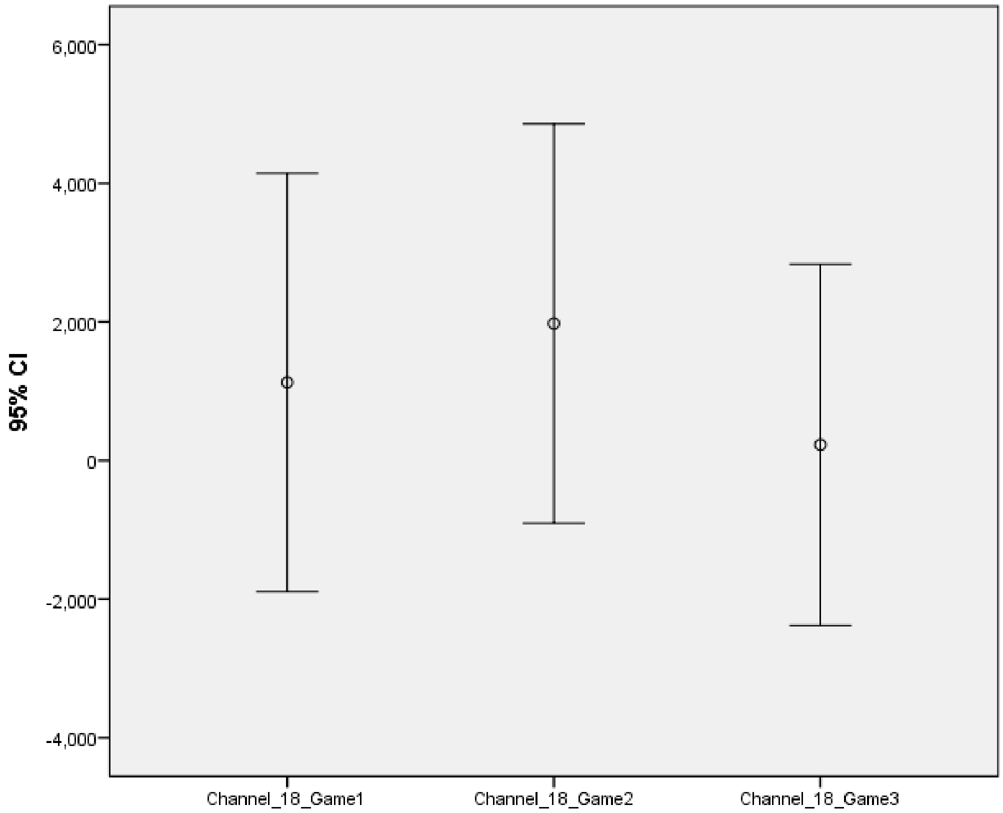
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_18	Sphericity Assumed	18361942.230	2	9180971.113	.614	.550	.053	1.228	.139
	Greenhouse-Geisser	18361942.230	1.376	13344660.960	.614	.496	.053	.845	.122
	Huynh-Feldt	18361942.230	1.508	12177450.980	.614	.509	.053	.926	.126
	Lower-bound	18361942.230	1.000	18361942.230	.614	.450	.053	.614	.111
Error(Channel_18)	Sphericity Assumed	328888538.100	22	14949479.000					
	Greenhouse-Geisser	328888538.100	15.136	21729262.230					
	Huynh-Feldt	328888538.100	16.587	19828681.030					
	Lower-bound	328888538.100	11.000	29898958.000					

a. Computed using alpha = .05



Descriptive Statistics

	Mean	Std. Deviation	N
Channel_19_Game1	1568.0779	5355.99538	12
Channel_19_Game2	4379.1285	5666.96757	12
Channel_19_Game3	1990.7330	4855.95392	12

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Channel_19	.798	2.261	2	.323	.832	.962	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
 Within Subjects Design: Channel_19

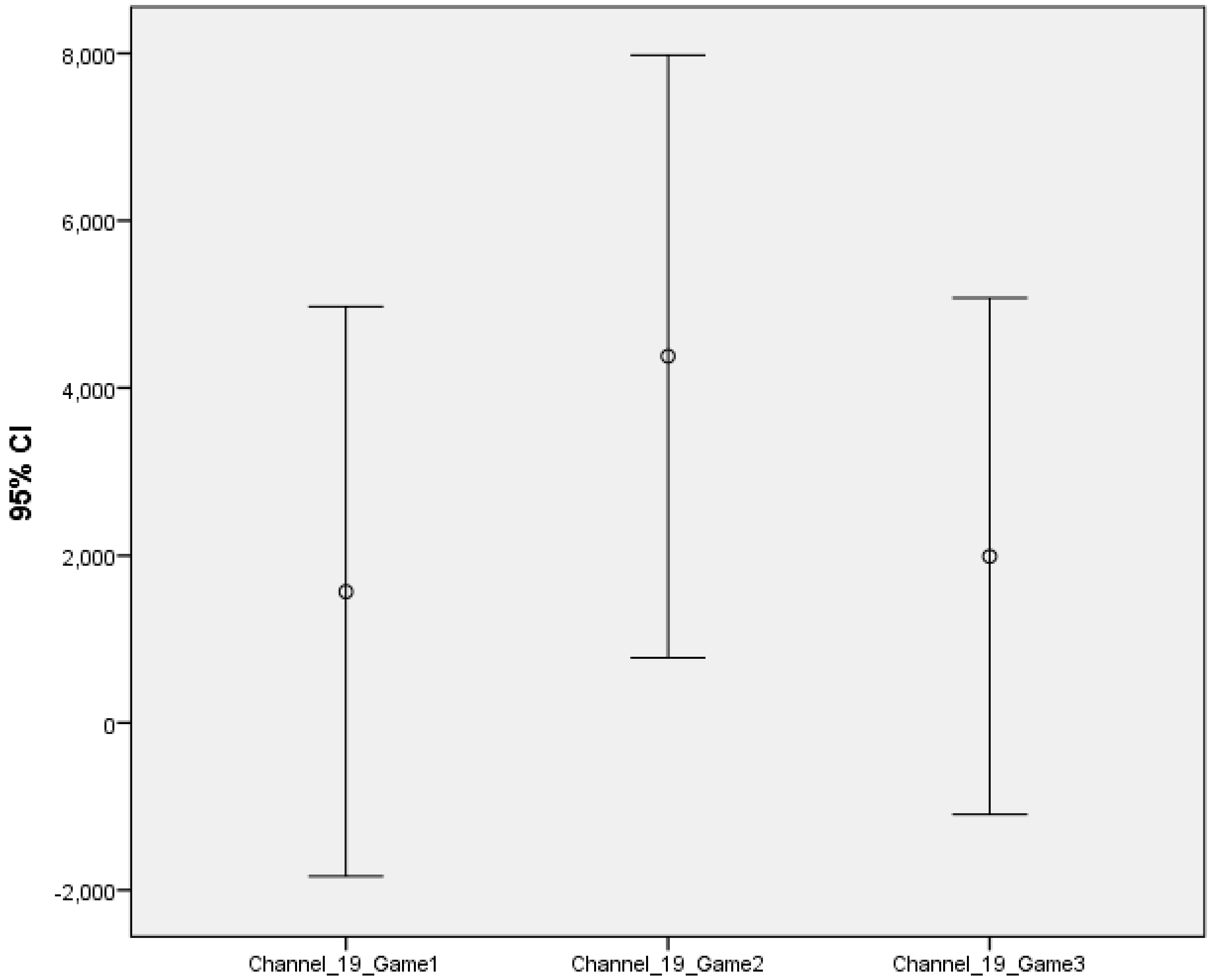
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Channel_19	Sphericity Assumed	55140299.900	2	27570149.950	1.108	.348	.091	2.215	.219
	Greenhouse-Geisser	55140299.900	1.663	33149626.250	1.108	.341	.091	1.842	.201
	Huynh-Feldt	55140299.900	1.924	28664225.220	1.108	.347	.091	2.131	.215
	Lower-bound	55140299.900	1.000	55140299.900	1.108	.315	.091	1.108	.161
Error(Channel_19)	Sphericity Assumed	547626518.600	22	24892114.480					
	Greenhouse-Geisser	547626518.600	18.297	29929626.540					
	Huynh-Feldt	547626518.600	21.160	25879916.390					
	Lower-bound	547626518.600	11.000	49784228.960					

a. Computed using alpha = .05


8,000
6,000
4,000
2,000
0
-2,000
95% CI
Channel_19_Game1
Channel_19_Game2
Channel_19_Game3

Appendices 3E

Cohen's *d* and 95% Confidence Intervals for Games 2-3 for all variables collected; Performance, Subjective self-reports, Psychophysiological data and 21-EEG Channel Power.

Performance Variables

Variables	Game 1 M (SD)	Game 2 M (SD)	Game 3 M (SD)	1−β (power)	F (df1 = 2, df2= 22)	h_p^2	*p*	Cohen's *d* [95% CI]
Total Points	1.67 -1.44	2 -1.28	2.1 -1.16	0.1	0.34	0.03	0.72	0.07 [-.73, .88]
Goal Difference	0.67 -1.9	0.75 -1.22	0.92 -1.44	0.06	0.08	0.01	0.92	0.11 [-.69, .91]
Ball Possession	51.33 -1.89	52 -3.59	51.54 -3.19	0.08	0.19	0.02	0.83	-0.17 [-.97, .63]
Number of Fouls*	4.42 -1.78	8.33 -2.27	9.92 -2.39	1	18.41	0.63	<.01	0.7 [-.13, 1.52]

Subjective Self-Reports

Variables	Game 1 M (SD)	Game 2 M (SD)	Game 3 M (SD)	1−β (power)	F (df1, df2)	h_p^2	*p*	Cohen's *d* [95% CI]
Arousal	7.85 (.96)	7.76 (.82)	7.68 (.93)	0.08	0.23 (2, 46)	0.01	0.79	-0.13 [-.93, .67]
Pleasantness	7.96 (.92)	7.67 (.82)	8.00 (.81)	0.27	1.32 (2, 46)	0.05	0.28	0.61 [-.21, 1.43]
Attention	7.92 (.88)	8.00 (.98)	7.99 (.74)	0.06	0.07 (2, 46)	0	0.93	-0.02 [-.82, .78
SE	7.92 (.95)	8.11 (.66)	7.64 (.94)	0.18	0.86 (2, 22)	0.07	0.44	-0.53 [-1.35, .28]
OE	7.81 (.77)	7.67 (.75)	7.36 (1.23)	0.21	1.06 (2, 22)	0.09	0.36	-0.4 [-1.21, .41
Likability	8.26 (.94)	7.76 (.85)	7.68 (.88)	0.53	2.82 (2, 46)	0.11	0.07	-0.12 [-.92, -.68]

Psychophysiological Data

Variables	Game 1 M (SD)	Game 2 M (SD)	Game 3 M (SD)	1−β (power)	F (df1, df2)	h_p^2	*p* value	Cohen's *d* [95% CI]
HR*	81.10 (5.40)	82.50 (5.90)	80.92 (6.52)	0.69	3.87 -2,238	0.03	0.02	-0.33 [-.58, -.07]
HRV*	50.78 (7.12)	50.50 (8.90)	55.21 (8.71)	0.99	12.96 (1.89,224.60)	0.1	0	0.59 [.33, .84]
Alpha Peak	9.98 (.19)	9.93 (.17)	10.08 (.21)	0.37	2 (2,22)	0.15	0.16	0.8 [-.03,1.63]
Theta/Beta	.62 (.25)	.60 (.26)	.65 (.18)	0.07	0.18 (2,22)	0.02	0.84	0.24 [-.56, 1.05]

21-EEG Channel Power

Brain Location	Variables	Game 1 M (SD)	Game 2 M (SD)	Game 3 M (SD)	1−β (power)	F (df1, df2)	h_p^2	*p*	Cohen's *d* [95% CI]
Frontal	Fp1	-6354.00 (3063.51)	-9001.83 (2354.41)	-7262.61 (2325.28)	0.58	3.38 (2,22)	0.24	0.05	0.69 [-.14, 1.51]
	Fp2	-6495.59 (3368.97)	-9570.45 (3323.08)	-7677.94 (3474.58)	0.58	3.38 (2,22)	0.24	0.05	0.65 [.17, 1.47]
	F7	-5736.71 (2189.77)	-7131.61 (1912.33)	-6280.70 (1688.08)	0.46	2.56 (2,22)	0.19	0.1	0.56 [-.26, 1.37]
	F3	3971.68 (5277.07)	5744.61 (3084.58)	5837.39 (2253.34)	0.25	1.83 (1.10, 11.99)	0.14	0.2	0.03 [-.77, .83]
	Fz	4710.33 (2622.82)	5811.38 (4069.10)	6880.13 (3337.93)	0.42	2.32 (2,22)	0.17	0.12	0.43 [-.38, 1.24]
	F4	1316.19 (4287.58)	1175.36 (6703.62)	-342.37 (5284.06)	0.17	0.79 (2,22)	0.07	0.46	-0.42 [-1.23, .39]
	F8	-6602.63 (2672.71)	-8155.72 (952.34)	-6758.70 (1691.00)	0.45	2.54 (2,22)	0.19	0.1	0.75 [-.08, .1.58]
Central	C3	6969.30 (4289.84)	9126.25 (3584.26)	8620.09 (1447.42)	0.52	3 (2,22)	0.22	0.33	-0.22 [-1.03, .58]
	Cz	5413.70 (2639.98)	7866.62 (3802.48)	7648.40 (3885.67)	0.49	2.79 (2,22)	0.2	0.08	-0.08 [-.88, .72]
	C4	2455.52 (4084.40)	4853.50 (3223.88)	2955.27 (3566.27)	0.27	1.41 (2,22)	0.11	0.27	-0.51 [-1.33, .30]

Brain Location	Variables	Game 1 M (SD)	Game 2 M (SD)	Game 3 M (SD)	1−β (power)	F (df1, df2)	h_p^2	*p*	Cohen's *d* [95% CI]
Temporal	T3	-6361.20 (2085.23)	-6917.21 (1192.79)	-6536.37 (918.43)	0.12	0.5 (2,22)	0.04	0.61	0.27 [-.53, 1.08]
	T4	7.62 (3809.56)	-1585.35 (5534.15)	-1737.18 (4251.06)	0.16	0.73 (2,22)	0.06	0.49	-0.04 [-.84, .76]
	T5	-4069.87 (1919.55)	-3650.55 (2342.57)	-3484.01 (2003.23)	0.11	0.49 (2,22)	0.09	0.63	0.11 [-.69 ,91]
	T6	-1849.65 (9039.40)	1623.70 (11282.29)	-384.11 (9892.05)	0.09	0.33 (2,22)	0.03	0.73	0.14 [-.99, .61]
Parietal	P3	1856.37 (4011.48)	3717.65 (5173.88)	2681.14 (5080.18)	0.17	0.81 (2,22)	0.07	0.46	0.23 [-1.10, .52]
	Pz	1863.85 (6550.56)	5300.74 (6530.30)	1499.11 (6213.71)	0.27	1.79 (1.35,14.82)	0.14	0.2	-0.7 [-1.52, .12]
	P4	455.82 (4957.44)	1884.34 (4144.54)	673.37 (3178.36)	0.12	0.52 (2,22)	0.05	0.6	-0.33 [-1.13, .48]
Occipital	O1	1126.60 (4750.18)	1976.14 (4533.64)	227.00 (4102.71)	0.12	.61 (1.38,15.14)	0.05	0.49	-0.45 [-1.26, .36]
	O2	1568.08 (5356.00)	4379.13 (5666.97)	1990.73 (4855.95)	0.22	1.11 (2,22)	0.09	0.35	-0.48 [-1.29, .33]