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Older Adult Video Game Preferences in Practice: Investigating the Effects of Competing or Cooperating

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Abstract

Video game interventions with the aim to improve cognition have shown promise for both younger (e.g., Powers et al., 2013) and older adults (e.g., Toril, Reales, and Ballesteros, 2014). Most studies suggest that fast-paced action games produce the largest benefits, but a recent video game intervention with older adults found that an action game intervention can result in poor adherence (Boot et al., 2013). To increase intervention adherence, we investigated older adult video game preferences that might bolster adherence by having participants play a competitive game (Mario Kart DS) or a cooperative game (Lego Star Wars: The Complete Saga) alone or with a partner. Although hypotheses regarding cooperative and multi-player gameplay were not supported, converging evidence suggests multi-player game play may lead to greater enjoyment, which was related to intervention adherence in a previous study (Boot et al., 2013). Insights for gaming intervention studies in older populations are also provided.

Keywords

Older Adults; Video Games; Multiplayer Gameplay; Competition; Cooperation

INTRODUCTION

Age-Related Cognitive Decline

As we age, various cognitive faculties begin to decline. Based on the findings of the Seattle Longitudinal Study, in which over 5,000 people were tested beginning in 1956, Schaie (2005) found that participants demonstrated a tendency to improve on primary mental abilities (e.g., verbal meaning, spatial orientation, inductive reasoning, numbering, and word fluency) until their late 30s or early 40s, and began to decline on these abilities beginning in their 60s, with this decline increasing in severity after they reached their 70s. Increases in age-related cognitive decline are associated with difficulty performing instrumental activities of daily living (IADLs; e.g., Stuck et al., 1999), which are essential tasks older adults must be able to perform to maintain their independence (see Salthouse, 2010, for a review of age-related cognitive change). This association between cognition and independence suggest that interventions capable of boosting cognition may have important and wide-ranging consequences.

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Intervention Strategies Combating Age-Related Cognitive Decline

In an effort to combat age-related cognitive decline, many intervention strategies have been employed by aging researchers (for a more in-depth review of aging interventions, see Hertzog, Kramer, Wilson, & Lindenberger, 2008). Some have focused on improving one specific aspect of cognition through "top down" strategy training (e.g., mnemonics training to strategically improve memory; Baltes & Kliegl, 1992), while others have focused on broadly increasing cognition through "bottom up" extended practice of cognitive abilities (e.g., Incrementally training discrimination through an increasingly difficult recognition task to improve memory; Jennings & Jacoby, 2003). In a review of far transfer (i.e., transfer of learning between different contexts) in cognitive training of older adults by Zelinski (2009), she concluded that extended practice training was superior to strategy training with older adults due to the fact that extended practice training requires less self-regulation in retrieval than strategy training. Zelinski also notes that an adaptive approach that remains challenging, but not overwhelmingly difficult, is central to extended practice training. Zelinski and Reyes (2009) discuss video games' potential use in extended practice interventions for older adults in their review on the subject, and state that action video games could be an ideal vehicle for administering extended practice training that trains general strategies through an adaptive approach (i.e., the player starts out on an easy beginner level and works their way up to more difficult levels).

Video Game Effects in Younger and Older Adults

Previous video game intervention studies have shown a number of abilities can be improved in young adults, such as mental rotation (De Lisi & Cammarano, 1996; Feng et al., 2007; Terlecki et al., 2008), and spatial attention (Feng et al., 2007; Green & Bavelier, 2003; 2006). Video game training interventions show great promise for use in older adult populations as well, with improvements found in older adults' task-switching, working memory, visual short-term memory, and reasoning abilities (Basak et al., 2008). Belchior et al. (2013) observed increases in selective visual attention after older adults played a first person shooter game (Medal of Honor). They even observed similar gains in visual attention, relative to no-contact controls, for older adults after playing Tetris, a game often used for active control groups in similar training studies with younger adults. While cardiovascular exercise has been shown to improve executive control processes in older adults (Colcombe & Kramer, 2003) as well as volume in the hippocampus (i.e., the brain structure thought to be the center for memory) and memory (Erickson et al., 2009), this level of activity is not possible for some seniors due to the fact that decline in cognitive function often coincides with physical declines (Black & Rush, 2002). A recent meta-analysis investigating whether extended practice interventions or aerobic exercise lead to significant improvement on untrained cognitive tasks by Hindin and Zelinski (2012) found that both intervention types produced gains in untrained cognitive tasks of similar Cohen's *d* effect size (both ES = 0.33), suggesting that both intervention types are similarly effective.

Challenges for Older Adult Video Game Interventions

There remain considerable challenges to meet for video games to be successful in improving older adult cognition. If existing, commercially available, video games are to be successfully used as a means of remediating age-related cognitive decline in older adults, adoption and use of video game technology is necessary. Some older adults do indeed consider themselves gamers, contrary to popular perception (i.e., someone that plays video games > 10 hours a week; e.g., Pearce, 2008; De Schutter, 2011). Since 1999, the Entertainment Software Association (ESA) has estimated 9% of the North American video game audience was over the age of 50, which rose to 19% in 2005, 24% in 2007, and 29% in 2011 (Entertainment Software Association, 2011). A study of baby-boomer gamers (Pearce, 2008) found that nearly a third of their sample, collected through online communities known to be frequented by gamers over the age of 40, played video games 20–40 hours a week, enough to classify them as “hardcore gamers”. Pearce (2008) also found that this population preferred intellectually challenging games over speed and reflex-oriented games, but reported playing a wide range of different genres. In a study of the population of older gamers in Flanders, De Schutter (2011) found that most of the older gamers (age range 45–85) sampled were females (57.9% of the sample) who prefer to play casual games (i.e., usually free online browser-based games) on their PC to challenge themselves.

While most video game systems have been designed with younger audiences in mind, usability issues with older adults are common. These issues may be minimized in the future with more emphasis during the design process on older adults’ needs (Charness & Boot, 2009), hopefully making future video game interventions in this population more enjoyable. Another crucial factor in determining whether or not older adults adopt a new technology is perceived benefit (Melenhorst, 2002). Along with perceived ease-of-use, perceived usefulness (benefit) is a central component to many models of technology acceptance such as Davis’ (1989) technology acceptance model (TAM) as well as Renaud and Biljon’s (2008) senior technology acceptance model (STAM). An important extension in STAM is the addition of a social influence factor, which raises an issue when it comes to video game adoption by older adults, who may be inclined to see video game usage at their age as being socially unacceptable, childish, or a waste of time (Sherry, Desouza, et al., 2003), despite recent evidence for video game-plays’ broad benefits in young adult populations (e.g., Powers et al., 2013). IJsselsteijn et al. (2007) note that this perceived lack of benefits in older adults may be more detrimental to digital game adoption than difficulties in learning how to use a new interface. The current study, rather than focusing on usability issues, seeks to find different aspects and methods of game-play in pre-existing, commercially available games that may help enhance older adults’ adherence to a proposed video game intervention.

Improving Adherence in Video Games by Adding a Social Interaction Component

One way of accomplishing the adherence goal is to highlight the opportunity for social interaction that is present in many commercially available video games. Social interaction has been shown to be positively related to cognitive functioning and there is experimental evidence to suggest that it facilitates cognitive performance (Ybarra et al., 2008).There is evidence in the physical exercise literature that when people exercise with others, especially in cohesive groups, they show better levels of adherence when compared to when they exercise alone (Burke et al., 2006; Carron, Hausenblas, & Mack, 1996; Dishman & Buckworth, 1996), but there is also counter evidence that older adults prefer to exercise alone (Wilcox, King, Brassington, & Ahn, 1999). However, Beauchamp, Carron, McCutcheon, & Harper (2007) found that older adults showed a positive preference for exercising in groups of similarly aged individuals. This suggests that older adults' adherence may indeed be improved in video game interventions involving a social component that consists of similarly aged participants, and in the case of video games, similarly skilled people. In studies of video game uses and gratifications, social interaction through multiplayer play has been shown to be a major predictor of playing time in younger gamers (Jansz & Tanis, 2007; Sherry, Desouza, et al., 2003; Sherry, Lucas, et al., 2006). Multiplayer video games, which can be either competitive or cooperative, seem to be one way of increasing social interaction. In an online survey study, Vorderer et al., (2003) found a correlation, albeit weak ($r=.10$, $p<.01$), between younger gamers' computer-game-specific self-efficacy and motivation to choose competitive computer games. Older adults are likely to have lower levels of computer-game-specific self-efficacy than the younger adults that took part in Vorderer and colleagues' (2003) study, suggesting that they would be more likely shy away from competitive computer games. Mayr et al. (2011) found that competitiveness peaks at age 50, and steadily declines with age, suggesting that competitive games may be most attractive from young to middle adulthood. Gajahdar et al. (2010) found that older adults were less competitive, anti-competitive even, when compared to younger adults in similarly designed empirical studies (Gajahdar et al., 2008, 2009a). Gajahdar and colleagues (2010) also observed that communication between older gamers was not focused on competitiveness, contrary to previous results found with younger adults (Gajadhar et al., 2009b). Similar to Pearce (2008) and Nap et al. (2009) who found that older adults enjoyed teaching and helping other players, older adults in the study were more interested in helping and supporting each other. This observation suggests that a successful video game intervention for older adults should steer away from competitive games, and toward cooperative games.

Do older adults perceive multiplayer video game-play as social? It evidently depends on the proximity of the other players. Nap et al. (2009) showed that older adults have negative perceptions of co-play over the internet due to fears of failure during competition, as well as not wanting to be tied to specific times when others would be available. They did however, like the idea of playing cooperatively with friends and relatives in the same room. Gajadhar et al. (2010) found that older adults felt more competent, challenged, and immersed and also had more fun when they played video games side-by-side rather than at a distance over the internet. Khoo and Cheok (2006) observed positive experiences in a co-located cross-generational multiplayer game in which grandparents played with their grandchildren and children.

One potential way of increasing adherence in video game interventions would be to take advantage of socioemotional selectivity theory (SST), which states that as individuals feel they have less time left in life, they become increasingly selective and choose to invest more time and resources into emotionally meaningful goals and activities, such as interacting with loved ones, over pursuing novel goals or activities (Carstensen et al., 1999). This emphasis on interacting with loved ones over pursuing novel activities (such as video games) is nicely illustrated in a study that investigated intergenerational play between grandparents and grandchildren in a variety of play interactions. Davis et al. (2011) observed that the grandchild was the center of the grandparents' attention for all assessed interactions, not the interaction itself. Even though there are older adults that consider themselves gamers (e.g., De Schutter, 2011), video games are something novel to many older adults, and through the lens of SST, represent an activity that is unlikely to be pursued with vigor. This is illustrated well by a recent intervention study using the hand-held Nintendo DS that suffered from low adherence rates in a fast-paced action video game that was disliked by many of the participants (Mario Kart DS), but greater adherence in a game designed for an older audience to enhance “brain fitness” that was relatively well-liked, though both suffered from some usability issues (Brain Age 2; Boot et al., 2013). Another important aspect of Boot et al. (2013) was that participants were paid for their participation, as well as provided with the game system and game. Even under these ideal conditions, attrition was high in the action game group, and the fact that participants in the brain fitness game played significantly more than those in the action game group echoes perceived benefit’s important role in technology adoption by older adults (Melenhorst, 2002). Perhaps one potential way of increasing adherence in action video game interventions in older adults may be to have participants play video games cooperatively with friends or loved ones. The social aspect might even help in retaining trained material. Whitlock et al. (2010) stated that pair-practice was largely successful in training their older participants on a complex computer game, and that their participants reported enjoying the pair-practice and wishing that it lasted longer.

Current Study and Hypotheses

The current study sought to investigate older adults’ video game preferences by giving them experience with a competitive game, Mario Kart DS (MK), or cooperative game, Lego Star Wars: The Complete Saga (LSW), playing either alone, or with their spouse/partner. After receiving training on their game, participants played their game alone, or with their spouse or partner for 7 hours over 10 days and kept a journal of their experience, including the amount of time played per session, and an enjoyment rating per session. It is hypothesized that participants given the cooperative game will play a longer amount of time in comparison to those given the competitive game (Hypothesis 1), and that they will also have more positive enjoyment ratings toward the game than those given the competitive game after the 10 day trial period (Hypothesis 2). It was also hypothesized that those in the multiplayer conditions would play their games longer (Hypothesis 3), and enjoy their games more than those in the single-player conditions (Hypothesis 4).

METHODS

Participants

In total 66 participants were recruited from the Tallahassee (58 total) and Miami (8 total) areas. Of the 66 participants, 39 were female. Group means and standard deviations for age, as well as sample size are presented in Table 1.

Most participants came from the Florida State University and University of Miami branches of the CREATE (Center for Research and Education on Aging and Technology Enhancement) labs’ participant databases, and had participated in previous studies. Individuals who had participated in the Boot et al. (2013) study were only contacted for piloting purposes, and were not contacted to participate in the current study. Participants not in the CREATE lab databases were recruited using general newspaper and television advertisements. Participants were recruited as couples, older than 65 years of age, and had to meet a pre-screen requirement of having a score higher than 25 on the Mini-Mental Status Examination (MMSE; Folstein, Folstein, & McHugh, 1975) and have an "intact" score on the Short Portable Mental Status Questionnaire (less than two errors; Pfeiffer, 1975), and show no significant memory deficits on the Wechsler Memory Scale (Logical Memory subscale; age-adjusted criterion; Wechsler, 1997) before inclusion in the study. Participants in the current study passed all pre-screen requirements. Due to difficulty finding participants, the age requirement was lowered, with the age range of the current sample being 55–88 years of age. The requirement for couples in the single player condition was eliminated as the data collection process went on, with couples being assigned to the multiplayer conditions and single participants filling out the single player conditions. A univariate ANOVA with player condition and game as between-subject factors and age as the dependent variable found no significant differences in age between player conditions ($F(1, 54) = 3.45$, $p = .07$, $MSE = 155.7$), game ($F(1, 54) = 0.020$, $p = .89$, $MSE = 0.898$), or the game by player condition interaction ($F(1, 54) = 1.32$, $p = .26$, $MSE = 59.8$). Eight participants from Miami introduced to the study through senior community groups did not provide their age and were not found in Miami's participant database to be contacted for this information. See Figure 1 for a consort diagram (see http://www.consort-statement.org/ for guidelines) of participation in the study.

Procedure

Participant couples came into the lab and were randomized into the cooperative (Lego Star Wars: The Complete Saga) or competitive (Mario Kart DS) game group, as well as randomized into single player or multiplayer condition. Danowski and Sacks (1980) found that small groups were preferred to individual instruction or large-groups when introducing older adults to computers, so large training groups were avoided, and small groups were used when possible (e.g., multi-player conditions). This gave the study a 2x2 design, giving four unique groups: Lego Star Wars multiplayer (LSW-M), Mario Kart DS multiplayer (MK-M), Lego Star Wars single-player (LSW-S), and Mario Kart DS single-player (MK-S). LSW is a "platform" game in which players fight against enemies and advance through levels in a 3-D environment. It was chosen partially because, while still falling under the action game genre, it presents more self-paced game-play than the fast-paced racing game MK, which was used in Boot et al. (2013), and was not very well liked by participants due to its fast pace and difficulty.

The participant was given LSW or MK and then trained on how to play their game with their co-located spouse or partner if they were in the multiplayer condition. If they were assigned to the single player condition, one of the couple was trained on one of the video games while the other completed an unrelated experiment during this training. The other member of the couple was eventually also given a game, and couples played different games and proceeded through the experiment serially, instead of in parallel for the multiplayer condition.

During training, participants were guided by lab assistants to learn the concept of their game, how to navigate the controls, and were taught how to play the game. Participants were able to ask the assistant for help with any difficulties. This hands-on training time was to give the participant experience with the game and to be sure the participant knew how to play the game outside of the lab, without assistance. There was a phone number that participants were told to call and ask for help if they found themselves stuck in their respective game. This training time with a partner also gave the participant practice playing with an individual who (usually) had comparable video game experience.

The participant had to meet specific training goals tailored to either game. Participants playing LSW had to attain relative mastery of controls, complete first level, learn how to save a game state, and learn how to make purchases using accrued points. Participants playing MK had to attain relative mastery of controls, go through an introduction to each of the different game types, and learn what the different items do in the game. After these training goals were met, and after at least 45 minutes of training, the participants ceased game-play and were then asked to fill out a Video-Game-Specific Self-Efficacy Scale (VGSE; Vorderer et al., 2003), a Game Experience Questionnaire (GEQ; IJsselsteijn, de Kort, & Poels, 2008; Poels, de Kort, & IJsselsteijn, 2008), and a workload index, the NASA-TLX (Hart & Staveland, 1988). All of these measures are described in the Measures section.

After this session, the participants took their game system home for a trial period of 10 days. They were asked to play a total of 7 hours over the course of the 10 days, and record the length of their playing sessions, their experience during their playing sessions, and their impressions of the game and game-play in a journal provided to them. When they returned to the lab after this time period, they brought back their game systems and journals and were given the same measures from their first session to see if experience with the game over the trial period had an effect on their previous video game-related attitudes. It is important to note that data collected at the second time point was reported in reference to the participants' in-home game-play over the trial period, and therefore was not an immediate reflection of recent gameplay, but rather a retrospective of their in-home experience with the game system over the 10 days.

Measures

GEQ-Core Module—Developed by IJsselsteijn, de Kort, and Poels (2008), this questionnaire assesses game experience as composite scores of seven components: Immersion, Flow, Competence, Positive and Negative Affect, Tension, and Challenge. Each composite score is composed of responses on at least 5 items (each composite score included an extra item for researchers interested in translating the measure for use in languages other than English). The GEQ is a relatively new measure that is still lacking validation, but there has been some material published on (Poels, de Kort, IJsselsteijn, 2012). Participants responded to brief statements on a 0–4 point scale (0: not at all, 1: slightly, 2: moderately, 3: fairly, 4: extremely).

NASA-TLX—This subjective, multidimensional assessment measure was developed by the Human Performance Group at NASA's Ames Research Center and is used to measure perceived workload in order to assess a task, system, or team's effectiveness or other aspects of performance (Hart & Staveland, 1988). It has been cited in over 550 studies (Hart, 2006) and is widely used in human factors research. The NASA-TLX provides scores for Mental Demand, Physical Demand, Temporal Demand, Performance, Effort, and Frustration. Participants are asked to place a mark within a line that has 20 delineated spaces (from low to high for all variables besides Performance, which goes from perfect to failure).

VGSE Scale—We used a form similar to that used in Vorderer et al. (2003) which was an adapted version of Schwarzer and Jerusalem's (1995) Generalized Self-Efficacy Scale that assesses self-efficacy in a video game context. Participants are given a video game-related statement (e.g., I can always manage to solve difficult problems in video games if I try hard enough) and asked to assess how true that statement is by circling one of four statements of increasing veracity (e.g., "Not at all true" through "Exactly true"). Participants' responses were averaged to give a VGSE score for each participant at both time points.

Coding of Qualitative Journal Data—To analyze participants' journal content, three trained coders independently coded participants' journal entries for statements of enjoyment, achievement/mastery, frustration, human factors-related issues (such as eye strain or fingers hurting from playing), insufficient in-lab training, and insufficient take-home instructional materials to see if any of these helped explain differences observed between game and player conditions.

RESULTS

Homogeneity of Variance Check between Dyads and Single Participants

Due to the LSW-M and MK-M conditions participating in dyads, there was expected to be less variance in these conditions, specifically, for playing time as dyads played together. Independent-samples t-tests were run on the player conditions for average session enjoyment rating and total time played. Results of the t-tests indicated that neither average session enjoyment rating ($t(58) = -1.37$, $p = 0.18$, $d = -0.33$) nor total time played ($t(58) = 0.36$, $p = 0.72$, $d = 15.7$) were significantly different across player condition (single versus multiplayer). Levene's test for equality of variances was not significant for average session enjoyment rating ($F(1, 58) = 0.76$, $p = 0.39$) but was significant for total time played ($F(1, 58) = 5.10$, $p = 0.03$), indicating homogeneity of variance across player conditions for average session enjoyment, but not total time played. Due to this violation, total time played analyses will use log transformed total time played values, for which Levene's test was not significant ($F(1, 58) = 3.25$, $p = 0.08$).

Hypothesis Testing

To test hypotheses 1 and 3, that participants in the LSW and multiplayer groups played their game longer than those in the other groups, a univariate ANOVA with game (MK or LSW) and player condition (single vs. multiplayer) as the between-subjects variables was performed on log transformed total playing time (in minutes). The ANOVA indicated no effect of player condition ($F(1, 59) = 0.12$, $p = 0.73$, $MSE = 0.01$), no effect of game ($F(1, 59) = 0.001$, $p = 0.98$, $MSE = 7.73\text{x}10^{-5}$), and no interaction between the two variables ($F(1, 59) = 1.30$, $p = 0.46$, $MSE = 0.10$). Figure 2 shows the hours played by player condition.

To test hypotheses 2 and 4, that participants in the LSW and multiplayer groups enjoyed their game more than those in the other groups, a univariate ANOVA was conducted with game and player condition as the between-subjects variables. The ANOVA for average session enjoyment indicated a marginal effect for player condition ($F(1, 59) = 3.90$, $p = 0.053$, $MSE = 2.72$) with players in the multiplayer condition reporting higher enjoyment ratings. A significant effect of game ($F(1, 59) = 12.96$, $p < 0.002$, $MSE = 9.06$) was also found, with participants that played MK reporting more enjoyment on average per session. The interaction between player condition and game ($F(1, 59) = 2.01$, $p = 0.16$, $MSE = 1.41$) was not significant. It should be noted that these responses are on a 5 point scale (1–5), and that average session enjoyment ratings trended around the neutral point in all groups (between 2 and 3). With that being said, values above 2.5 show a positive level of enjoyment. Figure 3 shows the means for average session enjoyment rating by game. Table 2 shows the group means and standard deviations for the enjoyment ratings and total hours played.

MK Adherence Compared to Boot et al. (2013)

Adherence in the MK game condition was compared between studies to investigate if the changes made in the current study significantly increased adherence. Total time played for those that played MK was analyzed and compared to those that played MK in Boot et al. (2013). As would be expected with such different requests in length of commitment, an *F* test found that the shorter intervention time (7 hours of gameplay over 10 days vs.60 hours over 3 months) in the current study lead to less variability in the amount of time played by participants who completed the intervention than in the previous Boot et al. (2013) study ($F(13, 32) = 43.73$, $p < 0.0001$). An independent samples *t*-test on the percentage adherence (capped at 100%) found that the current study's percentage adherence (79.05%, $SD = 30.17$) was significantly greater than the previous intervention (36.3%, $SD = 31.85$; $t(45) = 4.37$, $p < 0.0001$). A similar *t*-test was run on total time played and found that MK participants in Boot et al., (2013) played a greater amount ($t(45) = 4.62$, $p < 0.0001$).

Computing the Factor Scores for the GEQ and NASA-TLX

To see how participants' gameplay experiences (GEQ) and perceptions of workload demand (NASA-TLX) changed after experience with their game, both were assessed immediately after their initial exposure to their game, and again after their 10-day in-home experience. Factors scores were computed to reduce the chance of type I error due to the study's low sample size and the large number of variables to be analyzed among the composite scores of the GEQ and NASA-TLX, as well as the unknown factor structures of both of the measures in question. Factor scores were computed for the GEQ's seven composite scores (Competence, Immersion, Flow, Tension, Challenge, Negative Affect, Positive Affect) and the NASA-TLX's six scores (Mental Demand, Physical Demand, Temporal Demand, Performance, Effort, Frustration) for both time points. Strict factorial invariance and three factors for each scale were assumed using Mplus (Muthén & Muthén, 1998–2011) to conduct an exploratory factor analysis using a GEOMIN rotation that allowed the factors to be correlated. The intercepts, variances, and factorial loadings of the observed GEQ and NASA-TLX items were held the same at the two time points in order to ensure comparability of the factors at both time points, while the factorial mean and factorial variance were allowed to be free. The factor structure provided adequate model fit, based on the chi-square test of model fit of X^2 (233) = 317.7, $p < 0.001$, an RMSEA of 0.074 with a 90% confidence interval of 0.052 to 0.094, CFI = 0.915, TLI = 0.881. See Table 3 for a comparison of factor structures and their indices of fit. Factor loadings and their significances for the GEQ and NASA-TLX respectively are provided in Tables 4 and 5. Note that the STDYX standardized loadings are reported since the covariates are continuous. These loadings are more like standardized regression coefficients than correlations, so values above 1 should be possible (Jöreskog, 1999). As should be expected, the STDYX standardized loadings and variances vary at post-training measurement and measurement after the 10-day in-home trial period since we allowed them to vary between both measurement points, while the unstandardized values were identical between post-training measurement and measurement after the 10-day in-home trial period. A correlation matrix of the GEQ and NASA-TLX factors is provided in Table 6.

GEQ Factor Score Analyses

A two-way, repeated measures ANOVA was performed on the three factor scores positive game experience (a combination of competence, immersion, positive affect, and flow), challenging learning (a combination of flow, tension, challenge, and negative competence), and negative game experience (a combination of tension, challenge, negative affect, and a negative coefficient for positive affect) for both post-training measurement and measurement after the 10-day in-home trial period with player condition and game as between-subjects variables and factor and time point as within-subject variables. See the in-depth results of the GEQ factor score ANOVA in Table 5. The ANOVA revealed a significant three way interaction of time of measurement, factor, and game (F(1.33, 82.15) = 14.39, $p < 0.001$, MSE = 0.86). A follow-up contrast revealed that the negative game experience factor saw a greater increase after the 10-day in-home trial period for those that played LSW instead of MK (F(1, 64) = 14.13, $p < 0.001$, MSE = 16.87), while the positive game experience factor and the challenging learning factor both showed greater decreases after the 10-day in-home trial period for those that played LSW than those that played MK (F(1, 64) = 6.34, $p < 0.02$, MSE = 3.85) and (F(1, 64) = 16.30, $p < 0.001$, MSE = 13.92) respectively. Figure 4 illustrates the relationships between time of measurement, game, and GEQ factor. The increase in the negative game experience factor, combined with the significantly greater decreases in the positive game experience factor and the challenging learning factor suggest that LSW participants were considerably less engaged and more frustrated than their MK counterparts.

NASA-TLX Factor Score Analyses

A two-way, repeated measures ANOVA was performed on the three factor scores game engagement (a combination of physical demand, temporal demand, and performance), mental effort (a combination of mental demand and effort), and frustration (just frustration) for the two time points with player condition and game as between-subjects variables and factor and time point as within-subject variables. The ANOVA revealed a three-way interaction between time, NASA-TLX factor, and game (F(1.21, 75.03) = 8.62, $p < 0.004$, MSE = 1.34). A follow-up contrast of this three-way interaction showed that the game engagement factor was found to increase for the MK group after the in-home trial period, while it decreased for those that played LSW ($F(1, 64) = 5.02$, $p < 0.03$, $MSE = 3.02$) and the frustration factor increased significantly more for the LSW group than those who played MK ($F(1, 64) = 8.64$, $p < 0.006$, $MSE = 26.17$). The mental effort factor did not vary significantly by game over this time period ($F(1, 64) = 1.61$, $p = 0.21$, $MSE = 1.17$). These relationships are graphically represented in Figure 5. MK participants' rise in game engagement and LSW participants' decline further suggests that LSW participants were not as engaged as their MK counterparts as well more frustrated, as evidenced by significantly higher scores on that factor, despite reporting indistinguishable levels of mental effort.

Video Game-Specific Self-Efficacy Analyses

Next, we explored the effect of player condition and game on participants' video game-specific self-efficacy ratings. A two-way, repeated measures ANOVA was performed on participants' VGSE scores at the two time points to investigate the effect of gameplay experience on VGSE with player condition and game as between-subjects variables and time point as the within-subjects variable. The ANOVA revealed a main effect of time ($F(1, 62) = 7.05$, $p < 0.02$, $MSE = 0.86$) and an interaction of time and game ($F(1, 62) = 12.98$, $p < 0.002$, $MSE = 1.58$), indicating that the VGSE scores differed by game and time point. A follow-up contrast of this interaction found that participants playing different games did not show a difference in VGSE at time 1 ($F(1, 62) = 0.681$, $p = 0.41$, $MSE = 0.26$), but those that played MK had higher VGSE scores at time 2 ($F(1, 62) = 4.88$, $p < 0.032$, $MSE = 1.58$).

Qualitative Analyses of Journal Entries

For insight into how participants' game experience during the in-home usage went, three trained coders read participants' journal entries, and kept a count of mentions of enjoyment, in-game achievement or mastery, frustration, human factors related issues, insufficient in-lab training, and insufficient take-home materials. Inter-rater reliability between the three coders was calculated after the first 62 participants, and was found to be good (see Table 9 for Kappa values between the three raters). Average values for each qualitatively coded variable by group are presented in Table 10.As a secondary validity check we regressed the GEQ and NASA-TLX factor scores on each qualitative measure, and with the exception of human factors-related issues the multiple correlation was significant with the largest being .61 for qualitative enjoyment. A two-way MANOVA with player condition and game as between-subjects variables and the qualitative ratings for enjoyment, achievement/mastery, frustration, human factors issues, insufficient training, and insufficient take-home materials were used as the within-subjects variables. This MANOVA revealed main effects of both player condition ($F(6, 51) = 2.73$, $p < 0.023$, Partial Eta$^2 = 0.243$) and game ($F(6, 51) = 5.49$, $p < 0.001$, Partial Eta$^2 = 0.392$). The multivariate tests for player condition revealed significant differences in mentions of enjoyment with the multiplayer condition reporting more enjoyment in their journal entries ($F(1, 59) = 4.85$, $p < 0.033$, $MSE = 14.88$). Those in the multiplayer condition also were more likely to report that the take-home instructional materials were insufficient for trouble-shooting problems in the game ($F(1, 59) = 5.34$, $p < 0.025$, $MSE = 5.49$). The multivariate tests for game revealed that participants playing MK reported more enjoyment ($F(1, 59) = 12.43$, $p < 0.002$, $MSE = 38.12$) as well as more human factors issues ($F(1, 59) = 8.64$, $p < 0.006$, $MSE = 22.53$), while participants playing LSW reported significantly more frustration ($F(1, 59) = 18.91$, $p < 0.001$, $MSE = 93.42$) and were more likely to state that the take-home materials were insufficient ($F(1, 59) = 5.34$, $p < 0.025$, $MSE = 5.49$). These relationships are illustrated in Figures 6 and 7.

DISCUSSION

We sought to investigate older adult video game preferences by having participants play a cooperative or competitive game with or without a partner from the comfort of their home over a period of 10 days, and looking at that experience's effect on playing times and enjoyment ratings. The a priori hypotheses of more time played and higher enjoyment ratings within those who played a cooperative game with a partner were not observed. We next outline some of the reasons for this finding, highlighting overlooked characteristics of cognitive aging interventions using video games and the characteristics of the games used in them.

Differences between Games

The cooperative LSW and the competitive MK differed greatly in what they demanded from the player(s) in terms of pre-requisite knowledge of video game concepts (i.e., unfamiliar "adventure" game concept in LSW vs. familiar racing game concept in MK) as well as time needed to make meaningful in-game progress, and these differences likely affected the current study in unexpected ways. Compared to MK's concept of racing with its real-world analog, older participants' relative unfamiliarity with the "platform adventure game" concept that was fundamental to LSW plausibly lead LSW participants to record more qualitative frustrations in their journals, more complaints of the take-home reference materials being insufficient, report higher levels of frustration on their NASA-TLX's, as well as higher levels of the negative game experience factor on their GEQs. LSW participants reported lower levels of video game specific self-efficacy than MK participants after experience with their game as well. Despite recording more human factors-related issues with the game such as eye, hand, or neck strain from gameplay in their journals, MK participants gave significantly higher enjoyment ratings per session and also reported more enjoyment in their journals than those who played LSW. Future studies interested in looking at the differential effects of competitive and cooperative gameplay would be well-advised to select a single game that offers both types of gameplay in order to avoid such between-game differences.

In order to save progress in LSW, participants were required to complete a level: a task that took most participants nearly an hour, whereas MK participants could play in increments of 3–5 minutes (the time needed to complete a race or challenge). This difference between gameplay demands highlights an important video game preference of older adults: they are not typically "marathon" gamers like many younger adults are. Games designed with older adults in mind, or chosen for future aging interventions, should have similar small gameplay intervals that do not require full attention for long blocks of time in order to make progress.

Differences between Player Conditions

Converging evidence of multi-player game play's positive effect on enjoyment (the marginally significant effect on average enjoyment ratings as well as significantly more statements of enjoyment found in the coded journal entries seems) suggest that having older adults play video games with a peer can potentially raise levels of enjoyment, which were found to influence the overall amount of time played in Boot et al., (2013). There were significantly more statements of enjoyment in the multiplayer and MK conditions made by participants in their journals, as shown in Figures 6 & 7, though the interaction of player condition and game was not found to be significant.

The nature of participants' interactions with each other when playing the cooperative or competitive game was contrary to a priori hypotheses. Though speculative, this may be due to competitors of similar levels of skill and familiarity enjoying MK, while cooperators that often lacked familiarity with LSW's game concepts had a less enjoyable and more frustrating experience. MK was partially chosen as the competitive game in the current study because it was not well-liked in Boot et al. (2013), with participants complaining about finding the game boring and repetitive, its controls being difficult on those with arthritis, its temporally demanding gameplay, the amount of knowledge needed to play (e.g., what certain items do and how to use them), as well as the difficulty of the computer opponent that controlled the other racers. LSW provided a cooperative "adventure" action game that was not as temporally demanding as MK, as well as more forgiving in terms of computer difficulty, with more open-ended gameplay as well. Participants could explore its levels at their own pace and could collaborate with a partner to solve the game's puzzles and play through its story, or so it was thought. The previously discussed lack of concept familiarity lead to many participants having difficulty retaining the training they received in the lab, forcing them to continually reference the game designer's instruction manual that was written in poorly contrasting, small font size. In fact, some participants in the LSW multiplayer group mentioned in their journals that they had assigned one of them to "look through the book" for hints while the other continued to try different things in the game. This lead to more confusion than successful cooperation for many, which was clear from the high levels of frustration in those that played LSW. Conversely, competing against a partner of similar skill in MK was found to be much more enjoyable than expected. Not only did competing with a similarly skill-matched player take care of the computer difficulty problems experienced in Boot et al., (2013), it seemed to have a motivating effect for some.

Caution in Interpreting Adherence Differences between Boot et al., (2013)

It should be acknowledged that differences in terms of adherence and enjoyment between this study and Boot et al., (2013) are speculative, and may not be due to playing with others alone. The large differences between participants' required level of commitment relative to the current study (60 hours over 3 months vs. 7 hours over 10 days), the enhancements made to the training materials based on the difficulties encountered in Boot et al., (2013), as well as overall amount of training participants received could all be potentially driving the differences in adherence. Since there was no cognitive data collected in the current study, participants were not fatigued from a taxing battery of tests and had the benefit of devoting most of the time in the lab to game training. Future video game interventions would be well-served to separate cognitive testing and training days as well, so that participant performance on the cognitive battery and retention of trained material are both maximized.

Limitations and Recommendations

The current study was not without its limitations. Difficulty finding participants lead to a smaller than ideal sample size, despite the initial inclusion criteria being lowered (e.g., age) or eliminated (e.g., need to be part of a couple in single player condition). One reason for this was that the current study was presented to potential participants as, “a study on older adult video game preferences.” Many older adults that were contacted for participation were wholly uninterested in such a study, based solely on this description. Another limitation was the previously mentioned lack of similarity in gameplay demands for older adults. Participants in this study took nearly an hour to complete a level in LSW, whereas each race in MK lasted 3–5 minutes, leading to marked differences in enjoyment and adherence. Future studies would be well-served to use games with similar gameplay time demands, if not the same game that has both competitive and cooperative modes. A final limitation was the difference between LSW participants’ performance during the initial training session and their in-home performance. Though trained for a similar amount of time than their MK counterparts, LSW participants seemingly retained far less of their training, as evidenced by their higher levels of frustration in their journal entries, disapproval of the take-home material’s sufficiency, and overall lower play times and enjoyment ratings.

The current study sought to investigate older adult video game preferences for cooperative or competitive gameplay with or without a partner that might be leveraged to increase adherence to and enjoyment in cognitive aging interventions using action video games. Even though a priori hypotheses were not upheld, the study provides insights for future video game interventions in older adult populations. Shorter intervention periods might lead to greater percentage intervention adherence with less variation, as evidenced by the comparison of MK adherence between this study and Boot et al., (2013). Longer interventions would most likely benefit from periodic “booster” sessions in which participants return to the lab with their game and demonstrate their abilities or ask questions about any difficulties they may be having with their game. Basak et al. (2008) had participants play their games in-lab only, and while that might be prohibitive in terms of labor and resources, booster sessions could serve a similar purpose if scheduled regularly enough. Booster sessions could also help cut down on frustrations related to insufficient training or take-home instructional materials, and provide the researcher with an opportunity to track how the participants are progressing through the intervention as well. Despite the finding in Mayr et al., (2011) that competitiveness peaks in the 50s, properly-matched competition seemed to benefit enjoyment of MK in the current study. Cooperative games selected for older adult use in interventions should avoid being too confusing by taking advantage of familiar, real-world concepts, or minimizing the amount of video game familiarity or experience needed to enjoy them, as the current cohort of older adults is largely unfamiliar with video games’ idiosyncrasies.

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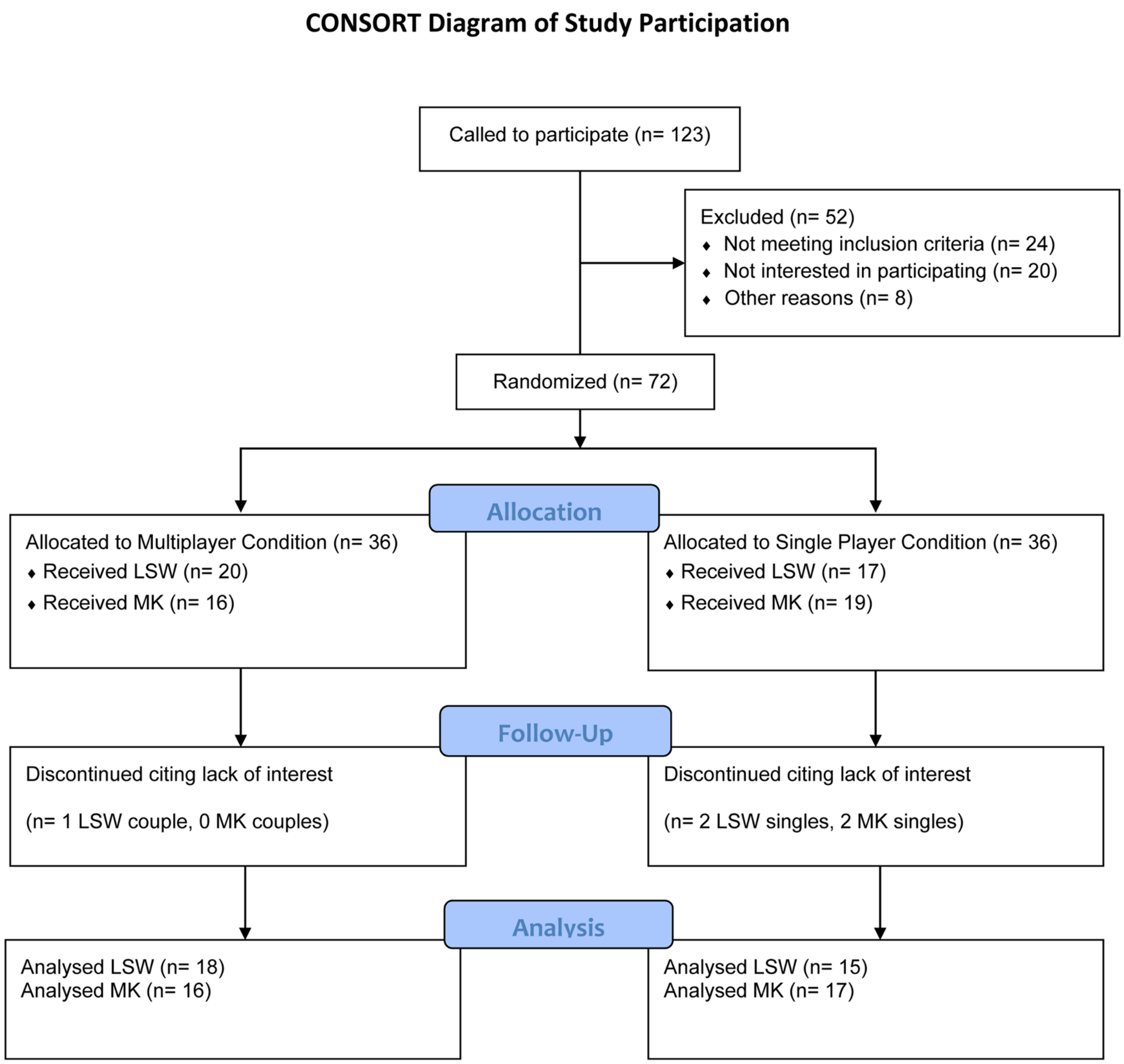

Figure 1.
CONSORT Diagram of Study Participation

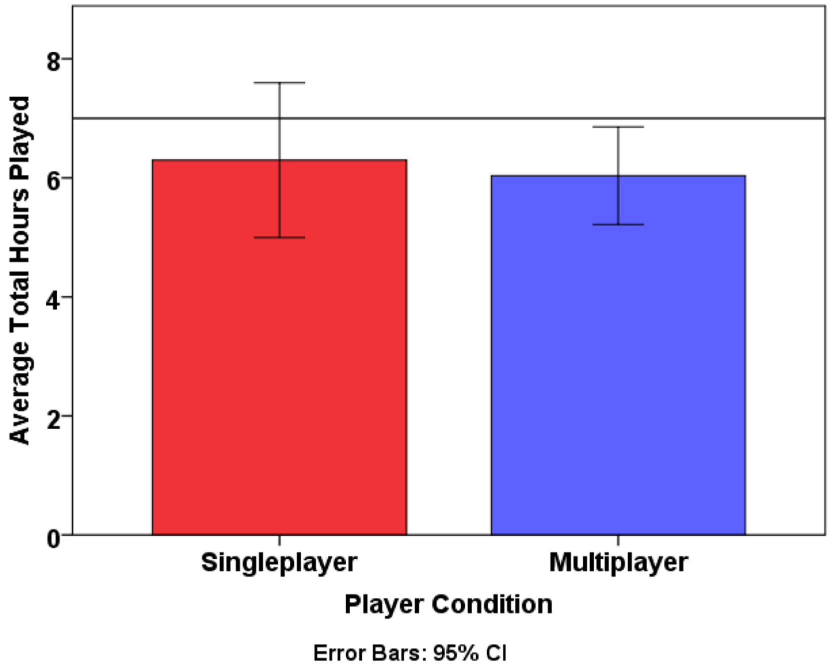

Figure 2.

Average Total Hours Played by Player Condition.

Line placed at the amount of time requested of participants by experimenters (7 hours over the 10 days)

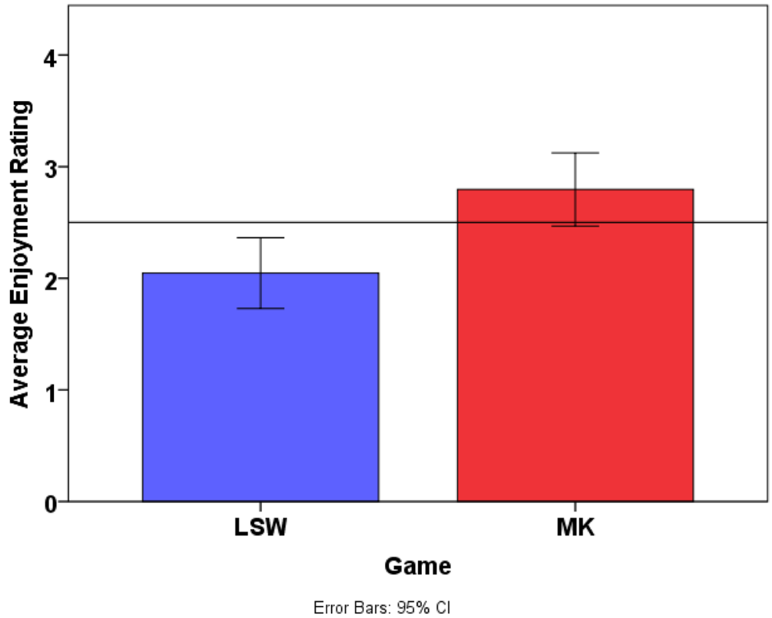

Figure 3.

Average Session Enjoyment Score by Game.

Line placed at 2.5 to show neutral point of enjoyment scale

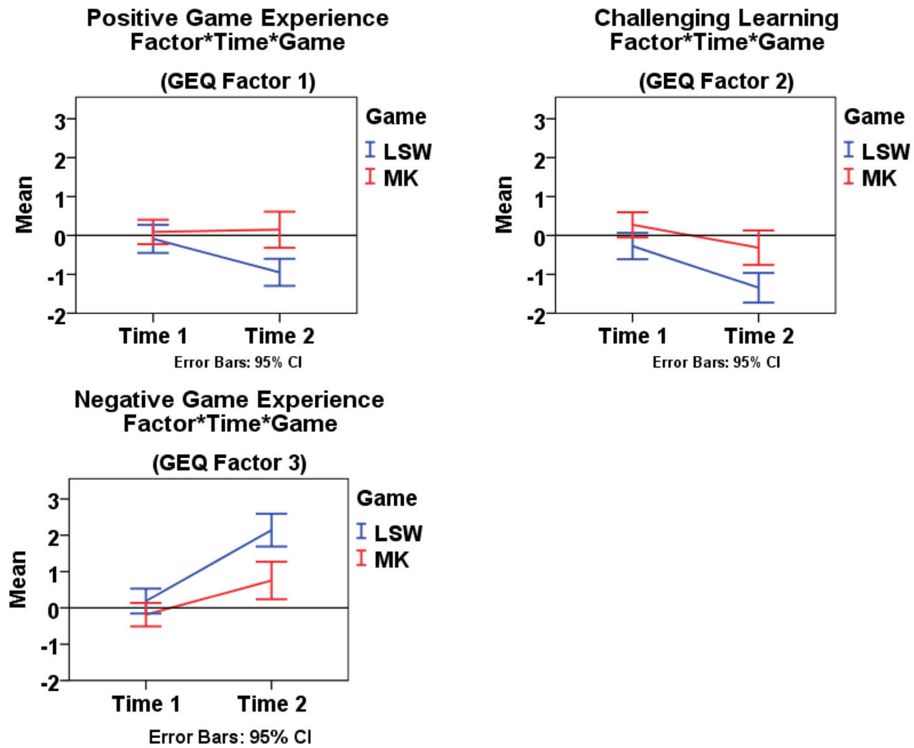

Figure 4.

GEQ Factor Scores* Time *Game Interaction

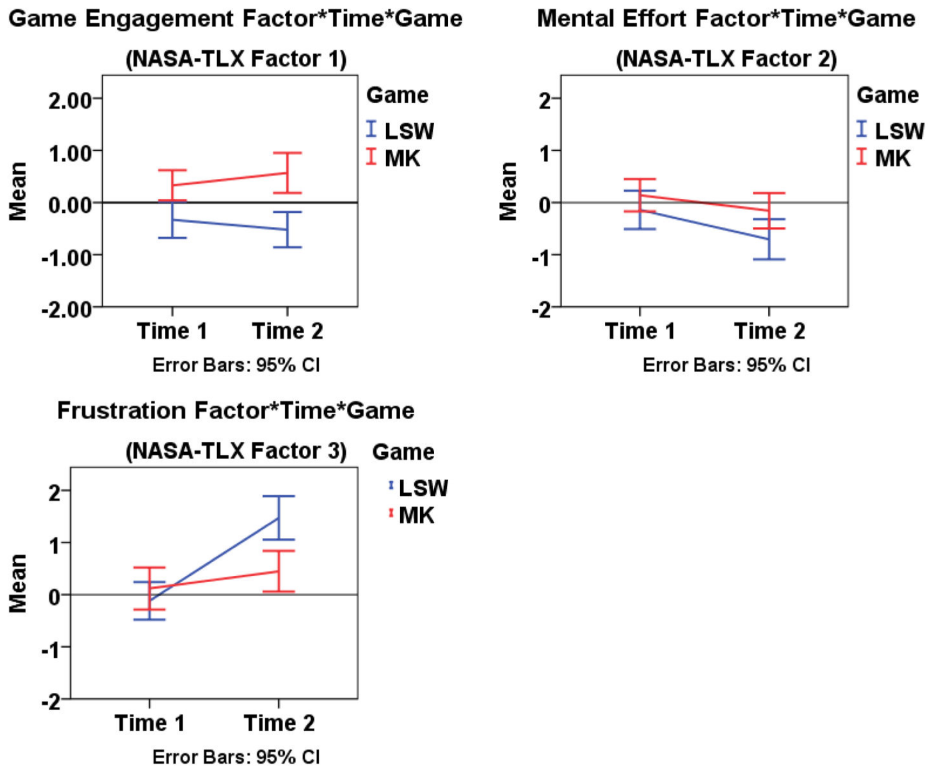

Figure 5.
NASA-TLX Factor Scores*Time*Game Interaction

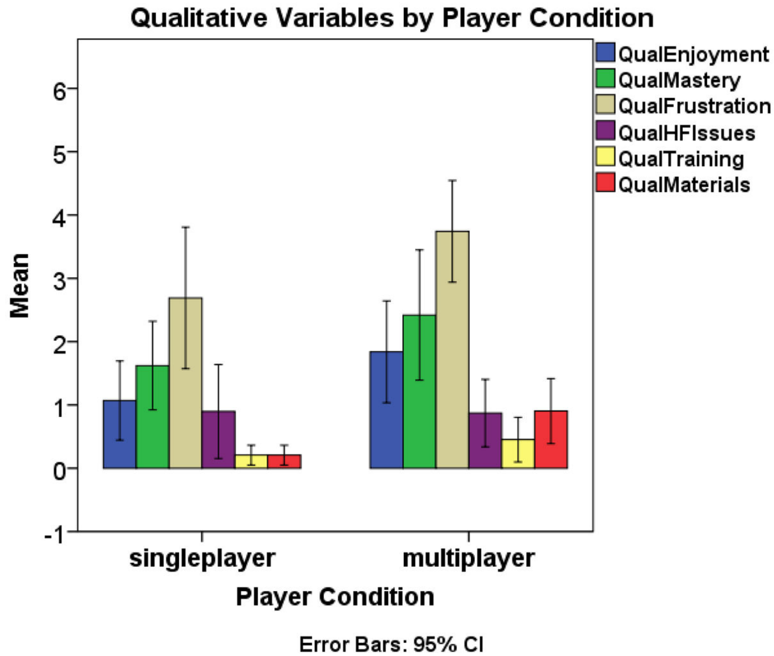

Figure 6.
Qualitative Variables by Player Condition

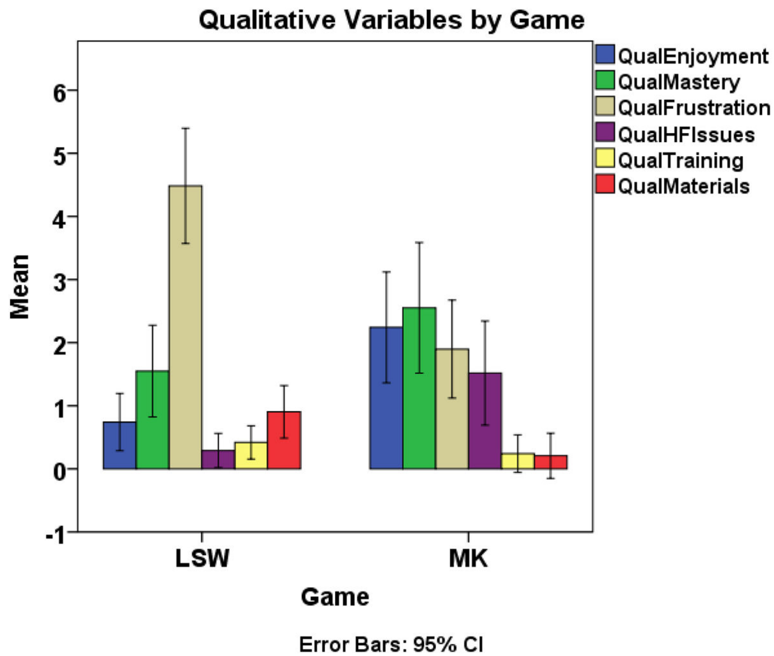

Figure 7.
Qualitative Variables by Game

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Table 1

Group Characteristics

Group	***N***	**Mean Age (*SD*)**
LSW-M	18	75.08 (8.91)
MK-M	16	72.79 (8.63)
LSW-S	15	69.73 (4.76)
MK-S	17	71.53 (4.20)

LSW denotes Lego Star Wars, MK denotes Mario Kart DS, M denotes multiplayer, and S denotes single-player

Table 2

Enjoyment Ratings & Hours Played by Group

Group	Average Enjoyment Rating (SD)	Average Total Hours Played (SD)
LSW-M	2.09 (0.907)	5.73 (2.53)
MK-M	3.19 (0.728)	6.41 (1.92)
LSW-S	1.97 (0.788)	6.55 (3.14)
MK-S	2.45 (0.873)	6.11 (3.59)

Table 3

GEQ & NASA-TLX Factor Structure Comparisons

Factor Structure	CFI	TLI	RMSEA	X^2 Test of Model Fit	X^2 Difference Test
3 GEQ 3 NASA	0.915	0.881	0.074, 90% CI = 0.052, 0.094	X^2 (233) = 317.7, $p < 0.001$	
3 GEQ 2 NASA	0.880	0.849	0.083, 90% CI = 0.064, 0.101	X^2 (258) = 376.6, $p < 0.001$	X^2 (25) = 58.9, $p < 0.001$
3 GEQ 1 NASA	0.759	0.721	0.113, 90% CI = 0.098, 0.129	X^2 (281) = 519.8, $p < 0.001$	X^2 (48) = 202.1, $p < 0.001$
2 GEQ 3 NASA	0.823	0.778	0.101, 90% CI = 0.085, 0.118	X^2 (259) = 434.8, $p < 0.001$	X^2 (26) = 117.1, $p < 0.001$
2 GEQ 2 NASA	0.788	0.754	0.107, 90% CI = 0.091, 0.122	X^2 (280) = 490.5, $p < 0.001$	X^2(47) = 172.9, $p < 0.001$
2 GEQ 1 NASA	0.669	0.640	0.129, 90% CI = 0.115, 0.143	X^2 (299) = 627.7, $p < 0.001$	X^2 (66) = 310.0, $p < 0.001$
1 GEQ 3 NASA	0.663	0.613	0.134, 90% CI = 0.119, 0.148	X^2 (283) = 616.9, $p < 0.001$	X^2 (50) = 299.2, $p < 0.001$
1 GEQ 2 NASA	0.629	0.599	0.136, 90% CI = 0.122, 0.150	X^2 (300) = 667.6, $p < 0.001$	X^2 (67) = 349.9, $p < 0.001$
1 GEQ 1 NASA	0.539	0.524	0.148, 90% CI = 0.135, 0.162	X^2 (315) = 772.3, $p < 0.001$	X^2 (82) = 454.6, $p < 0.001$

X^2 Difference Test is a comparison to the best model, the one with three factors for both the GEQ and NASA-TLX.

Table 4

GEQ Factor Loadings

Post-Training Measurement

Composite Score	**Positive Game Experience T1** Loading	**Positive Game Experience T1** Significance	**Challenging Learning T1** Loading	**Challenging Learning T1** Significance	**Negative Game Experience T1** Loading	**Negative Game Experience T1** Significance
Competence	**1.003**	***p* < 0.001**	**−0.358**	***p* < 0.015**		
Immersion	**0.614**	***p* < 0.001**				
Flow	**0.256**	***p* < 0.009**	**0.510**	***p* < 0.001**		
Tension			**0.720**	***p* < 0.001**	**0.925**	***p* < 0.001**
Challenge			**1.025**	***p* < 0.001**	**0.274**	***p* < 0.022**
Negative Affect					**0.739**	***p* < 0.001**
Positive Affect	**0.569**	***p* < 0.001**			**−0.444**	***p* < 0.001**

Measurement after the 10-Day In-Home Trial Period

Composite Score	Positive Game Experience T2 Loading	Positive Game Experience T2 Significance	Challenging Learning T2 Loading	Challenging Learning T2 Significance	Negative Game Experience T2 Loading	Negative Game Experience T2 Significance
Competence	**1.198**	***p* < 0.001**	**−0.423**	***p* < 0.015**		
Immersion	**0.659**	***p* < 0.001**				
Flow	**0.276**	***p* < 0.013**	**0.545**	***p* < 0.001**		
Tension			**0.829**	***p* < 0.001**	**1.294**	***p* < 0.001**
Challenge			**1.180**	***p* < 0.001**	**0.383**	***p* < 0.018**
Negative Affect					**0.912**	***p* < 0.001**
Positive Affect	**0.521**	***p* < 0.001**			**0.490**	***p* < 0.001**

Non-significant values are suppressed. These loadings are more like regression coefficients than they are correlations, so values above 1 are acceptable (Jöreskog, 1999). Significant factor loadings lower than .250 are not reported. The unstandardized values were fixed to be equal but extractions were allowed to be different, which is why the standardized coefficients look different that the unstandardized.

Table 5

NASA-TLX Factor Loadings

Post-training measurement

Scale	**Game Engagement T1**		**Mental Effort T1**		**Frustration T1**	
	Loading	**Significance**	**Loading**	**Significance**	**Loading**	**Significance**
Mental Demand			**0.650**	$p < 0.001$		
Physical Demand	**0.389**	$p < 0.002$				
Temporal Demand	**0.666**	$p < 0.001$				
Performance	**0.376**	$p < 0.013$				
Effort			**0.876**	$p < 0.001$		
Frustration					**1.000**	$p < 0.001$

Measurement After the 10-Day In-Home Trial Period

Scale	Game Engagement T2		Mental Effort T2		Frustration T2	
	Loading	Significance	Loading	Significance	Loading	Significance
Mental Demand			**0.673**	$p < 0.001$		
Physical Demand	**0.381**	$p < 0.002$				
Temporal Demand	**0.728**	$p < 0.001$				
Performance	**0.422**	$p < 0.015$				
Effort			**0.922**	$p < 0.001$		
Frustration					**1.000**	$p < 0.001$

The unstandardized values were fixed to be equal but extractions were allowed to be different, which is why the standardized coefficients look different than the unstandardized.

Table 6

GEQ and NASA-TLX Factor Score Correlations

	G1_F1	G1_F2	G1_F3	G2_F1	G2_F2	G2_F3	N1_F1	N1_F2	N1_F3	N2_F1	N2_F2	N2_F3
G1_F1	1											
G1_F2	**−0.489**	1										
	$p < 0.001$											
G1_F3	**−0.541**	**−0.455**	1									
	$p < 0.001$	**$p < 0.001$**										
G2_F1	**0.609**	**0.578**	**0.477**	1								
	$p < 0.001$	**$p < 0.001$**	**$p < 0.001$**									
G2_F2	**0.462**	**0.769**	−0.570	**0.794**	1							
	$p < 0.001$	**$p < 0.001$**	**$p < 0.001$**	**$p < 0.001$**								
G2_F3	**−0.281**	**−0.435**	**0.621**	**−0.760**	**−0.731**	1						
	$p < 0.03$	**$p < 0.001$**	**$p < 0.001$**	**$p < 0.001$**	**$p < 0.001$**							
N1_F1	−0.020	**0.582**	0.001	**0.327**	**0.479**	−0.157	1					
	$p = 0.874$	**$p < 0.001$**	$p = 0.994$	**$p < 0.008$**	**$p < 0.001$**	$p = 0.207$						
N1_F2	−0.015	**0.547**	**−0.358**	0.087	**0.324**	−0.197	**0.712**	1				
	$p = 0.907$	**$p < 0.001$**	**$p < 0.004$**	$p = 0.488$	**$p < 0.009$**	$p = 0.112$	**$p < 0.001$**					
N1_F3	**−0.321**	**0.152**	**0.563**	−0.151	0.078	0.130	**0.397**	0.174	1			
	$p < 0.01$	**$p = 0.222$**	**$p < 0.001$**	$p = 0.228$	$p = 0.532$	$p = 0.300$	**$p < 0.002$**	$p = 0.161$				
N2_F1	0.239	**0.692**	−0.097	**0.648**	**0.794**	**−0.493**	**0.727**	**0.365**	**0.499**	1		
	$p = 0.053$	**$p < 0.001$**	$p = 0.438$	**$p < 0.001$**	**$p < 0.001$**	**$p < 0.001$**	**$p < 0.001$**	**$p < 0.004$**	**$p < 0.001$**			
N2_F2	0.229	**0.623**	**−0.357**	**0.282**	**0.570**	**−0.252**	**0.709**	**0.642**	0.238	**0.671**	1	
	$p = 0.064$	**$p < 0.001$**	**$p < 0.004$**	**$p < 0.03$**	**$p < 0.001$**	**$p < 0.05$**	**$p < 0.001$**	**$p < 0.001$**	$p = 0.055$	**$p < 0.001$**		
N2_F3	−0.141	−0.073	**0.244**	**−0.460**	**−0.296**	**0.637**	−0.041	**−0.007**	**−0.257**	**−0.334**	**−0.066**	1
	$p = 0.259$	$p = 0.561$	**$p < 0.05$**	**$p < 0.001$**	**$p < 0.02$**	**$p < 0.001$**	$p = 0.745$	**$p = 0.955$**	**$p < 0.04$**	**$p < 0.007$**	**$p = 0.600$**	

Significant correlations are marked in bold. GEQ factors are signified by G1 and G2 for post-training measurement and measurement after the 10-day in-home trial period, respectively. NASA-TLX factors are signified by N1and N2. Factors are ordered the same as in Tables 2 and 3

Table 7

Two-Way Repeated Measures ANOVA on GEQ Factor Scores

Source	*df*	*F*	η	*p*
		Between Subjects		
Player Condition (P)	1	0.86	0.014	0.36
Game (G)	1	3.07	0.047	0.09
P*G	1	1.23	0.019	0.273
Within-Group Error	62	*MSE* = 1.18		
		Within Subjects		
Time (T)	1	2.73	0.042	0.1
T*P	1	0.01	$1.66\text{x}10^{-4}$	0.92
T*G	1	2.27	0.035	0.14
T*P*G	1	0.117	0.002	0.733
Within-Group Error (Time)	62		*MSE* = 0.185	
Factor (F)	1.29	20.14	0.245	< 0.0001**
F*P	1.29	1.31	0.021	0.267
F*G	1.29	12.1	0.163	< 0.0001**
F*P*G	1.29	0.874	0.014	0.379
Within-Group Error (Factor)	80.03	*MSE* = 3.67		
T*F	1.33	82.76	0.572	< 0.0001**
T*F*P	1.33	0.014	$2.18\text{x}10^{-4}$	0.952
T*F*G	1.33	14.39	0.188	< 0.0001**
T*F*P*G	1.33	2.42	0.038	0.114
T*F Within-Group Error	82.15	*MSE* = 0.86		

Greenhouse-Geisser values reported. Asterisks denote significant *p*-values.

Table 8

Two-Way Repeated Measures ANOVA on NASA-TLX Factor Scores

Source	*df*	*F*	η	*p*
Between Subjects				
Player Condition (P)	1	0.112	0.002	0.739
T*Game (G)	1	3.19	0.049	0.079
T*P*G	1	0.01	$1.54\text{x}10^{-4}$	0.923
Within-Group Error	62	*MSE* = 2.69		
Within Subjects				
Time (T)	1	5.18	0.077	.026**
T*P	1	0.009		0.926
T*G	1	1.36	0.021	0.248
T*P*G	1	15.35	0.024	0.22
Within-Group Error (Time)	62	*MSE* = 0.609		
Factor (F)	1.69	21.44	0.257	< 0.0001**
F*P	1.69	0.102	0.002	0.872
F*G	1.69	17.75	0.223	< 0.0001**
F*P*G	1.69	0.171	0.003	0.807
Within-Group Error (Factor)	104.46	*MSE* = 0.908		
T*F	1.21	20.19	0.246	< 0.0001**
T*F*P	1.21	0.246	0.004	0.667
T*F*G	1.21	8.62	0.122	0.003**
T*F*P*G	1.21	0.135	0.002	0.762
T*F Within-Group Error	75.03	*MSE* = 1.34		

Greenhouse-Geisser values reported. Asterisks denote significant *p*-values.

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Table 9

Inter-rater Reliability Ratings (Kappa)

Qualitative Variable	Raters 1 & 2	Raters 1 & 3	Raters 2 & 3
Enjoyment	0.498	0.445	0.573
Achievement/Mastery	0.538	0.535	0.409
Frustration	0.649	0.427	0.455
HF Issues	0.805	0.954	0.763
Insufficient Training	0.520	0.647	0.656
Take-home Materials Insufficient	0.573	0.595	0.507

Table 10

Qualitative Journal Variable Averages (SD) By Group

Variable	LSW-M	MK-M	LSW-S	MK-S
Enjoyment	0.833 (1.34)	3.23 (2.42)	0.615 (1.12)	1.44 (1.93)
Mastery	1.72 (2.24)	3.38 (3.28)	1.31 (1.60)	1.88 (2.03)
Frustration	4.33 (1.75)	2.92 (2.53)	4.69 (3.33)	1.06 (0.998)
HF Issues	0.222 (0.732)	1.77 (1.74)	0.384 (0.768)	1.31 (2.50)
Insuff. Training	0.389 (0.850)	0.539 (1.13)	0.462 (0.519)	0 (0)
Take-Home Materials Insuff.	1.22 (1.35)	0.462 (1.39)	0.462 (0.519)	0 (0)