Gaming preferences of aging generations

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K.A. Blocker, T.J. Wright, W.R. Boot, Gaming preferences of aging generations. Gerontechnology 2014;12(3):174-184; doi:10.4017/gt.2014.12.3.008.00 Increasing evidence suggests that action digital game training can improve a variety of perceptual and cognitive abilities, including those that decline most with age. Unfortunately, previous work has found that older adults dislike these games and adherence may be poor for action game-based interventions. The focus of the current study was to better understand the types of games older adults are willing to play and explore predictors of game preference (e.g., gender, age, technology experience, personality). With this information action games might be modified or developed to maximize adherence and cognitive benefit. Older adults were administered a modified version of an existing game questionnaire and a custom game preference survey. Clear preferences were observed that were similar between participants with and without previous digital game experience (with puzzle and intellectually stimulating games being most interesting to older adults in our sample, and massively multiplayer online games and first-person shooters being least interesting). Personality, demographic, and technology experience variables were also collected. Interesting trends suggested the possibility that several demographic and personality variables might be predictive of game preference. Results have implications for future directions of research, designing games that would appeal to older adult audiences, and for how to design custom games to maximize intervention adherence based on individual difference characteristics.

Keywords: video games, older adults, technology adoption, technology acceptance

The United States and many other industrialized nations face a rise in the proportion of their populations consisting of older adults in the next four decades[1]. A question of increasing importance is how to help seniors maintain the cognitive abilities that support their performance of daily activities required for independent living[2]. Observed relations between declining cognitive abilities and difficulty performing the everyday tasks required for independence suggest that by improving basic cognitive functioning, it may be possible to help seniors maintain their independence longer[3,4].

Unfortunately, methods to improve general cognitive abilities have been elusive[2,5]. Training on one task typically improves performance on that task, but it is rare that this training benefits the performance of other tasks (transfer is narrow rather than broad). Rather than engaging in 'brain training' to improve the performance of everyday tasks, a large body of research suggests that time might be better spent directly training or supporting these everyday tasks (e.g., driver education and training, changes to roadway design to improve driving performance of aging road-users). However, a recently proposed exception to this general rule of 'narrow transfer of training' is training that involves digital games. Digital game training, since it appears to produce general cognitive and perceptual improvements on tasks other than the game itself, may be one of the most promising methods currently being investigated to improve cognition and combat age-related cognitive decline[6-10].

Digital game play has been linked to a number of potential cognitive and perceptual benefits demonstrated both cross-sectionally (comparing gamers to non-gamers) and in game training studies. For example, action digital game play has been linked to enhanced perceptual and attentional abilities such as useful field of view[6], multiple object tracking[7], visual acuity[8], and contrast sensitivity[9]. In addition, real-time strategy digital game training has led to improvements in visual memory and task-switching ability[11]. Overall, digital game training holds some promise as an effective training tool to increase a wide variety of cognitive and perceptual abilities[12-15]. Many of these studies have involved young adults, but benefits also may generalize to older adults as well[11,16-18]. Although there is still debate regarding the nature and size of game effects on cognition, game training effects appear to be much more robust compared to more typical 'brain training' interventions[19].

Though digital game interventions are promising, they may be challenging to implement as a

means to address age-related cognitive decline. Like all technology, successful use and acceptance of digital gaming technology may be challenging for older adults, as learning to use these devices requires cognitive abilities that decline with age[20]. Game and game system design that does not take into account the preferences and abilities of older gamers may contribute to low digital game adoption rates, disinterest in gaming, and poor intervention adherence[21]. Unfortunately, despite potential benefits to cognition described above, older adult populations are generally not targeted audiences when it comes to the designing of digital games.

In addition to demonstrating the efficacy of game interventions, an equally important aspect of using games to reduce age-related decline is designing games that are compatible with older adults' abilities, needs, and wishes. The difficulty of using games to improve cognition in an older adult population is highlighted by a study by Boot et al.[22]. This study compared training effects of an action game[23] (Mario Kart DS®) to the effects of a 'brain fitness' game[24] (Brain Age®). Although research suggests that faster-paced action-oriented games improve perceptual and cognitive abilities more than brain fitness games[19,25], older adults in this study demonstrated extremely poor adherence to the action game. Participants were asked to play their assigned game for 60 hours over the course of three months. Those assigned the brain fitness game trained for approximately 60 hours. However, participants assigned the faster-paced action-oriented game trained for an average of only 22 hours. A third of the participants initially assigned to the action game condition dropped out of the study compared to only one participant in the brain fitness game condition. Overall, no training benefits were observed, which may be attributed to the fact that the game that the study authors predicted to have the largest cognitive benefits was disliked by older adults and did not engage them.

By better understanding the game preferences of older adults, digital games may be more appropriately designed to promote cognitive functioning (i.e., have action elements) while also containing themes and game elements that induce intervention adherence. Furthermore, digital games offer a source of entertainment and pleasure that older adults may be denied if games do not take into account their abilities and preferences. Some initial work has been done examining the digital game preferences of seniors. An important finding is the prevalent distaste for violence in digital games among older adults[26]. In addition to an aversion to violence, 80% of surveyed baby boomers preferred intellectually stimulating gameplay over games that are speed and reflex-oriented[27]. This result was replicated in a study by De Schutter[28] in which a sample of older adults preferred the intellectual stimulation of puzzle games over other genres. Gender differences in game preference have also been observed, as older female gamers were found to prefer cartoonish graphics while male gamers were more partial toward realism[26]. Although the content of digital games plays an important role in whether or not older people will participate, adjustments should also be made to eliminate many of the alienating usability issues that might deter seniors from fully and comfortably accessing digital games, such as input devices that may be difficult for older adults to manipulate and unintuitive user interfaces[29-31]. However, the limitations of these studies, such as relatively small sample sizes and a lack of diversity among game genres, as well as a general focus on those with previous gaming experience, have impeded progress in better understanding the desires and motivations of older adult gamers.

The purpose of the current study was to further characterize the types of games that older adults are willing to play and the specific game features that they find appealing. A sample of older adults (both gamers and non-gamers) was asked about their digital game history as well as their game preferences. In addition to these data, a variety of personality and demographic data were collected to determine whether game preference might be predicted. These data might be useful in modifying action games and other games with beneficial cognitive effects to make these types of interventions more appealing to older adults. Results may also provide insight in how best to maximize adherence by designing games that take into account individual differences such as gender and personality characteristics. That is, it may be possible to customize game-based interventions based on the properties of the individual to further increase intervention adherence and maximize intervention benefits. Finally, this information might be used to design games to help older adults experience the entertainment and pleasure that younger gamers often derive from digital game play[32].

Method

Participants

Three hundred and sixty-five surveys were sent via mail in the Tallahassee, Florida region, and an additional 35 surveys were distributed to a local church group to individuals 55 years of age or older. In total, out of 400 surveys distributed, sixty-eight participants returned surveys (17% return rate; 41 males, 23 females, and 4 unknown; M=72.6 years, SD=7.6). While this response rate

is lower than ideal, it is not abnormal with respect to survey research[33]. Nevertheless, in order to check for response bias, an interest-level analysis was conducted[34]. A concern might be that due to the survey topic only those with a strong interest in gaming would respond, resulting in a biased view of older adults' opinions with respect to digital gaming. An interest-level analysis checks whether interest in the topic of the survey is associated with different responses, a sign that this bias is present. We used gamer status (whether a participant played digital games or not) as a proxy for interest in the topic of gaming and found that responses did not differ greatly between these groups (see results section). This increases confidence that reported results are generalizable beyond individuals with a strong a priori interest in gaming.

Sixty-two participants self-reported as 'White/Caucasian', three as 'Black/African American', two as 'Multi-racial', and one participant self-reported 'No Primary Group'. The majority of participants were married (57.4%) and retired (80.9%). Participants reported that they were generally of average health (M=3.46, SD=0.82, 1=Poor, 5=Excellent). Of those that responded to the video game history survey, 45.6% indicated that they played digital or computer games, 51.5% said they did not, and 2.9% did not respond to that question.

Measures

Background information survey

A modified version of the Demographic and Background Questionnaire[35] was used to collect basic demographics such as the participant's age, level of education, ethnicity, and other relevant information.

Ten-Item Personality Inventory (TIPI)

The Ten-Item Personality Inventory[36] was used to briefly assess the Big-Five personality dimensions (extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience) of participants by asking them to rate themselves according to their agreement with ten statements of various personality traits (test-retest reliability=0.72[36]). Items were on a 7 point Likert scale which ranged from 1 (disagree strongly) to 7 (agree strongly). Half of the items were reverse-scored.

Technology experience questionnaire

A modified version of the Computer and Technology Experience Questionnaire[37] was used to assess the participant's usage and familiarity with computers, the Internet, and other related technological activities. Of primary interest for analyses reported here, participants rated how often they used computers or the Internet to accomplish tasks using a 4 point Likert scale (1=not used, 4=used frequently). Examples included sending email and paying bills online. Experience across these twenty-nine different tasks was summed to create a technology experience score. For this questionnaire and all remaining surveys, a measure of internal consistency, or the extent to which all items measure the same construct was calculated[38]. A Cronbach's α greater than 0.7 is typically considered acceptable. Within the current sample, the internal consistency of this scale was high (Cronbach's α=0.92).

Video game preferences survey

The Video Game Preferences survey[39] was designed to assess the perceived importance of various digital game features. The survey was modified to be appropriate to both current gamers and non-gamers by asking non-gamers to think of a hypothetical digital game that they might enjoy playing and then answer questions about this game. Participants rated the importance of 22 features using a 5 point Likert scale from 1 (Not at all) to 5 (A must-have feature). Examples of items from this survey include, "The game allows me to search for hidden things." and "The game allows me to explore unfamiliar places." Based on the observations of Quick et al.[39], at least six factors (fantasy, exploration, fidelity, companionship, challenge, and competition) were expected to be revealed through a principal components analysis (PCA). With the addition of four items to the original survey, factors relating to familiarity and violence were also possible. Within the current sample, the internal consistency of this measure was high (Cronbach's α=0.90), thus all items appear to be measuring the same construct.

Video game interest survey

The Video Game Interest Survey (developed by the authors) was used by participants to rate their interest in eleven digital game genres. Each genre was presented with a general description of its characteristics. Although there are no standard definitions of game genres[40], descriptions were generated or adapted from various online sources including Wikipedia. An example is provided below:

Massively Multiplayer Online Video Game: Massively Multiplayer Online Games (also known as 'MMOs') enable players to cooperate and compete with other players online on a large scale to complete specified objectives, as well as to interact meaningfully with people around the world[41].

Participants were asked to rate their interest in the type of digital game using a 5 point Likert scale from 1 (not at all interested) to 5 (very interested). Within the current sample, this survey

demonstrated high internal consistency (Cronbach's α=0.88). The similar overall pattern of preference/interest between this survey and the Video Game Preferences survey provides an indication about the validity of the survey (see Results section).

Video game history survey

The Video Game History Survey (developed by the authors) assessed one's usage of digital games. Specifically, it measured the amount of time that the participant played digital games, the games they played most frequently, as well as with what gaming device and with whom they played digital games. Of primary interest to the reported analyses was the question in which participants indicated whether or not they played digital games.

Tabletop game preferences survey

The Tabletop Game Preferences Survey (developed by the authors) was used to assess the participant's involvement with non-digital games such as card, board, or puzzle games, as well as what games they played most frequently and with whom they usually played these games. The three items that were used in the reported analyses below indicated whether or not participants played card, puzzle or board games (Cronbach's α=0.58).

Procedure

Each participant received a packet which contained a letter to the participant, two informed consent forms (one to keep, one to send back), a survey, a contact form in case the participants might be interested in future research, as well as a pre-paid return envelope for those that received the survey through the mail. The survey was divided into three sections to assess background and health information, technology experience, and opinions on digital games. The completed surveys and other materials were then mailed back to the university via the pre-paid envelopes or were picked up from the participating organizations. In terms of compensation, participants who completed and returned the survey were entered into a raffle for a $50 grocery store gift card which was awarded to two participants chosen at random.

Results and discussion

Older adults' game preferences

Results did not provide strong evidence that the pattern of preferences differed between those reporting and not-reporting digital game experience, so data were combined in reported analyses. First, we present evidence for the lack of difference between gamers and non-gamers in the sample with respect to game feature preference and game interest. Game feature preference ratings were entered into an ANOVA with game experience (gamer or non-gamer) as a between-subjects factor and feature dimensions (all 22 features from the Video Game Preference Survey) as a within-subjects factor. It was noted that the tests for the interaction between preference and game experience (as well as the test for the interaction between interest and game experience) violated the assumption of sphericity. Accordingly, Greenhouse-Geisser corrected degrees of freedom and p-values are reported. Overall, older adults' preferences for game features were similar, as there was no main effect of game experience, $F(1,57)=0.01$, $p=0.92$, and game experience did not significantly interact with feature dimension preference, $F(10.48,597.21)=1.66$, $p=0.08$. Although not significant, this trend for an interaction appeared to be driven by a tendency for gamers to prefer games that only required a single player more than non-gamers, and a tendency for non-gamers to prefer games that allowed the player to play a character of the opposite gender compared to gamers (*Figure 1*). Older adults' interests in game genres were also similar, as there was no main effect of game experience, $F(1,58)=0.00$, $p=0.96$, and game experience did not significantly interact with genre interest, $F(7.45,432.20)=1.84$, $p=0.07$. Though non-significant, this trend for an interaction appeared to be driven by gamers tending to prefer puzzle games more compared to non-gamers, and non-gamers preferring roleplaying games more than gamers (*Figure 2*). In sum, gamers and non-gamers were very similar in terms of their digital game play feature and genre preferences.

As a next step, older adults' gaming preferences, regardless of gamer status, were analyzed. Participants were asked about their interest in playing eleven video game genres. Their preference ratings were then compared to a neutral value (3) to examine for significant interest or disinterest in each type of game. One sample t-tests were used to assess significance (*Figure 2a and 2b*). As a conservative approach, a Bonferroni correction was applied (alpha=0.005) to correct for multiple comparisons. Any interest ratings that were significantly greater than three were considered to indicate interest whereas any ratings that were significantly less than three were considered to indicate disinterest. Any values not statistically different from the neutral value suggest a neutral stance.

Across all participants, the game types that were significantly interesting were those that were intellectually stimulating such as puzzle games, $t(66)=6.33$, $p<0.001$, and educational games, $t(66)=6.44$, $p<0.001$. There was also a trend

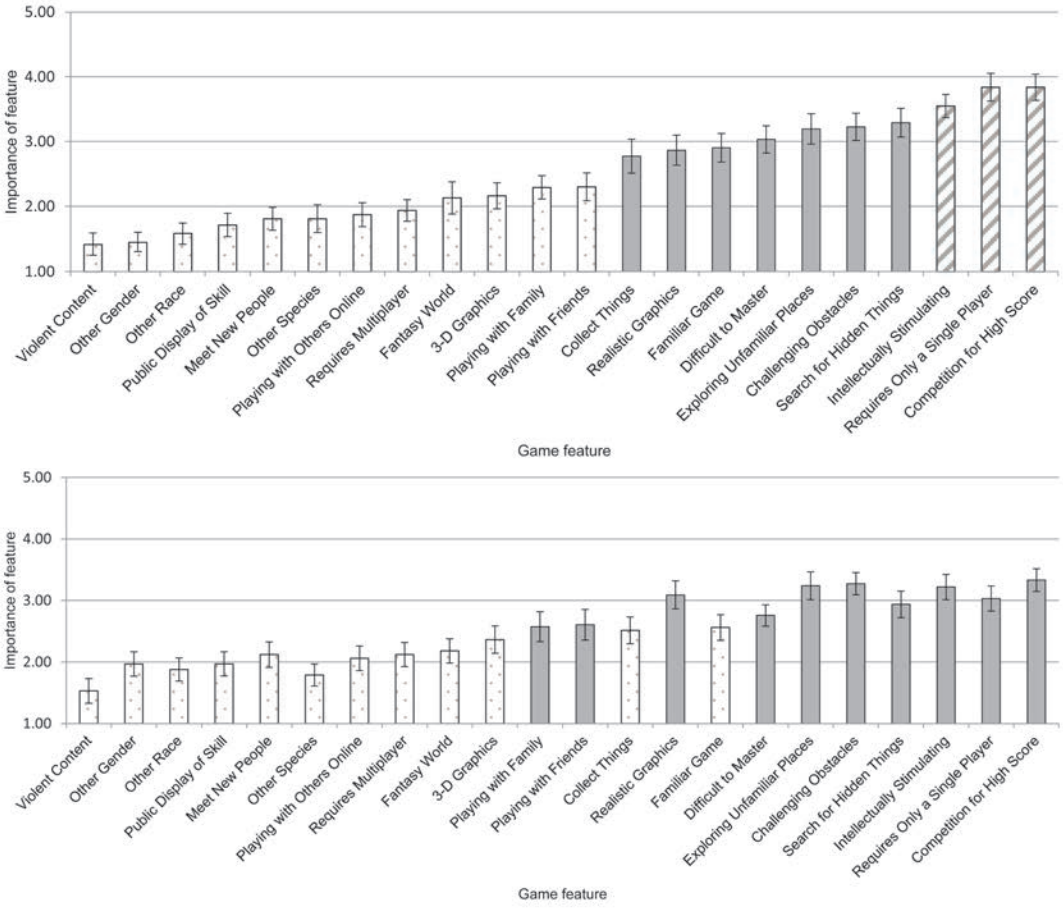

Figure 1. The perceived importance, on a scale of 1-5, of various video game features for older adults. The top figure displays the perceived importance of a selection of 22 video game features for older adult gamers, and the bottom figure displays the perceived importance of these same features for older adult non-gamers; Features that were preferred ($p<0.05$) are represented by the white bars with diagonal lines while games that were not preferred ($p<0.05$) are represented with the white bars with dots; Neutral games ($p>0.05$) are represented in gray; A one-sample t-test against the neutral value (3) was used to assess significance; The error bars represent standard error

for interest in strategy games as well as simulator games ($t(66)=1.81$, $p=0.07$ and $t(66)=1.91$, $p=0.06$, respectively). Participants were not interested in playing massive multiplayer online games or shooters (all p's<0.001). There was also a trend for participants to not be interested in sports games or role playing games (all p's<0.08). Also of importance was that action games, which have shown potential at improving perceptional and cognitive abilities, were observed to be of generally neutral interest to the participants ($t(61)=-0.701$, $p=0.49$), and were found to be in the middle of the 11 game types in terms of perceived interest.

Next, older adults' preferences for specific game features were examined. Participants were asked to describe the importance of 22 various game features. Their preference ratings were once again compared to a neutral value (3), and one sample t-tests were used to assess significance. A Bonferroni correction was once again applied (alpha=0.002) as a conservative approach to correct for multiple comparisons. Any preference ratings that were significantly greater than three (neutral) were considered to be preferred whereas any ratings that were significantly less than three were considered to be not preferred. Any values not statistically different from the neutral value suggest a neutral stance (*Figure 1a and 1b*).

Older adults in general (combining gamers and non-gamers) significantly preferred games that allowed them to compete for a high score, $t(65)=4.38$, $p<0.001$. There were also trends for older adults to prefer games that required only a single player, $t(64)=2.74$, $p=0.008$ and that emphasized intellectual challenge over quick re-

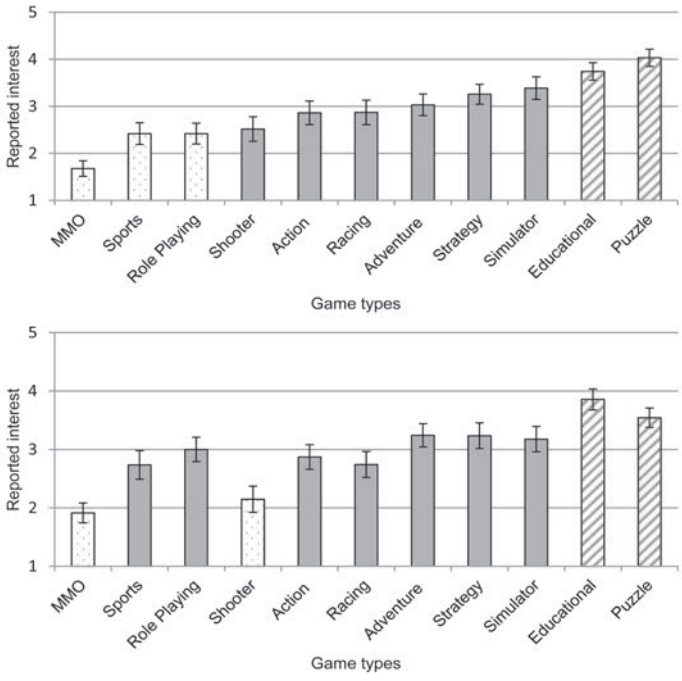

Figure 2. Game type interest, on a scale of 1-5, of older adults; The top figure (a) displays the interest of older adult gamers, and the bottom figure (b) displays the interest of older adult non-gamers; Game types that were preferred (p<0.05) are represented by the white bars with diagonal lines while games that were not preferred (p<0.05) are represented with the white bars with dots; Neutral games (p>0.05) are represented in gray; A one-sample t-test against the neutral value (3) was used to assess significance; The error bars represent standard error; MMO = Massively Multiplayer Online game

flexes, t(64)=3.01, p=0.004. Games with violent content, fantasy characteristics or with social components like multiplayer or online play were generally not preferred (all p's≤0.001 compared to neutral). As can be seen from *Figure 1*, the pattern for all older adults (gamers and non-gamers) was similar, with violent and fantasy content ranking near the bottom in terms of preference, and intellectual challenge and competition ranking near the top. The Video Game Interest Survey, developed by the authors, provided converging evidence game genres involving fantasy, social, violence, and fast-paced elements were found to be less interesting compared to more intellectually challenging genres.

Factor analysis

In order to examine individual differences in game preference, the 22 item Video Game Preferences Survey adapted from Quick and colleagues[39] was condensed. The six factors previously found by Quick et al.[39] were as follows: fantasy, exploration, fidelity, companionship, challenge, and competition. A principal components analysis was conducted using Varimax rotation for the main purpose of data reduction. An Eigenvalue less than one was adopted as the cutoff. This analysis revealed that 79% of the total variance in the data could be accounted for by seven factors (*Table 1*). Factor 1 was related to social game features such as the opportunity to meet new people, play online with other people, play games that require more than one player, play games that allow the displaying of skills in public, and play games that allow playing with friends. This factor is referred to as the Social Factor and represents a combination of the Companionship and Competition Factors found by Quick et al.[39]. Factor 2 was related to immersive exploration, including game features such as realistic graphics, 3D graphics, exploration of unfamiliar places, collection of things, and the search for hidden things. This factor is referred to as the Exploration Factor and represents a combination of the Exploration and Fidelity Factors observed by Quick et al.[39]. Factor 3 was related to challenging features, including challenging obstacles that must be overcome, are difficult to master, allow competition for a high score, and emphasize intellectual challenges over quick reflexes. This factor is referred to as the Challenge Factor and corresponded with the identically named factor found by Quick et al.[39]. Factor 4 was related to fantasy characters, including allowing the player to take on a race, gender, or species other than his or her own. This factor is referred to as a Fantasy Character Factor. Factor 5 was related to fantasy environments (i.e., the game is set in a fantasy world). This factor is referred to as the Fantasy Environment Factor. These two Fantasy Factors comprised the Fantasy Factor found by Quick et al.[39]. An additional factor analysis forcing six factors, similar to the factor structure of Quick et al.[39], was conducted. The two fantasy factors remained even with this approach, and the factor structure and item loadings were similar overall. Factor 6 was related to familiar content or players, environmental variables associated with increased levels of comfort (i.e., the game is a computerized version of a game I already know and is one that I can play with my family). This factor is referred to as the Familiarity Factor. Finally, factor 7 was related to violence (i.e., the game should have violent content). This factor is referred to as the Violence Factor.

Predicting game preferences

Individual differences in game preferences were examined. See Table 2 for descriptive statistics concerning the individual difference variables related to technology experience and personality factors. Note that the degrees of freedom fluctuate for the analyses due to failure of some participants to complete all the items included in the survey packet. As no a priori predictions were made concerning individual differences in game preferences, the Bonferroni correction was once again applied (alpha=0.001) to correct for multiple comparisons. This conservative correction resulted in no significant individual difference predictors, but the results of these exploratory analyses are still informative as trends in the data can be further explored in future research. First, potential gender differences were explored. Independent samples t-tests revealed only one trend for a difference in terms of gender, $t(54)=-2.65$, $p=0.01$, with women ($M=0.46$, $SD=0.95$) tending to rate game features related to the Familiarity Factor as being more important compared to the male respondents ($M=-0.25$, $SD=0.98$). No other components were approaching significance with respect to gender (all p's>0.09).

The impact of age and technology experience on game preference was also explored, as measured by these seven game preference factors. Again, all the findings discussed are trends as no correlation was significant after applying the Bonferroni correction. There was a trend for age to be related to the Fantasy Character Factor, $r(51)=0.33$, $p=0.02$, which suggested that with increasing age, there was a tendency for older adults' preference for game features that allowed them to play as fantasy characters to increase. Also, a positive trend existed between technology experience and the Exploration Factor, $r(49)=0.39$, $p<0.01$, which suggested that those with more technology experience preferred games that would allow them to explore unfamiliar areas to search for and collect hidden things. As a next step, personality differences in game preferences in an older adult population were explored. The results of a bivariate correlation between the seven-factor principal component analysis and the personality scores from the Ten-Item Personality Inventory are shown in Table 3.

Negative trends were found between the Violence Factor and emotional stability, $r(52)=-0.29$, $p=0.03$, extraversion, $r(52)=-0.29$, $p=0.04$, and agreeableness, $r(53)=-0.30$, $p=0.03$, which suggested that those who were less emotionally stable, less agreeable, and more introverted tended to prefer violent digital game features. Positive trends were found between the Fantasy Character Factor and participants' openness to experi-

Table 1. Factor loadings of the Video Game Preference Survey based on a principal components analysis using Varimax rotation with Kaiser normalization; Table presents standardized loadings; Variables are presented in descending order by loading within each factor; Loadings with absolute values less than 0.50 were omitted

Parameter	Factors						
				Fantasy			
	Social	Exploration	Challenge	Character	Environment	Familiarity	Violence
Meet new people	0.883						
Play online	0.856						
Multiplayer	0.750						
Display skills in public	0.709						
Play with friends	0.597						
Realistic graphics		0.818					
3D graphics		0.797					
Explore unfamiliar places		0.660					
Collect things		0.650					
Hidden things		0.646					
Single player		0.540					
Challenging obstacles			0.819				
Difficult to master			0.765				
Compete for high score			0.700				
Intellectually challenging			0.582				
Other race				0.865			
Other gender				0.821			
Fantasy world					0.821		
Other species				0.534	0.621		
Familiar games						0.777	
Play with family						0.646	
Violent content							0.892

Table 2. Descriptive statistics of Technology Experience Questionnaire and the five personality factors derived from the Ten-Item Personality Inventory; SD=Standard Deviation

Parameter	n	Mean	SD
Tech Experience	55	71.87	17.08
Extraversion	63	4.14	1.57
Agreeableness	64	5.49	1.15
Conscientiousness	64	6.19	0.88
Emotional Stability	63	5.51	1.28
Openness to Experiences	64	5.28	1.13

ence, $r(53)=0.34$, $p=0.01$, which suggested that those more open to novel experiences tended to prefer games with fantasy character features, as well as between the Familiarity Factor and agreeableness, $r(53)=0.40$, $p<0.001$, which suggested that those who were more agreeable tended to prefer familiar games and familial participation.

Finally, the existence of an association between general game play (non-digital gaming, including board games) and overall digital game use was examined. However, this was not the case. Participants reported whether or not they used digital games and also whether or not they played board, puzzle, or card games. Chi-square tests showed that general tabletop game use was not found to be predictive of digital game use when assessing board game usage, $\chi^2(1,n=65)=0.41$, $p=0.84$, card game usage, $\chi^2(1,n=64)=0.76$, $p=0.38$, and puzzle game usage (e.g., crossword puzzles and jigsaw puzzles), $\chi^2(1,n=64)=1.34$, $p=0.25$.

Conclusions

Although digital game interventions may be beneficial, older adults must adhere to them for these types of interventions to be effective. In order to design or modify cognitively beneficial games to maximize adherence, the types of games and game content older adults are likely to find appealing must be understood. Trends existed for various individual difference characteristics such as gender, age, and personality traits to predict game preference, as measured by the seven factors derived from a modified digital game preference survey[39]. A preference for intellectually stimulating games (puzzle, educational, and strategy) was observed in the sample and was consistent with previous research[26-28]. These results generally held true for older adults with and without digital game experience. In addition, a preference for single-player gameplay is consistent with previous research suggesting that including social elements in gameplay does not positively influence older adults in the same manner as younger adults[42]. Finally, a general aversion for violent content in digital games was also observed and was consistent with previous research on the topic[26].

Individual differences in preference most likely would need to be considered to achieve maximal adherence to game-based interventions. However, our results add to a growing consensus regarding game preferences of seniors. Preferences in our USA sample were consistent with preferences in older adult European samples[26,28] and other older adult North American samples[27,43].

Based on the respective items that comprise the Familiarity Factor, a novel finding in the current study is that a trend existed for females to prefer both familiar games and social settings more than males. As males tend to comprise the majority of the video game culture[44-46], research on better understanding the differences in game preference between genders may increase our ability to design customized game interventions to maximize adherence. It is important to note, however, that this gender difference was not predicted and did not remain statistically significant after taking a conservative approach and correcting for multiple comparisons. Future work should examine if this relationship is robust with a larger sample.

Also unique to this study is the suggestion that the personality characteristics of older adults may be predictive of their game preferences. Consistent with Nap et al.[26], older adults rated games with violent features as the least preferred overall. Unfortunately, games with the more violent features also tend to be more action-oriented and have resulted in the most perceptual and cognitive benefits[47-49]. While previous intervention studies have considered this preference in respect to the choice of an intervention (choosing a non-violent action-oriented game, e.g., Boot et al[22]), the potential of personality factors to facilitate the personalization of interventions to increase compliance is promising. For example, if the trend for introversion/extraversion to predict preference for violent content holds true, violent content might be reduced for participants high in extraversion. However, it may not be wise to increase violent content to cater to the preferences of introverted and emotionally unstable older adults to improve game-based adherence.

Results are consistent with the striking differences in intervention adherence observed by Boot et al.[22]. In their study, the intellectually challenging game, Brain Age®[23], was much preferred, and induced much greater adherence compared to an action game. Future research is needed to better understand how to incorporate the potential benefits of action games and the preferences of older adults for intellectually stimulating games in order to maximize the benefits and compliance of possible cognitive interventions. Ideally, these interventions, both digital games or multi-modal

interventions that incorporate game features[50], can take into account gender and personality differences as well to deliver custom interventions to induce maximal intervention adherence. In fact, in the exergame literature, discussion of personalization of interventions to increase compliance has already begun[51]. The current results inform these discussions and suggest that intervention compliance may be related to game preferences.

We acknowledge limitations of the current study. While statistical power may be an issue for this factor analysis study (n=68) and may limit the generalizability of the reported results, this study utilized a larger sample size than many studies examining gaming preferences[26,43]. It should also be noticed that there were differences concerning the results of the principal components analysis of the 22 video game features in our sample compared to the findings of Quick and colleagues[39]. There are a number of possible reasons why the factor structure differed. One reason is undoubtedly the addition of questions. It is also probable that the factor structure is different for younger and older adults. A third possibility is that, due to the generally low number of participants for a PCA, factor loadings may be somewhat unstable. It also would have been ideal to have included more questions regarding preferences for violent/non-violent content. A single question largely loaded on what we interpreted as the violence factor in the PCA of our modified version of the Video Game Preferences Survey. Also, as the participants of this study all resided within the general vicinity of Tallahassee, Florida, cultural and other location-relevant variables may limit generalization to a larger population. However, as mentioned previously, general older adult gamer preferences were consistent with other studies. Finally, another limitation comes from assessing preferences using a survey method. Presenting game descriptions to older adults who are unfamiliar with specific genres provides an initial indication of game preferences, but results should be confirmed by assessing preferences after giving older adults hands-on experience.

The current study's hypothesis that personal factors such as age, gender, personality, technology experience, and other characteristics could be used to help predict the gaming preferences of older adults is likely accurate. With the data collected, it is likely that designing digital games for older adults that can be custom-tailored to the preferences of the individual holds great promise in working to create effective interventions to aid in achieving and maintaining healthy cognition and, thus, fostering functional independence for older adults. More broadly, digital games might be designed using this information, not to improve cognition, but to allow older adults to access the rich and rewarding entertainment experiences that digital games have to offer.

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References

1. Lutz W, Sanderson W, Scherbov S. The coming acceleration of global population ageing. Nature 2008;451(7179):716-719; doi:10.1038/nature06516
2. Hertzog C, Kramer AF, Wilson RS, Lindenberger U. Enrichment effects on adult cognitive development. Psychological Science in the Public Interest 2009;9(1):1-65; doi:10.1111/j.1539-6053.2009.01034.x
3. Ball K, Owsley C, Sloane M, Roenker D, Bruni J. Visual attention problems as a predictor of vehicle crashes in older drivers. Investigative Ophthalmology & Visual Science 1993;34(11):3110-3123
4. Diehl M, Willis SL, Schaie KW. Everyday problem solving in older adults: Observational assessment and cognitive correlates. Psychology and Aging 1995;10(3):478-491; doi:10.1037//0882-7974.10.3.478
5. Boot WR, Blakely DP. Mental and physical exercise as a means to reverse cognitive aging and enhance well-being. In: Hartman-Stein PE, editor, Enhancing Cognitive Fitness: A Guide to the use and development of community programs. New York: Springer; 2011; pp 25-44; doi:10.1007/978-1-4419-0636-6_2
6. Green CS, Bavelier D. Action video game modifies visual selective attention. Nature 2003;423(6939):534-537; doi:10.1038/nature01647
7. Green CS, Bavelier D. Enumeration versus multiple object tracking: The case of action video game players. Cognition 2006;101(1):217-245; doi:10.1016/j.cognition.2005.10.004
8. Green CS, Bavelier D. Action-video-game experience alters the spatial resolution of vision. Psychological Science 2007;18(1):88-94; doi:10.1111/j.1467-9280.2007.01853.x
9. Li R, Polat U, Makous W, Bavelier D. Enhancing the contrast sensitivity function through action video game training. Nature Neuroscience 2009;12(5):549; doi:10.1038/nn.2296
10. Li R, Polat U, Scalzo F, Bavelier D. Reducing backward masking through action game training. Journal of Vision 2010;10(14):33; doi:10.1167/10.14.33
11. Basak C, Boot WR, Voss MW, Kramer AF. Can training in a real-time strategy videogame attenuate cognitive decline in older adults? Psychology and Aging 2008;23(6):765-777; doi:10.1037/a0013494
12. Green CS, Bavelier D. Learning, attentional control, and action video games. Current

Biology 2012;22(6):R197-R206; doi:10.1016/j.cub.2012.02.012
13. Powers KL, Brooks PJ, Aldrich NJ, Palladino MA, Alfieri L. Effects of video-game play on information processing: A meta-analytic investigation. Psychonomic Bulletin & Review 2013;20(6):1055-1079; doi:10.3758/s13423-013-0418-z
14. Boot WR, Blakely DP, Simons, DJ. Do action video games improve perception and cognition? Frontiers in Psychology 2011;2:226; doi:10.3389/fpsyg.2011.00226
15. Boot WR, Simons DJ, Stothart C, Stutts C. The pervasive problem with placebos in psychology: Why active control groups are not sufficient to rule out placebo effects. Perspectives on Psychological Science 2013;8(4):445-454; doi:10.1177/1745691613491271
16. Anguera JA, Boccanfuso J, Rintoul JL, Al-Hashimi O, Faraji F, Janowich J, Kong E, Larraburo Y, Rolle C, Johnston E, Gazzaley A. Video game training enhances cognitive control in older adults. Nature 2013;501(7465):97-101; doi:10.1038/nature12486
17. Belchior P, Marsiske M, Sisco SM, Yam A, Bavelier D, Ball K, Mann WC. Video game training to improve selective visual attention in older adults. Computers in Human Behavior 2013;29(4):1318-1324; doi:10.1016/j.chb.2013.01.034
18. Dustman RE, Emmerson RY, Steinhaus LA, Shearer DE, Dustman TJ. The effects of videogame playing on neuropsychological performance of elderly individuals. Journal of Gerontology 1992;47(3):168-171; doi:10.1093/geronj/47.3.P168
19. Owen AM, Hampshire A, Grahn JA, Stenton R, Dajani S, Burns AS, Howard RJ, Ballard CG. Putting brain training to the test. Nature 2010;465(7299):775-778; doi:10.1038/nature09042
20. Czaja SJ, Charness N, Fisk AD, Hertzog C, Nair SN, Rogers WA, Sharit J. Factors predicting the use of technology: Findings from the center for research and education on aging and technology enhancement (CREATE). Psychology and Aging 2006;21(2):333-352; doi:10.1037/0882-7974.21.2.333
21. McLaughlin AC, Gandy M, Allaire JC, Whitlock LA. Putting fun into aging – overcoming usability and motivational issues in video games for older adults. Ergonomics in Design 2012;20(2):13-20; doi:10.1177/1064804611435654
22. Boot WR, Champion M, Blakely DP, Wright T, Souders DJ, Charness N. Video games as a means to reduce age-related cognitive decline: attitudes, compliance, and effectiveness. Frontiers in Psychology 2013;4:31; doi:10.3389/fpsyg.2013.00031
23. Nintendo EAD, Group No. 1. Mario Kart DS® [Nintendo DS]. Kyoto: Nintendo; 2005
24. Nintendo SPD. (2006). Brain Age® [Nintendo DS]. Kyoto: Nintendo
25. Ackerman PL, Kanfer R, Calderwood C. Use it or lose it? Wii brain exercise practice and reading for domain knowledge. Psychology and Aging 2010;25(4):753-766; doi:10.1037/a0019277
26. Nap HH, Kort YAW de, IJsselsteijn WA. Senior gamers: Preferences, motivations and needs. Gerontechnology 2009;8(4):247-262; doi:10.4017/gt.2009.08.04.003.00
27. Pearce C. The truth about baby boomer gamers: A study of over-forty computer game players. Games and Culture: A Journal of Interactive Media 2008;3(2):142-174; doi:10.1177/1555412008314132
28. Schutter B de. Never too old to play: The appeal of digital games to an older audience. Games and Culture 2011;6(2):155-170; doi:10.1177/1555412010364978
29. IJsselsteijn WA, Nap HH, Kort YAW de, Poels K. Digital game design for elderly users. In: Kapralos B, Katchabaw M, editors, Proceedings of the 2007 Conference on Future Play; 15-17th November, 2007; Toronto, Canada. New York: ACM; pp 17-22; doi:10.1145/1328202.1328206
30. Charness N, Boot WR. Aging and information technology use: Potential and barriers. Current Directions in Psychological Science 2009;18(5):253; doi:10.1111/j.1467-8721.2009.01647.x
31. Docampo Rama M., de Ridder HD, Bouma H. Technology generation and age in using layered user interfaces. Gerontechnology 2001;1(1):25-40; doi:10.4017/gt.2001.01.01.003.00
32. Sherry JL. Flow and media enjoyment. Communication Theory 2004;14(4):328-347; doi:10.1111/j.1468-2885.2004.tb00318.x
33. Shih TH, Fan X. Comparing response rates from web and mail surveys: A meta-analysis. Field Methods 2008;20(3):249-271; doi:10.1177/1525822X08317085
34. Rogelberg SG, Stanton JM. Introduction understanding and dealing with organizational survey nonresponse. Organizational Research Methods 2007;10(2):195-209; doi:10.1177/1094428106294693
35. Czaja SJ, Charness N, Dijkstra K, Fisk AD, Rogers WA, Sharit J. (2006). Demographic and Background Questionnaire. CREATE Technical Report CREATE-2006-02
36. Gosling SD, Rentfrow PJ, Swann WB. A very brief measure of the big-five personality domains. Journal of Research in Personality 2003;37(6):504-528; doi:10.1016/S0092-6566(03)00046-1
37. Czaja SJ, Charness N, Dijkstra K, Fisk AD, Rogers WA, Sharit, J. (2006). Computer and Technology Experience Questionnaire. CREATE Technical Report CREATE-2006-03
38. Cronbach LJ. Coefficient alpha and the internal structure of tests. Psychometrika 1951;16(3):297-334; doi:10.1007/BF02310555
39. Quick JM, Atkinson RK, Lin L. Empirical taxonomies of gameplay enjoyment: Personality and video game preference. International Journal of Game-Based Learning 2012;2(3):11-31; doi:10.4018/ijgbl.2012070102
40. Latham AJ, Patston LL, Tippett LJ. Just how expert are "expert" video-game players? Assessing the experience and expertise of video-game players across "action" video-game genres. Frontiers

in Psychology 2013;4:941; doi:10.3389/fpsyg.2013.00941
41. Massively multiplayer online game. Wikipedia, The Free Encyclopedia. Retrieved 18:15; http://en.wikipedia.org/w/index.php?title=Massively_multiplayer_online_game&oldid=6; retrieved July 22, 2014
42. Gajadhar BJ, Nap HH, Kort YA de, IJsselsteijn WA. Out of sight, out of mind: co-player effects on seniors' player experience. Proceedings of the 3rd International Conference on Fun and Games. ACM; 2010; pp 74-83; doi:10.1145/1823818.1823826
43. McKay SM, Maki BE. Attitudes of older adults toward shooter video games: An initial study to select an acceptable game for training visual processing. Gerontechnology 2010;9(1):5-17; doi:10.4017/gt.2010.09.01.001.00
44. Cruea M, Park SY. Gender disparity in video game usage: a third-person perception-based explanation. Media Psychology 2012;15(1):44-67; doi:10.1080/15213269.2011.648861
45. Lucas K, Sherry JL. Sex differences in video game play: A communication-based explanation. Communication Research 2004;31(5):499-523; doi:10.1177/0093650204267930
46. Entertainment Software Association (ESA). Essential Facts About the Computer and Video Game Industry: 2014 Sales, Demographics, and Usage data. 2014; www.theesa.com/facts/pdfs/ESA_EF_2014.pdf; retrieved February 1, 2014
47. Ferguson CJ. The good, the bad and the ugly: A meta-analytic review of positive and negative effects of violent video games. Psychiatric Quarterly 2007;78(4):309-316; doi:10.1007/s11126-007-9056-9
48. Ferguson CJ. Blazing angels or resident evil? Can violent video games be a force for good? Review of General Psychology 2010;14(2):68; doi:10.1037/a0018941
49. Prot S, Anderson C, Gentile DA, Brown SC, Swing EL. The Positive and Negative Effects of Video Game Play. Media and the Well-Being of Children and Adolescents; 2014; p 109
50. Anderson-Hanley C, Arciero PJ, Brickman AM, Nimon JP, Okuma N, Westen SC, Merz ME, Pence BD, Woods JA, Kramer AF, Zimmerman EA. Exergaming and older adult cognition: a cluster randomized clinical trial. American Journal of Preventive Medicine 2012;42(2):109-119; doi:10.1016/j.amepre.2011.10.016
51. Göbel S, Hardy S, Wendel V, Mehm F, Steinmetz R. Serious games for health: personalized exergames. Proceedings of the international conference on Multimedia. ACM; 2010; pp 1663-1666; doi:10.1145/1873951.1874316