

Baby Boomers and Gaze Enabled Gaming

Soussan Djamasbi^(✉), Siavash Mortazavi, and Mina Shojaeizadeh

User Experience and Decision Making Research Laboratory,
Worcester Polytechnic Institute, 100 Institute Road, Worcester, MA, USA
{01609djamasbi,01609smortazavi,
01609minashojaei}@wpi.edu

Abstract. Despite common belief, Baby Boomers form a sizable population of gamers. Paying attention to how this generation experiences a game can help companies that target this group of users increase their market share. To address this need, this study examines Baby Boomers' reaction to a new way of manipulating objects in a game, namely with their eyes. In particular, the study focuses on testing the impact of two different gaze activation strategies on Baby Boomers' interaction experience of a game. We tested two gaze enabled games that provided different levels of flexibility in their respective gaze activation strategies. Our results showed that Baby Boomers had a significantly better interaction experience with the game that had a more flexible gaze activation strategy.

Keywords: Activation strategy · Gaze interaction · User experience · Game play · Baby boomers · Human technology interaction · HCI

1 Introduction

Older users form nearly half of the adult gamers in the US, and the number of this group of gamers is growing [5, 6, 9]. According to a recent report by the Entertainment Software Association [4], the number of gamers that were 50 or older increased by 32 % in this past year alone. Thus, understanding preferences of the older generation users can provide valuable insight for developers who are planning to design for this growing target market.

Motivated by this need, in a recent study we examined the reaction of Baby Boomers to several gaze interaction methods for a single player memory game [1]. As high quality eye tracking devices are becoming more readily available and affordable [2], using gaze as a new way to interact with games is becoming more and more viable and interesting. Because we use our eyes to attend to objects in our visual field, using gaze to manipulate objects may provide an engaging game experience for many users.

The preliminary results of our recent study showed that older users did not enjoy using their gaze to manipulate objects in the memory game as much as their younger counterparts did [1]. The full analysis of our data suggested that a more flexible way to activate game objects may help to improve the experience of gaze interaction for Baby Boomers.

To test this possibility, in this study we examined the reactions of Baby Boomers to two different gaze activation strategies, which afford different levels of flexibility to users to manipulate game objects. This examination required the development of a new gaze enabled game that had a more flexible activation strategy than the memory game that we used in our previous study. In the following sections, we provide a brief background for the two gaze enabled games that were used in this current study.

2 Background

The preliminary analysis of our most recent gaze interaction study showed that older users did not enjoy gaze as a way to interact with game objects in a single player PC memory game [1]. Compared to their younger counterparts, Baby Boomers rated the likability of gaze as selection/activation method much less favorably. Additionally, Baby Boomers gave low scores when asked to rate the naturalness of gaze as a method to interact with the game [1].

The full analysis of the data suggested that Baby Boomers may have had a poor gaze interaction experience because of the activation strategy that we used in the game. For example, Baby Boomers' average ratings for ability to activate game objects with gaze was quite low, 1.5 on a 7-point scale with 1 denoting low and 7 denoting high ratings. Similarly, their average rating for their ability to adjust to the activation strategy was 1.5 on a 7-point scale, again a very low score. The analysis of user comments as well as the review of the experimenter's observation logs supported the above ratings. These analyses suggested that the activation strategy used in the previous study made it challenging for users to view game objects without activating them. This in turn suggested that affording users a more flexible gaze strategy to activate target objects in the game is likely to improve the game experience for older users, who seemed to have a harder time with gaze interaction than their younger counterparts did.

To test this possibility, we designed and developed a new game, Space Shooter, which was a suitable choice for the development of a more flexible gaze activation strategy. We conducted a laboratory experiment to compare the impact of each of the two gaze activation strategies on their respective game experience. In the following sections, we provide a brief explanation for the two games and their activation strategies.

2.1 Simon

Simon is a single player memory/puzzle game. There are four game objects (squares) in this game that can be activated by a user if the user looks at them for a brief period (e.g., 500 ms). The objective of this game is to activate a set of game objects that are selected by the computer in a specific order. Every time a user activates a sequence of objects correctly, the computer increases the length of the sequence by one and thus challenges the user to play a more difficult round. If the player fails to activate the squares in the correct sequence, the player loses the game. Figure 1 displays a screenshot of the Simon game.



Fig. 1. A screenshot of the gaze enabled Simon game. The colorful squares are the objects of the game. The red circular dot represents a user's gaze point during the gameplay. To activate an object (e.g., the yellow square in the above scenario) the player has to directly look at the target object (Color figure online).

2.2 Space Shooter

Space Shooter is an action shooter game. There are three types of game objects in this game: spaceships, care packages, and cannons. The objective of the game is to destroy spaceships while saving the care packages that appear on the screen by activating (or deactivating) the three cannons that are available in the game (Fig. 2). In other words, while all game objects play an important role in the game, the user can activate only cannons. Unlike the Simon game, activating cannon does not require the player to look at the cannon directly. Instead, the player can activate a cannon by looking at the game scene. The activation strategy is set up in a way to fire the cannon on the game scene that is closest to player's gaze. The player receives points when he/she destroys a spaceship and loses points if he/she destroys a care package.

2.3 Activation Strategy

The strategy for selecting the game objects in the Simon game requires users to look directly at the target (e.g., a specific square). Our analysis of the data from a previous study [1] showed that Baby Boomers had a hard time controlling game objects with this activation strategy. Activating objects by directly looking at them makes it hard for users to view objects without activating them. This strategy also limits the player's viewing area when the player attempts to activate an object because the player can only



Fig. 2. A screenshot of the Space Shooter game. The cannons (bottom of the screen), spaceships (robot in upper right hand corner of the screen), and the care packages (Red Cross package in the middle left part of the screen) are the objects of the game. However, only cannons can be activated with gaze. The gray circular dot with the “+” sign represents a user’s gaze point during the gameplay. To activate a cannon (in this case the middle cannon) the player does not need to look at the cannon directly. For example, in the above scenario, the player can activate the middle cannon by looking anywhere in the middle of the screen (anywhere in the scene between the two blue dashed lines) (Color figure online).

attend to the object that he/she intends to activate. By expanding the activation area for an object, users can manipulate their desired objects while following other objects in the game. For this reason, the activation strategy in Space Shooter affords players more flexibility in controlling game objects. Players can activate cannons by looking at any area where the desired cannon is located. This allows users to activate the target cannon without restricting their ability to follow the movement of other game objects, i.e., the spaceships and care packages. We expect this flexibility in activation strategy to provide a better sense of control. Because Baby Boomers had a difficult time to control their gaze interaction in our previous study, we expect this strategy to provide older users with a better gaze interaction experience.

3 Methodology

Data from two different games, Simon and Space Shooter, was collected from five participants (2 male, 3 female), resulting in a sample of 10 sets of data. The participants ranged in age from 54 to 71. Each participant played both games in a counterbalanced order.

3.1 Measurements

In order to compare the differences in gaze activation strategies between the two games, we adopted interview questions from the ImmersiveNess of Games (ING) instrument by Norman [11]. Because we were interested in examining the impact of activation strategy on interaction experience, we used only the items that captured reactions to the activation method. We modified the items to match the gaze interaction method in our games. The following interview questions measured users' subjective experiences of the activation strategy on a 7-point scale:

- *Perceived control* measured the degree to which users were able to control their interaction with the game. Higher scores indicated better control.
- *Perceived naturalness* measured the degree to which interactions felt natural to users. Higher scores indicated experiences that were more natural.
- *Perceived ability to activate* measured the degree to which it was easy for the users to activate an object with their eyes. Higher scores indicated higher levels of perceived ability.
- *Adjustment to the activation method* measured the degree to which users felt they were able to adjust to using their eyes as an activation method. Higher scores indicated higher perceived adjustment.

3.2 Procedure

The experiment was conducted in a laboratory setting. Each participant was engaged in a 15-second calibration procedure. Tobii \times 30 eye tracking system and Tobii SDK was used to develop both games used in our study. The experimenter provided the participants with a brief explanation of the game. Each participant played both games in a counterbalanced order. The experiment was not timed. Participants played the games as long as they wished to play and at their own pace. After each game, participants completed a survey using the measures discussed in the previous section. After playing both games, users were asked to rank the two games from most favorite to least favorite and explain their experience with the game.

4 Results

We used paired t-tests to compare the experiences of the two activation strategies used in this study. The results of the t-tests showed that of the two activation strategies, the more flexible strategy used in the Space Shooter game was rated significantly more favorable. As shown in Table 1, the mean ratings for the perceptions of control (2.00 vs. 5.20), naturalness (2.30 vs. 5.00), ability to activate an object (2.40 vs. 5.60), and ability to adjust to the activation method (2.00 vs. 6.40) were all significantly higher for the more flexible activation strategy. The p-values for the aforementioned variables were all significant at the 0.01 level. The average ratings for the less flexible activation strategy were in the low range of the scale because they were all smaller than 3 on a 7-point scale with 1 denoting the lowest and 7 denoting the highest or best experience [1]. The mean

values for the more flexible activation strategy, on the other hand, were all in the high range (larger than 5) [1]. These results show that the impact of the two activation strategies on interaction experience were significantly different.

Table 1. Paired t-test comparing the experience of the less flexible activation strategy used in the Simon game with the experience of the more flexible activation strategy used in the Space Shooter game.

	Less flexible activation strategy (Simon)	More flexible activation strategy (Space shooter)	Significance
Control	2.00 (0.70)	5.20 (0.84)	t = 5.49 p = 0.005
Naturalness	2.30 (1.04)	5.00 (0.94)	t = 3.38 p = 0.028
Ability to activate	2.40 (0.55)	5.60 (1.52)	t = 4.35 p = 0.012
Adjustment to the activation method	2.00 (1.00)	6.40 (0.89)	t = 6.49 p = 0.003

After playing both games, the users ranked the games. The results showed that all users (100 %) ranked Space Shooter as their more favorite game. When participants were asked to explain their preferences, while 40 % indicated they liked both games almost equally well, they all indicated that it was much easier for them to control objects in the Space Shooter game. For example, they stated: “I liked Space Shooter, it was easier to play, I felt in control” or “Simon was hard to control” or “I was confused when playing Simon, hard to focus my eyes where I wanted to.”

5 Discussion and Conclusion

The results of this study show that activation strategy can have a significant impact on the gaze interaction experience. As indicated by the results, the self-reported ability to activate game objects and to adjust to the activation method was significantly higher for the more flexible activation strategy. Participants’ perceived ability to activate objects was in the high range when they played the game that had a more flexible gaze activation strategy. Their ratings for the same variable were in the low range when they played the game with the less flexible activation strategy. Participants also indicated that it was significantly easier for them to adjust to the gaze activation strategy that provided more flexibility.

Activation strategy also had a significant impact on participants’ perception of control. Participants’ self-reported ability to control the game was in the high range for the more flexible activation strategy and in the low range for the less flexible activation strategy. Additionally, the results showed that activation strategy influenced participants’ perception of the naturalness of gaze as a new way to manipulate objects in the game.

The above results revealed that participants rated the interaction experience of the less flexible activation strategy rather poorly (the mean values were all on the low range of the scale), while they rated the interaction experience of the more flexible activation strategy quite favorably (the mean values were all on the high range of the scale).

These results were supported by the analysis of interviews and observations. All participants favored the interaction experience of the more flexible game. Their comments indicated that perception of control was an important issue in their interaction experience.

The results taken together, show that the flexibility of the gaze activation strategy significantly and positively affected the interaction experience of the game. The results suggest that developing a flexible strategy for gaze controlled games is likely to make these types of games more fun and playable for older users.

Given the upward trend in the development of low-cost high quality eye tracking devices [2], and hence the increased viability of gaze interaction in gaming [1], along with the growing number of Baby Boomer gamers, the results of our study have important theoretical and practical implications. From a theoretical point of view, the results extend gaze control studies, particularly those that focus on investigating older users' preferences [1, 7, 13, 14]. The results also extend research that focuses on experience design for older adults in general [3, 8–10] and gaming in particular [1, 12].

From a practical point of view, the results of this study provide insight for designing appealing gaze activation strategies for older users. The results suggest that expanding the screen areas for activating an object is likely to increase older users' ability to adjust to gaze interaction and thus improve their perception of control and naturalness of gaze interaction. The results suggests that designing flexibility in the activation strategy is likely to provide a more positive user experience for gaze enabled games for older users.

6 Limitations and Future Research

As with any controlled laboratory study, the results are limited to the setting. We compared the interaction experience of the two games without focusing on performance. Had we required users to achieve a desired level of performance, we may have observed different results. In our study, participants could play as long as they wished. Requiring a time limit could affect our results. Participants in our study were new to gaze enabled games. Experience or long-term exposure to gaze interactive games or interfaces may influence how older users experience a gaze enabled game. Through exposure to gaze enabled devices and practice, users can master controlling objects with their gaze more effectively. This in turn, can improve their experience of gaze enabled games.

Sample size was another limitation of our study. Nevertheless, our results showed significant differences in experience of the two games. We also focused on Baby Boomers. Future studies with larger sample sizes are needed to see whether flexibility in selection is as favorable among younger users as it is among older users.

7 Contribution

The results of this study have important theoretical and practical implications. The results provide evidence that older users, at least initially, find gaze interaction more controllable and natural when the strategy for activating an object is more flexible. These results provide a first step in scientific examination of gaze activation methods in gaming. Our results showed that older users had significantly higher levels of perceived control, naturalness, ability to activate, and ability to adjust to the activation method for the more flexible activation strategy. From a practical point of view, the results provide valuable insight for developing a more successful gaze interaction experience for older adults.

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