Gaze Interaction and Gameplay for Generation Y and Baby Boomer Users

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Abstract. As high quality eye tracking devices become more readily available and affordable, gaze interaction is becoming a viable and fun way to interact with games. Because we direct our eyes toward objects that we choose to attend to, gaze is likely to provide a natural way to manipulate objects in certain types of games. However, little work has been done to design and test games that use gaze as an interaction method. Despite the popular belief that the majority of gamers are young, research shows that Baby Boomers also like to play games. Thus, understanding possible differences in interaction preferences of these two generations provides valuable insight for developers who are planning to design gaze-enabled games for these two populations. In this study, we examine the gaze interaction experience of Baby Boomer and Generation Y users by comparing them to the familiar mouse interaction experience.

Keywords: Gaze Enabled Interactions, Gaze Interaction, User Experience, Game Play, Baby Boomers, Human Technology Interaction, HCI

1 Introduction

Despite the popular belief that the majority of gamers are young, research shows that Baby Boomers also like to play games. Both Generation Y (people born between 1977 to 1994) and Baby Boomers (people born between 1946 to 1964) form a sizable portion of gamers in the United States. Recent reports by the entertainment industry show that about 32% of gamers in the United States are between the age of 18 and 34, and 26% of gamers in the United States are at least 50 years old [2, 3, 4]. With the advances in manufacturing high quality eye tracking devices, gaze is increasingly becoming an interesting interaction method in video games [5, 11]. However, little work has been done to test if there is a difference between Generation Y and Baby Boomer users in reacting to games that use gaze as an input method. Understanding preferences of the older and younger users can provide valuable insight for game developers who are planning to design for this growing target market.

In a recent study, we contrasted the reaction of Baby Boomer and Generation Y users for several gaze interaction methods [11]. In this current study, we examine the gaze interaction experience of the two generations by comparing it to an interaction experience that is familiar to them, namely the mouse interaction experience. To con-

duct this experiment, we used a gaze-enabled version of the single player memory game, Simon, that was developed in our lab. In the following sections, we provide a brief review of the relevant literature as well a short description of the memory game used in our study.

2 Background

Our 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 as much as their younger counterparts. Baby Boomers did not like to use blink as an activation method and rated the likability and naturalness of gaze as a selection/activation method much less favorably than younger users did [11].

Recent research, however, suggests that gaze interaction is likely to serve as a natural method for selecting objects on a computer screen. Because we use our foveal vision to look at objects that we wish to attend to, we naturally use our eyes to select objects that we wish to view on a computer screen (e.g., text, images, links, etc.) [6]. Research also suggests that gaze may also serve as a natural activation strategy in digital environments. For example, we often use gaze in social interactions to initiate, stop, or control the flow of our conversations [1]. Similarly, in certain situations, gaze may serve as an intuitive activation trigger or control in digital media. Thus, examining the impact of gaze interaction on user experience can help to identify situations that gaze can serve as a suitable, natural, and/or fun input method. Such an investigation can provide insight for designing more appealing gaze interaction experiences for both younger and older users.

In order to address this need, in this study, we compared users' gaze and mouse interaction experiences for younger and older users. This comparison allows us to gauge a new method of interaction against a familiar and commonly used method of interaction for both user groups.

2.1 Simon Memory/Puzzle Game

The game developed for this project was a gaze-enabled version of Simon, a single player memory/puzzle game. In this game, there are four game objects (squares) that can be activated by a user. To play, a user is required to remember and repeat a sequence that is played by the computer in a specific order. First, the computer plays a sequence by highlighting a series of colorful squares and their corresponding sounds and then the player repeats the same sequence. Every time a user activates a sequence of objects correctly, the computer increases the length of the sequence by one and thus makes the game harder for the user. If the player fails to remember the correct sequence, the player loses the game. The user can restart the game or exit it if he/she does not wish to continue playing.

We developed four different versions of the game so that players could select and activate objects using four different methods: 1) Gaze Only interaction method (gaze was used for both selecting and activating an object), 2) Mouse Only interaction method (the mouse was used for both selecting and activating an object), 3) Gaze & Click interaction method (gaze was used for selecting an object and a left mouse click

was used for activating an object), and 4) Mouse & Click interaction method (a left mouse click was used for selecting an object and gaze was used for activating an object). Figure 1 displays a screenshot of our Gaze Only interaction method.

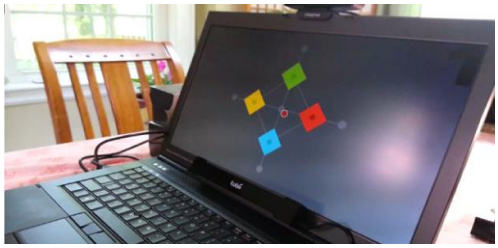


Figure 1: A screenshot of the gaze-enabled Simon game. The colorful squares are the objects of the game. Each object has a distinct color and an associated sound. The red circular dot represents a user's gaze point during the gameplay. A video of some of the gameplay of the gaze-enabled version of the game is available at http://youtu.be/2Sp4vHFOrw8.

2.2 Generation Y, Baby Boomers, and Gaze Interaction Experience

It is commonly believed that Generation Y is more comfortable using new technologies because this generation has been exposed to video games and other similar technologies since childhood. Because of its exposure to technology during childhood, Generation Y has a different expectation and interaction with technology as compared to Baby Boomers who started using technology at later ages [7, 8]. Grounded in this point of view, a number of studies show that the two generations react differently to different technologies. For example, Baby Boomer and Generation Y users show significant differences when they need to click on a link on a webpage or when they browse a webpage [6, 9]. These differences that stem from Baby Boomers' late start with technology, does not mean they have not embraced digital environments [6, 7, 8]. In fact, recent data shows that the number of older users who use digital media, particularly digital games, is growing rapidly [2, 3]. Thus, designing fun experiences that can engage both older and younger users becomes increasingly important in the gaming industry.

Recent trends in developing low-cost high quality eye tracking devices make it possible to introduce novel experiences, such as gaze interaction, in video gaming [6]. Because using gaze to play video games is still an untapped area in research and development, investigating users' reactions to gaze interaction is of significant importance to both theory and practice. Additionally, because Baby Boomers and Generation Y users form a healthy portion of gamers, it is important to understand possible differences between older and younger users in experiencing gaze enabled games.

One way to assess new experiences is by comparing it to familiar experiences. Thus, in this study, we compare the gaze interaction experience of our participants against their mouse interaction experience. To achieve this goal, we designed four different interaction methods to play a memory game. In this paper, we refer to these interaction methods as Gaze Only, Gaze & Click, Mouse Only, and Mouse & Click.

The Gaze Only interaction method uses gaze for selecting and activating an object. A user can select an object by looking at it. The user can activate an object by keeping his or her gaze on the object for a predetermined short amount of time (e.g., 500 milliseconds). The Gaze & Click interaction method uses gaze to select an object and a mouse click to activate it. In the Mouse Only interaction method, a user can select and activate an object by hovering the mouse over it. In Mouse & Click interaction method, a user can select an object by hovering the mouse over it; the user can activate the selected object by clicking on it.

3 Methodology

We collected a sample of 40 sets of data from 10 participants (4 Baby Boomer and 6 Generation Y) users. The study had a within subjects design, i.e., each participant played the games with the 4 different interaction methods specified above. The order by which the users were exposed to the above mentioned interaction methods were randomized to avoid possible order effects.

3.1 Measurements

In order to compare the differences in gaze activation methods, we adopted interview questions from the ImmersiveNess of Games (ING) instrument by Norman [10]. The interview questions in our experiment required users to report their subjective experiences on a 7-point scale. We used only the items that were related to reactions to interaction methods because our goal was to examine the difference between the four interaction methods among Baby Boomers and Generation Y users. The following interview questions were used to measure users' experiences of the different interaction strategies that we used in our study on a 7-point scale:

1. **Perceived control** measured the degree to which users were able to control their interaction with the game. Higher scores indicated better control.
2. **Perceived naturalness** measured the degree to which interactions felt natural to users. Higher scores indicated experiences that were more natural.
3. **Involvement** measured the degree to which players felt that they were involved with the game. The higher the involvement scores the less distracting the interaction method.
4. **Frustration** measured the degree to which users experienced frustration when interacting with the game. The higher the score the more frustrated the user.
5. **Interaction Experience** measured the general degree of users' subjective interaction experience. Higher scores indicated a better interaction experience.

3.2 Procedure

The experiment was conducted in a laboratory setting. Upon arrival, participants were provided with a brief explanation of the game and a short practice period for the gaze enabled interaction methods. Each participant was then involved in a 15 second

calibration procedure. The Tobii x30 eye tracking system and the Tobii SDK were used to develop the Simon game used in our study.

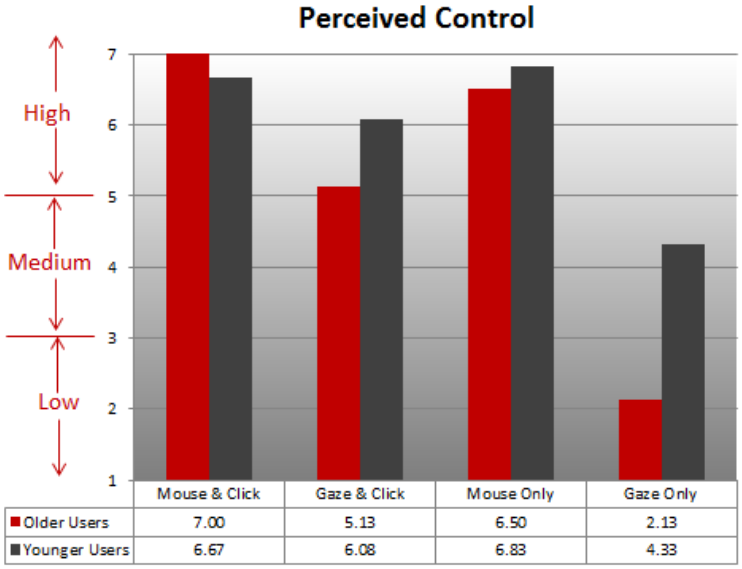
Each participant played the game four times, each time with a different interaction method. The interaction methods were assigned to participants in a random order. Users played each game as long as they wanted to or until they were unable to remember the sequence to repeat. The experiment was not timed. Each user played at his or her own pace. After each game, users were interviewed by the same experimenter using the measures discussed in the previous section. Users rated their interaction experience during the interview after each game.

4 Results

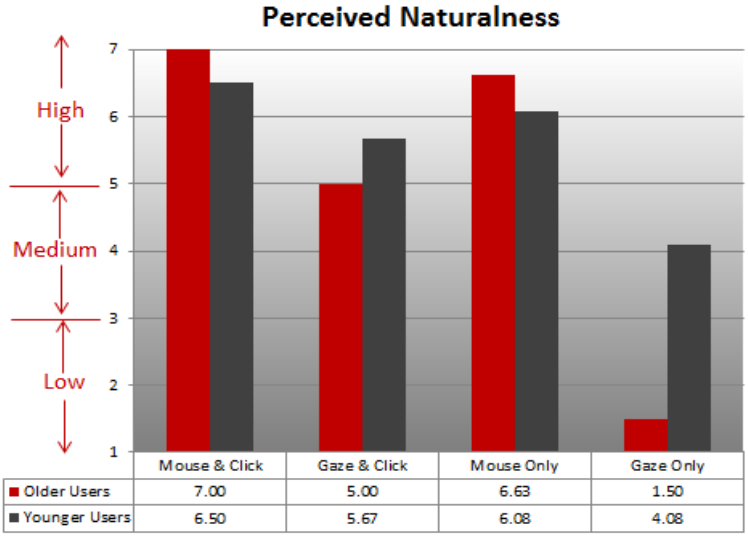
As in a prior study, average scores for each measure were calculated and displayed in a chart to provide a summary of user reactions per interaction method per user group [11]. In order to better understand the span of reactions, the charts were denoted with low, medium, and high "ranges" for participants' average scores: low ($1 \leq$ scores < 3), medium ($3 \leq$ scores < 5), and high ($5 \leq$ scores ≤ 7) [11].

As shown in Figure 2, Mouse & Click and Mouse Only methods were rated most favorably in both user groups. The average scores for these interaction methods for perceived control, naturalness, involvement, and interaction experience were well above 5 (high range). The average ratings for frustration for Mouse & Click and Mouse Only interaction methods were less than 3 (low range). Except for perceived control, Baby Boomers' average ratings for naturalness, involvement, and interaction experience for Mouse & Click and Mouse Only interactions were slightly higher than those ratings for the same interaction methods by Generation Y (Figure 2.a-2.e).

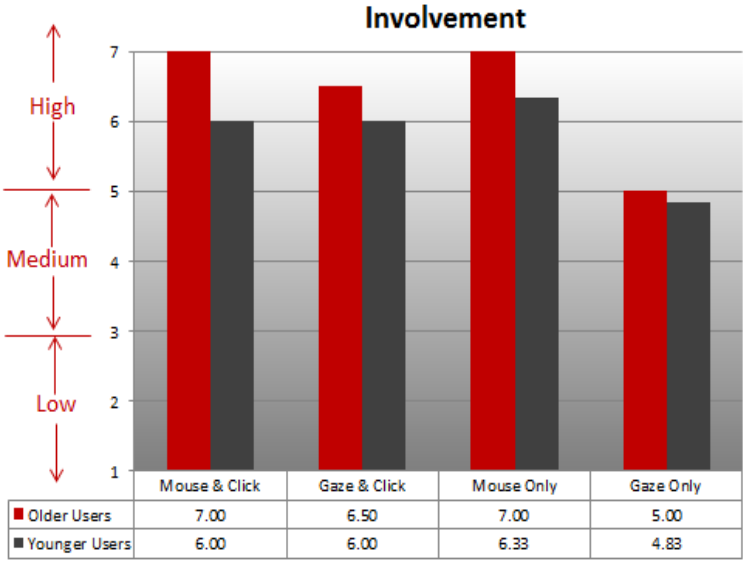
While both user groups' ratings for frustration were in the low range for Mouse & Click and Mouse Only interactions, Generation Y users exhibited more frustration with these two interaction methods than their older counterparts did. For example, the frustration ratings by Generation Y for Mouse & Click and Mouse Only interactions were closer to the medium range (2.67 and 2.50), while Baby Boomers' ratings for the same variable were quite low, 1.5 and 1.0 for Mouse & Click and Mouse Only interactions respectively.


Perceived Control
High
Medium
Low
7
6
5
4
3
2
1
Mouse & Click
Gaze & Click
Mouse Only
Gaze Only
Older Users
7.00
5.13
6.50
2.13
Younger Users
6.67
6.08
6.83
4.33

2.a

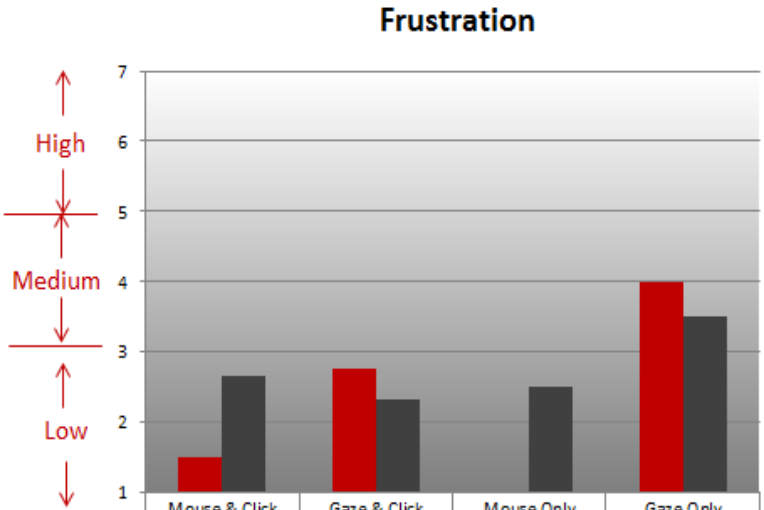

Perceived Naturalness
High
Medium
Low
7
6
5
4
3
2
1
Mouse & Click
Gaze & Click
Mouse Only
Gaze Only
Older Users
7.00
5.00
6.63
1.50
Younger Users
6.50
5.67
6.08
4.08

2.b



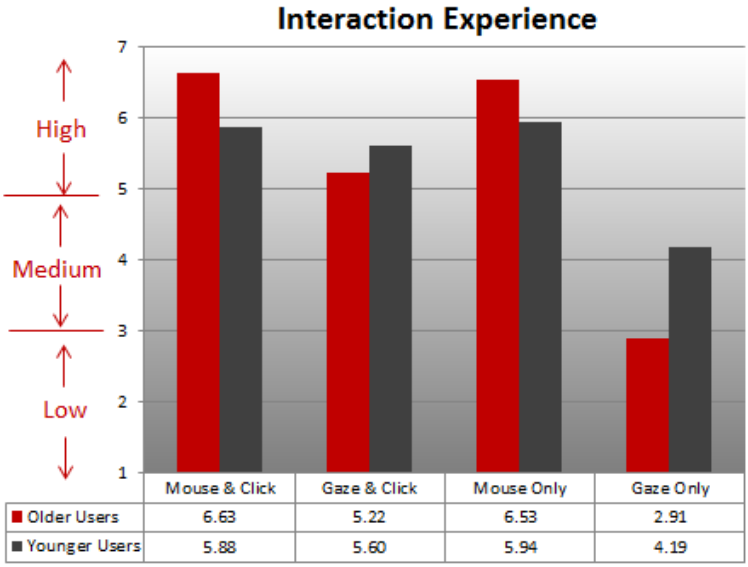
	Mouse & Click	Gaze & Click	Mouse Only	Gaze Only
Older Users	7.00	6.50	7.00	5.00
Younger Users	6.00	6.00	6.33	4.83

2.c



	Mouse & Click	Gaze & Click	Mouse Only	Gaze Only
Older Users	1.50	2.75	1.00	4.00
Younger Users	2.67	2.33	2.50	3.50

2.d



2.e

Figure 2. Average values of Perceived Control, Naturalness, Involvement, Frustration and Interaction Experience for Generation Y and Baby Boomers using different interaction methods.

For the Gaze & Click interaction method, Baby Boomers' frustration level was on the high end of the low range (2.75), which was relatively higher than their frustration levels for the mouse dominant interaction methods (1.5 and 1 for Mouse & Click and Mouse Only respectively). Generation Y, however, seemed to have experienced somewhat equal levels of frustration during the Gaze & Click, Mouse & Click, and Mouse Only interactions (2.33, 2.67, 2.50 respectively).

Both user groups rated the Gaze & Click interaction method more favorably than the Gaze Only interaction method for the variables control, naturalness, involvement, and overall experience. Both groups' ratings for the above mentioned variables were close to those of mouse dominant interaction methods (Mouse & Click and Mouse Only). This suggests that the Gaze and Click interaction experience was comparable to the familiar Mouse & Click and Mouse Only interaction experiences.

The Gaze Only interaction method was the least favorite in both user groups. The largest gap between the Gaze Only and the mouse dominant interaction methods was in the older user group. Older users rated control, naturalness, and interaction experience for the Gaze Only interaction in the low range while they rated the mouse dominant interaction methods in the high range (Figure 2.a-2.c, and 2.d).

The overall results indicate that perceived control, perceived naturalness, involvement and interaction experience scores for both groups of users fall within the high range when using Mouse & Click, Gaze & Click and Mouse Only interaction meth-

ods. These results suggest that Gaze & Click provided a comparable experience to that of the familiar mouse interaction methods. Using the Gaze Only method resulted in scores in the low and medium ranges for both groups. Between the two groups, older users had a less favorable experience using the Gaze Only method.

Together, these results suggest that gaze as an activation method in our study provided less satisfactory experience for both user groups. However, when gaze was used as a selection method and was combined with the familiar mouse click as an activation method, it enhanced the control and naturalness of the gaze-enabled method and reduced the level of the frustration, particularly for the older users.

5 Discussion and Conclusion

As discussed earlier, the familiar Mouse & Click and Mouse Only interaction methods were used as benchmarks for evaluating the Gaze & Click and Gaze only interaction methods. As expected, the ratings for the familiar methods of selecting and activating an object with a mouse were in the high range for perceived control, perceived naturalness, involvement, and interaction experience (Figure 2.a-2.d), and in the low range for frustration (Figure 2.b). Our results showed that both Generation Y users and Baby Boomer users rated the Gaze & Click interaction method in the high range. These ratings were similar to their ratings for the Mouse Only and Mouse & Click interaction methods. Frustration levels for the Gaze & Click interaction were low and were similar to frustration levels for the Mouse Only and Mouse & Click interaction methods. The Gaze Only interaction method, however, was not rated as favorably as the Gaze & Click interaction method, particularly by the older users.

The results show that, overall, the Gaze & Click interaction method provided an interaction experience comparable to that of the Mouse Only and Mouse & Click interaction methods for both generations. However, the similarities of these interaction experiences were more pronounced for the younger users.

These results contribute to gaze interaction research [11] and to prior research that examines generational differences in user experience of a technology [6, 13-16]. While more research is needed to extend this study, these initial results suggest that gaze interaction may provide a natural, fun, and challenging way to play games.

6 Limitations and Future Research

In this study, the games were not timed. Participants could play as long as they wanted. Applying a time limit could affect our results. If we would have required users to play the game in a limited amount of time and achieve a desired level of performance, the results may have been different. In addition, the sample size was small and the participants were new to the gaze enabled games. If participants were to gain experience in using gaze as an interaction method, they (especially Baby Boomers) may feel more comfortable playing gaze-enabled games. Future studies are needed to test these possibilities.

7 Contribution

The results of our study have important theoretical and practical implications. From a theoretical point of view, the results extend gaze interaction studies [11-13], as well as those studies that focus on generational differences in user experience design [8, 12-15]. The results also provide insight into gaze activation methods for gaming [11, 12]. From a practical point of view, the results provide valuable insight for developing a more successful gaze interaction experience for Baby Boomers as well as Generation Y users.

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