Train, Watch, Play – Effects of Observational Learning on Gameplay Performance

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Abstract

In response to the growing gaming and eSports industry, where skill enhancement is crucial, practice remains the dominant approach. Yet, the hidden potential of observational learning, which is common in gaming streams, has received little to no attention. This study investigates the usefulness of observational learning in skill development, with a secondary focus on break-time discussions. Twenty-six participants participated in a paired experimental setup with a Super Hexagon clone. Before the experiment, participants completed questionnaires on gamer identity, attentional control, and sport orientation. One of the pair was categorised as a player, while the other was classified as an observer. Both participants played a baseline session. This was followed by the player playing three additional sessions with one-minute breaks, which the observer observed. Following that, both participants had a post-session to measure their progress. No significant correlations emerged between questionnaires and performance variables. Analyses indicated no significant difference in the highest score improvement between players and observers, although players' average time improved significantly more. Break-time discussions shifted from game-related topics in the first break to unrelated content in the second break. This study marks an initial exploration into the possible use of observational learning for gaming skill enhancement. Subsequent studies, with larger samples and more complex tasks, are required to further affirm this positive influence of observational learning.

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Ever since the COVID-19 pandemic, the gaming industry has witnessed remarkable growth reaching nearly 250 billion dollars in value in 2022 (Grand View Research, 2022). In eSports, where people play games professionally, the market had a revenue of almost three and a half billion dollars in 2023 (Statista Market Insights, 2023). This surge in popularity extends beyond playing video games, as platforms dedicated to watching others play, such as Twitch, have experienced a 23% increase in total watch time (Valentine, 2022).

Players are often motivated to play video games with the goal of improving their skills, a drive that extends to the point of watching others play (Przybylski et al., 2010). This is especially the case for eSports players, who have a strong need to increase their abilities. A way in which intrinsic motivation can be heightened lies in creating circumstances that enhance a person's competence (Deci & Ryan, 1980). In the context of video games, increasing the games difficulty serves as an incentive, challenging players and pushing them to enhance their skills to progress (Ryan et al., 2006). Given the eagerness of gamers, especially eSports athletes, to rapidly improve their abilities, it is crucial to gain a deeper understanding of the methods that can speed up their skill development process.

Streaming, a significant part of the gaming industry, is not merely entertainment; viewers believe it can enhance their gaming skills (Weightman, 2020). This belief aligns with observational learning, the existing method where people can learn skills by watching others (Bandura, 1986). This method has been proven to be effective in improving motor and sports skills (Pollock & Lee, 1992; McCullagh & Weiss, 2004). However, its potential use in gaming remains unexplored. This study wants to address this gap of observational learning in the context of gaming.

The main purpose of this study is to investigate whether observing another person has benefits to one's performance in digital games. It was hypothesised that observing another

player play the game has benefits for the performance of the observer. Additionally, the secondary purpose of this research is to explore people's conversations during the breaks, anticipating conversations related to the game, and its relation to performance. This research wants to contribute insights into the intersection of observational learning and gaming performance.

Theoretical background

Observational learning

Observational learning, also known as modelling, can serve as an effective method for enhancing skill development (Bandura, 1986). This method demonstrated that individuals can acquire behaviours through observation (Sutherland, 1947). This idea challenged the most common perspective of behaviourism at the time, by emphasising cognitive processes in learning.

Observational learning has been researched even more over the last decades. Ever Since the introduction of the Social Learning Theory (SLT), the understanding of observational learning has grown (Akers & Jennings, 2016; Bandura & McClelland, 1977; Sutherland, 1947). According to the SLT, there are four processes which the learner has to go through for observational learning to work. These processes are attention, retention, production and motivation. Firstly, for observational learning to be successful, one has to pay attention to the model and behaviour shown. The second process is that of retention since one has to remember the behaviour to be able to produce the behaviour later on. Reproduction is the idea that one has to be able to perform the behaviour physically. To translate the mental representation of the behaviour cognitive skills are used. Lastly, motivation is needed to

acquire a new skill, which is influenced by expected rewards or by the observer's self-efficacy (Bandura, 1986).

Beyond these four processes, several other factors can influence the effectiveness of observational learning. Bandura and McClelland (1977) found that the characteristics of the model influence the learning outcomes. The ability of the model, status and how similar the model is to the observer all influence the ability to imitate the model. If the model is seen as competent, and therefore more credible, the likelihood of imitation is increased. Another factor that positively influences observational learning is the similarity, for example, age or gender, between the model and observer (Bandura & McClelland, 1977). This similarity can enhance the sense of relevancy and connection to the behaviour shown. Thus, several factors regarding the model can contribute to the effectiveness of observational learning

Aside from the model influencing the effectiveness, other aspects influence observational learning. For example, the complexity of the task can influence observational learning (Sweller, 1988). According to Sweller (1988), complex tasks result in a high cognitive load and due to this there is less space for learning a new skill. In contrast, a simple task has a low cognitive load and therefore is beneficial for learning. Research suggests that complex movement can be learned through observational learning (Kelly et al., 2010). The efficacy of observational learning can also be influenced by the emotional state of the observer (Bandura, 1986). Good feelings can improve focus and attentiveness. This results in the observer being more probable to focus on the model and the specifics of the tasks. On the contrary, negative emotions result in the focus of attention being more selective and narrow. This might negatively impact which behaviours are noticed and recalled. So, besides model characteristics, the complexity of the task and the mood of the observer influences the effectiveness of observational learning.

While the effect of observational learning on skill development in gaming remains unexplored, research in other contexts, such as sports, indicate its effectiveness. In research, eSports and traditional athletes are frequently compared due to the similar skills used (Taylor, 2015; Witkowski, 2012). eSports involves skills similar to traditional sports such as perceptual-motor skills, hand-eye coordination and several cognitive skills, for example, pattern recognition (Himmelstein et al., 2017; Norman et al., 2016). The effectiveness of observational learning of these skills has been researched in other areas. Research shows that observational learning can help with pattern and error recognition (Badets et al., 2006; Black & Wright, 2000; Carrol & Bandura, 1982). While observing, one can learn from the mistakes of the model without making the errors themselves. By observing others, the observer sees several examples and can therefore learn potential patterns. Observational learning is an effective method of skill enhancement in sports (Cumming et al., 2005; Wesch et al., 2007). Visually learning a technique or movement in sports is used as a common training method and allows observers to see the correct execution of a skill. For example, individuals were able to improve their golf skills by observing a model's form (Wesch et al., 2007). Thus, while gaming-specific research is lacking, observational learning is an effective method for skill acquisition in other contexts.

Spaced practice

Spaced practice, also called distributed practice, involves taking breaks in between training periods (Schmidt, 1982). Research on distributed practice has been around for a century, with the number of research done peaking around the 1950s through the 1970s (Donovan & Radosevich, 1999). It proves to be more effective than massed practice, where training is continuous (Baldwin & Ford, 1988). According to research, the cognitive

mechanism behind spaced practice appears to promote superior information retention and transfer, with benefits linked to improving long-term memory (Cepeda et al., 2009).

Most research done on spacing is criticised due to being in laboratory settings and researching rather simple tasks (Carpenter et al., 2012). However, Johanson et al. (2019) conducted non-laboratory research on spaced practice, focusing on its impact on motor skill development during gaming. In their research, they used a clone of the game *Super Hexagon* (Cavanagh, 2012). The game has a clear goal – to dodge obstacles and to keep playing as long as possible. The game is mainly based on perceptual-motor skills since one has to absorb the visual cues and select the right response which is a motor movement of pushing one key (Johanson et al., 2019).

The experiment, including a continuous gameplay control group, revealed that spaced practice significantly enhanced motor skill development compared to continuous play (Johanson et al., 2019). They systematically manipulated the break duration but found no optimal break period. However, the two-minute break demonstrated the most consistent improvements. In summary, the research findings emphasize the benefits of spaced practice in gaming skill enhancement and are therefore used as a method in this study.

Present study

With the growth of the gaming industry and specific eSports, there is an increasing need to find methods that can be used to improve one's gaming skills. This present study wants to investigate whether observation learning is a helpful method. It was hypothesised that observing another person has benefits to one's performance. The secondary purpose of this research is to explore what people discussed in the breaks in between playing.

Methods

Participants

A total of 26 individuals, aged 18 to 55 (M = 21.62), participated in the study. Of these participants, 21 identified as female, four as male and one as non-binary/third gender. In addition, 21 of these participants were from the Netherlands, seven from Germany, two from Lithuania, and one each from Bulgaria, Ecuador, Latvia, Poland, Romania, and Taiwan.

The participants were recruited through convenient sampling, with the majority gathered through the SONA. SONA, a website used by the University of Twente, facilitated the recruitment of first-year psychology students. In exchange for their participants, the students earned educational credits. A small number of additional participants, consisting of uncompensated friends, were also included. The study was approved by the Ethics Committee of the University of Twente (nr. 231144) and was approved before participants were recruited.

Inclusion criteria required people to be above the age of 18 and proficient in English since the entire experiment was conducted in English. Normal to normal corrected vision was also a prerequisite for participation.

Materials

This research employed an experimental task, the *Super Hexagon* clone, from the study done by Johanson et al. (2019). Because of this, the materials used were similar to their research, to gauge the participant's level of interest in and aptitude for the assignment. Several questionnaires were given before and after engaging with the game.

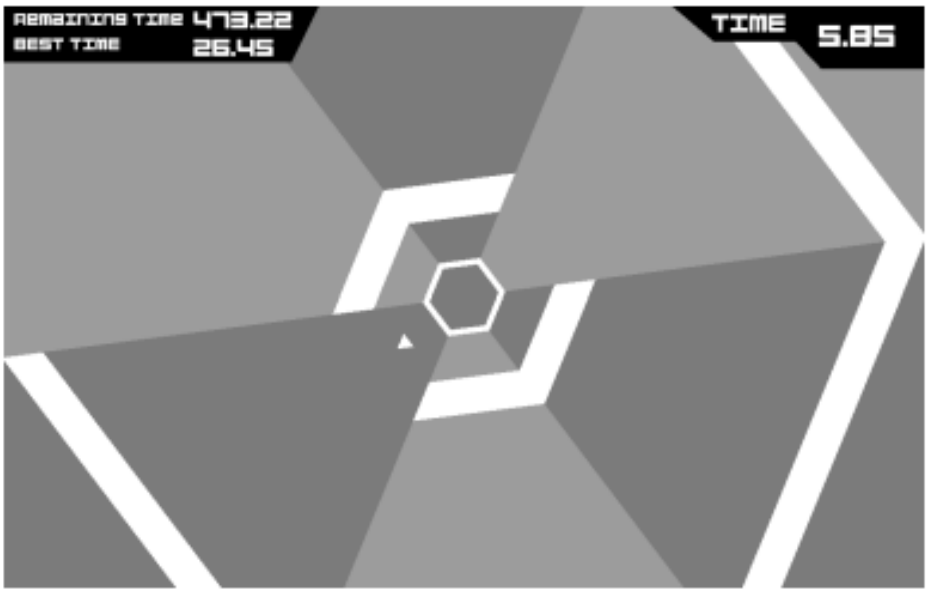
Super Hexagon Clone

The experimental task that was given to the participants was a clone of the game Super Hexagon, illustrated in Figure 1. The game is rather straightforward, using only two keys to control it. It also has a clear goal, namely steering clear of obstacles. This means that the participants could start playing directly. The participants play the game by rotating a triangle

to avoid the obstacles (the white bars). These obstacles gradually move inward resulting in the players needing to move around to avoid them. Given its simplicity, the game offered a low cognitive load, allowing for skill development (Haji et al., 2015; Sweller, 1988). The task was also suitable for observational learning, as participants could improve with this game by coding the patterns shown in the game (Buchanan & Wright, 2011; Proctor et al., 1990). The performance of the participants was measured by their time spent playing without colliding with the obstacles. The best time, representing the longest duration played in a single round, was displayed to participants.

Figure 1

Super Hexagon clone



Gamer Identity

The purpose of the Gamer Identity questionnaire was to investigate the relationship between participants' prior gaming experience and their likelihood of enjoying and committing to the job (Johanson et al., 2019). Two questions were asked to see if the participants identify as a gamer: "Are you experienced at playing video games?" and "Are

you a gamer?". The participants could answer on a 5-point Likert Scale, ranging from 1 being "not at all" and 5 being "extremely". The questionnaire had a high internal consistency with a Cronbach Alpha of 0.94.

Attentional Control Scale

The second questionnaire was the Attentional Control Scale (ACS) (Derryberry & Reed, 2002). People with better attention and task-specific concentration were expected to outperform others with this task. The 20-item self-report questionnaire measured two dimensions: the ability to focus and the ability to shift attention, with responses on a 4-point Likert scale (1 = almost, 4 = always). Participants were asked to answer questions like: "It's very hard for me to concentrate on a difficult task when there are noises around" and "I can quickly switch from one task to another". The ACS had a high internal consistency (Cronbach Alpha = 0.83) in this study and a high test-retest reliability with an average score of .61 (Derryberry & Reed, 2002).

Sport Orientation Questionnaire

Participants also completed the Sport Orientation Questionnaire (SOQ) (Gill & Deeter, 1988). This was included since competitive participants may exert more effort in the task. The 25-item self-report measurement featured three subcategories: competitiveness, win and goal orientation. An example question for the category competitiveness is "I am a competitive person". For the category win orientation "I have the most fun when I win". Lastly, an example question for the category goal orientation is "I set goals for myself when I compete" (Gill & Deeter, 1988). Participants could answer on a 5-point scale where 1 was "strongly disagree" and 5 was "strongly agree". The different subcategories have a high internal consistency in this study with Cronbach alpha coefficients ranging from .86 for goal

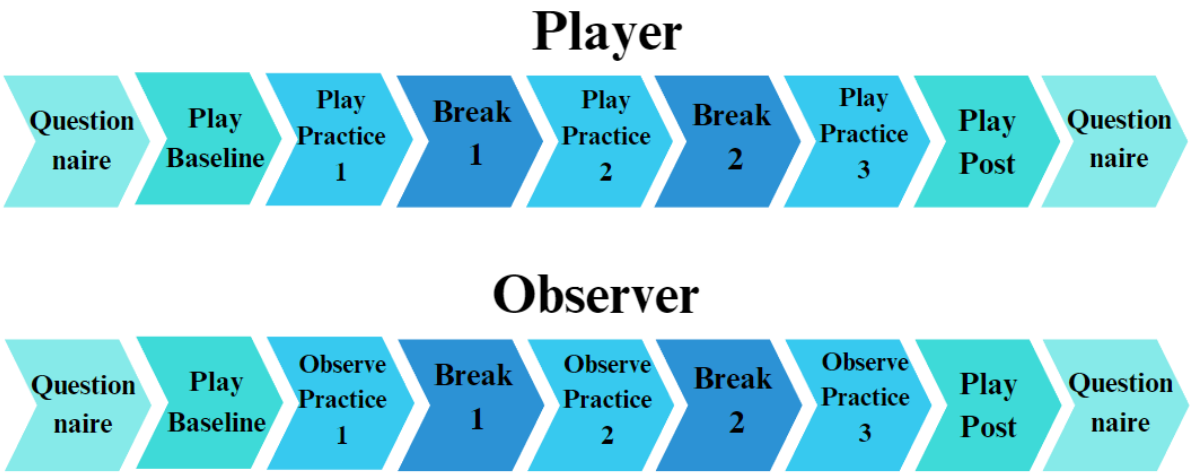
orientation, .86 for win orientation and .94 for competitiveness. The SOQ also has a sensible reliability, with a test-retest reliability for each item ranging from .39 to .76 (Gill & Deeter, 1988).

Mini Player Experience Inventory

After the participants played the game, participants answered the Mini Player Experience Inventory (MiniPXI) (Haider et al., 2022). This questionnaire has 11 items with a single item for the 11 constructs of the original PXI. An example of questions that were included in the MiniPXI is "I liked the look and feel of the game" or "the game was not too easy and not too hard to play". The MiniPXI had a single-item reliability average of .68 and the validity of 9 items out of 11 could be confirmed (Haider et al., 2022). In this study, it had a good internal consistency, with a Cronbach alpha of .84.

Figure 2

The procedure of the experiment



Procedure

With this experimental research, the participants needed to participate in pairs. The procedure can be found in Figure 2. Before the start of the experiment participants were asked to read the consent form. After the participants provided their consent, the participants could start with the first of the questionnaire via Qualtrics (www.qualtrics.com). The first part of the questionnaire included the Gamer Identity, ACS and SOQ. After this, the participants were divided either into the player or observer category. This was done randomly, the person with the lower SONA number or external ID was given the player role. The participants were told what the next part of the procedure would look like (for full instructions see Appendix A). In the player condition, one of the participants did a baseline session with the game, then had three training sessions with a one-minute break in between the sessions and lastly had a post-session with the game, see Figure 2. Each session with the game took five minutes. The breaks were included since research shows that spaced practice is more effective than practising continuously, ensuring that the players improve their skills (Baldwin & Ford, 1988). The duration of the break was chosen based on the research done by Donovan and Radosevich (1999), who stated that breaks ranging from one to ten minutes were the most beneficial. The other participant of the pair was assigned to the observer condition, also called observer. They played the baseline session with the game and then observed the three training sessions which the other participants played. During the observation, the participants were told to refrain from talking, especially talking about the game, so that they would focus on either playing or observing the game. Both the player and observer were told that during the break they could do whatever they wanted. Lastly, after observing, the participant played the post-session. After both participants finished the last session, they were asked to return to the questionnaires and fill in the last questionnaire, the MiniPXI. This concluded the experiment.

Data analysis

Performance data from the Super Hexagon game and questionnaire responses were analysed using R Studio version 2023.12.0+369. The preliminary analyses included t-tests, comparing the player and observer roles performance during the baseline session, and comparing the roles with the different questionnaires. Internal consistencies of the questionnaires were assessed using Cronbach's alpha. In addition, a linear multiple regression was used to assess the effect of the different questionnaires, the ACS, the SOQ and gamer identity, on the performance variables. New variables were created to measure performance changes, either from the baseline to the post-condition or from the baseline to the second session played.

Linear mixed models assessed the first research question, examining the impact of observing on performance. For the different performance variables, the difference in average or maximum time to post or second session was analysed with the different linear mixed models. The mixed models included a fixed effect for the role of the participants and a random effect for individual participants. The effect size of these analyses was quantified using Cohen's D. The significance level (alpha) for the statistical tests used was set at 0.05.

For the second research question, exploring what people talked about during their break, the break data was transcribed (see Appendices B to N). The content of the break was categorized into three groups: unrelated to the game, related to the game or game tactics.

Results

Preliminary results

To look at the performance of the participants with the game, the average and maximum duration, also called the high score, of the participants were measured. The average time is the mean duration of the trials played before it restarts due to a mistake made by a

player. The maximum duration is the highest score or longest time of a trial played in a session. Observers only participated in the baseline and post conditions, while the players had three practices, also called play sessions, in between the baseline and post conditions.

Baseline condition and roles

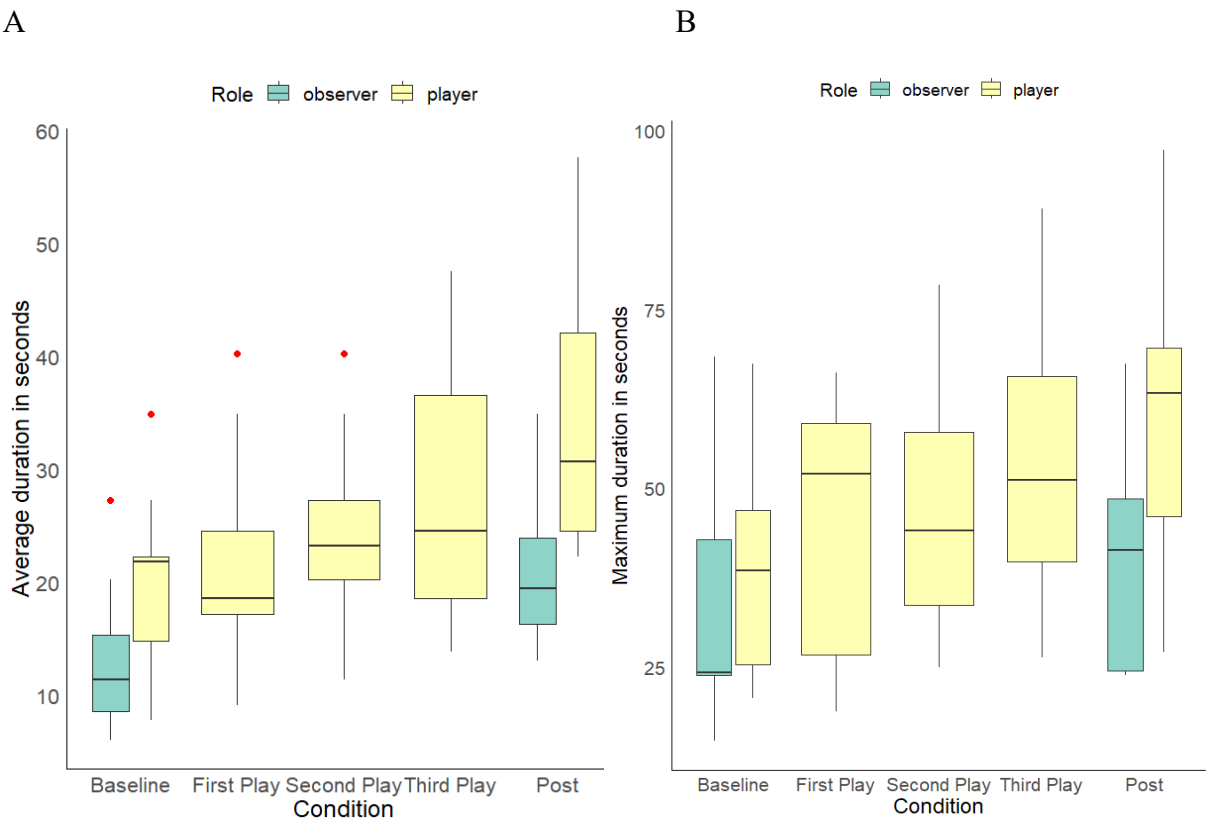
A Welch Two-Sample t-test was used to examine whether there was a difference in means for the roles of the average time at the baseline session. There was a non-significant difference $t(24) = -1.07$, $p = 0.296$ (95% *CI*: -13.65, 4.33). Thus these results indicated a non-statistically significant difference between the observer ($M = 15.80$, $SD = 10.74$) and the players ($M = 20.46$, $SD = 11.64$) for their mean time played at the baseline session. The same analysis was done for the maximum time for the roles. The Welch Two-Sample t-test showed a non-significant difference, $t(24) = -1.41$, $p = .173$ (95% *CI*: -20.96, 3.98). Thus, there is no significant difference between the means of the maximum time at the baseline session between the observer ($M = 31.49$, $SD = 14.68$) and the players ($M = 39.98$, $SD = 16.09$)

Task performance

In Figure 2, the different performance variables across the different conditions and the roles, either player or observer, can be seen. Figure 2A shows this for the average duration among all the conditions. Figure 2B shows this for the maximum duration. There was an increase in average and maximum duration for both roles. The midline of the boxplot is the mean, the whiskers represent the first and third quartiles. The outliers are shown by the red dots, which are 1.5 times the IQR.

Figure 2

Comparison of performance across the different conditions and roles: (A) Average duration, (B) Maximum duration



For the analyses and to see whether participants improved with the game, variables were created to measure the difference between the baseline and post-condition. The first variable is the difference between the baseline and post-session average time. The second variable is the difference in high scores between the baseline and post-condition.

Another set of variables was created to investigate the difference between the first and second sessions played by both the players and observers. For observers, this difference between the first and second sessions would be the difference between the baseline and post-session. However, for the players, this difference would be between the baseline and the first play session. The descriptive statistics of these variables can be seen in Table 1. First, the

differences between the average and maximum duration for all the participants are described. Then these differences are divided between the players and observers. Lastly, since the second difference for the second session for the observers is the same as the difference between baseline and post, the difference between the second session is only a different value for the players.

Table 1

Descriptive statistics of difference in seconds between the baseline session and post-session

Performance variables	*M*	*SD*	IQR	Minimum	Maximum
			Total		
Difference average time	8.84	11.04	8.87	-18.84	32.85
Difference maximum time	13.98	15.42	17.49	-18.51	43.61
			Observer		
Difference average time	4.29	9.72	10.56	-18.84	16.98
Difference maximum time	9.20	15.30	19.54	-18.51	40.44
			Player		
Difference average time	13.38	10.71	6.51	-12.08	32.85
Difference maximum time	18.76	14.56	17.00	2.62	43.61
Difference second session average time	1.18	8.40	12.29	-12.08	18.04
Difference second session maximum time	4.26	13.16	12.47	-15.07	34.78

Note. The second session difference variable for the players is the difference in performance from the baseline to the second session played. For observers, this variable is the same as the difference in performance from the baseline to the post-condition.

Relation between questionnaires and performance

Two-sample t-tests were used to see whether the questionnaires differed between the two roles. Only the subset competitiveness of the SOQ was significantly different between the two roles. The players scored higher on competitiveness (M = 3.43, SD = 0.74) than the observers (M = 2.64, SD = 1.05), $t(25) = -2.23$, $p = .037$. A multiple regression was used to test whether the different questionnaires, the ACS, the SOQ and one's Gamer Identity influenced the participants' performance. Both the difference in average and maximum time were used as separate independent variables.

A multiple regression analysis was utilized to examine the relationship between the dependent variable, the difference in average time and the predictor variables, and the means of the different questionnaires. The model was not statistically significant, $F(5, 20) = 0.63$, $p = .682$. The model had an *adjusted* R^2 of -0.08, indicating that the model might not be a good fit. The correlations of this model can be seen in Table 2. None of the predictor variables had a statistically significant correlation.

A multiple regression analysis examined the relationship between the dependent variable, the difference in maximum time and the predictor variables, and the means of the different questionnaires. The overall model was not statistically significant, $F(5, 20) = 1.51$, $p = .233$, with an *adjusted* R^2 of 0.09. Table 3 shows the correlation matrix for this multiple regression. None of the predictors reached statistical significance.

Table 2

Correlation matrix difference average time

Variable	*M*	*SD*	1	2	3	4	5	6
Difference average time	8.84	11.04	-	.18	.13	.05	-.20	.27
ACS	2.54	0.42		-	.41	.08	.13	.31
SOQ competitiveness	3.04	0.98			-	.70	.49	.51
SOQ win orientation	2.88	0.94				-	.31	.51
SOQ goal orientation	4.02	0.82					-	-.12
Gamer Identity	2.48	1.42						-

Note. * indicates $p < .05$

Table 3

Correlation matrix difference maximum time

Variable	*M*	*SD*	1	2	3	4	5	6
Difference maximum time	13.98	15.42	-	.14	-.17	-.34	-.18	.16
ACS	2.54	0.42		-	.41	.08	.13	.31
SOQ competitiveness	3.04	0.98			-	.70	.49	.51
SOQ win orientation	2.88	0.94				-	.31	.51
SOQ goal orientation	4.02	0.82					-	-.12
Gamer Identity	2.48	1.42						-

Note. * indicates $p < .05$

In short, this research used two performance variables, the mean and maximum time played. These variables were measured from the baseline to the post-condition and the baseline to the second session played. For the baseline session, there was no significant difference in performance between the roles. In addition, there was no significant correlation between the different questionnaires, the gamer identity questionnaire, ACS and SOQ, and the different performance variables.

The next section of the results are presented in three parts. The first section presents the main research question, investigating the benefits of observing on the performance from baseline to post-session, followed by the benefits of observing from the first to the second session played. The third section presents the data collected from the breaks.

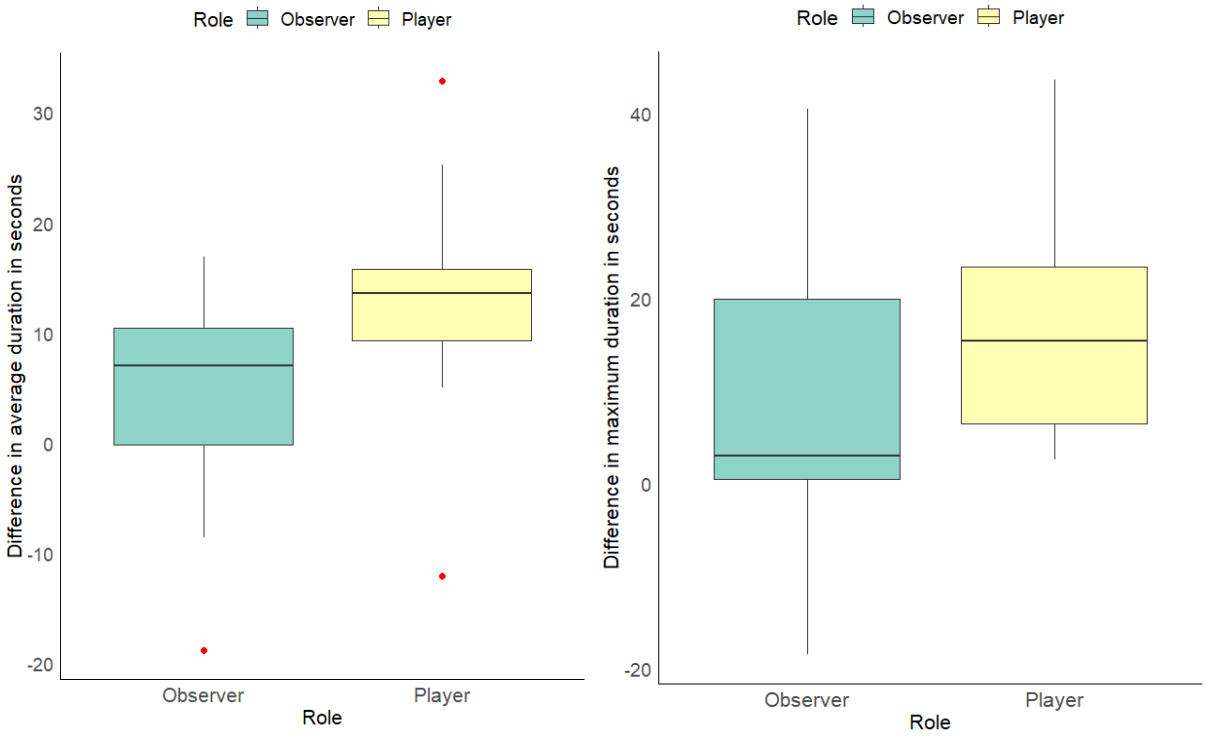
Does observing have benefits for performance in digital games: difference baseline to post condition?

For the main research question, we want to research whether observing someone play a digital game improves the performance of the observer. Is observing someone a beneficial method to improve your gaming skills? Figure 3 shows the difference in performance, both in average duration in Figure 3A and maximum duration in Figure 3B, from baseline to post for the different roles. The midline represents the mean, the whiskers are the first and third quartiles. Outliers are represented by red dots, which are one and a half times the IQR. To estimate the effect of the different roles a linear mixed model was used for both the difference in average and maximum time. The results show that for the high score, there was no difference between the observers and players, while there was a difference between the groups for the average time.

Figure 3

Comparison of the difference in performance from the baseline to post condition for the different roles: (A) Difference in average duration, (B) Difference in maximum duration

A B



To investigate the relationship between the difference in average time from baseline to post-condition and the roles a linear mixed model, using restricted maximum likelihood estimated (REML) and Satterthwaite's method for t-test, was utilized. The model included a fixed effect for the role of the participants (player/observer) and a random effect for individual participants. The results showed that the null hypothesis, that there was no difference between the roles on the improvement in average time, could be rejected, $t(24) = 2.27$, $p = .033$. The difference in average time from baseline to post for observers ($M = 4.29$, $SD = 9.72$) is significantly lower than the difference in average time for players ($M = 9.09$, $SD = 10.71$). The random effects of the participants indicated significant variability (*Variance* = 78.84, $SD = 8.88$), while the residual variance was 25.74 ($SD = 5.07$). The scaled residuals

ranged from -1.24 to 0.94, suggesting that the model represented the variability in the data adequately. The model also showed a significant negative correlation between the intercept and the roles ($r = 0.707$). Thus, the model displayed a significant effect of the roles on the difference in average time, suggesting that the observers improved significantly less than the players. The variability between the roles was revealed by the random effects. The same conclusion could be drawn when the average duration in seconds at the baseline condition was added as an additional random effect (see Appendix O).

The effect size, measured with *Cohen's d,* for the difference between the roles, player and observer, for the difference in average time from baseline to post session resulted as $d = 0.88$ (95% *CI*: -17.37, -0.80). This effect suggests a large effect, in favour of the players (Cohen, 1988).

To test the null hypothesis that there is no difference between the roles for the difference in maximum time, a linear mixed model was used. The model included a fixed effect for the role (player/observer) of the participant and considered the random effect related to individual participants. The results showed that the null hypothesis could not be rejected, $t(24) = 1.63$, $p = .116$. The analysis of the random effects illustrated significant variability at the participant level. The random intercept showed considerable variance (*Variance* = 192.21, *SD* = 13.86). The residual variance was 30.75 (*SD*= 5.55). The scaled residuals' distribution fell between -0.69 to 0.78, indicating that the model captured the data's variability. So, the effect of the intercept on the difference in maximum time was found to be significant by the linear mixed model. However, the effect of the roles did not achieve statistical significance. When the maximum duration in seconds at the baseline is concluded as an additional random effect the same conclusion can be drawn (see Appendix O). Thus, there was no difference between the roles on the performance in maximum time from baseline to post. The random effects showed significant fluctuations at the individual levels.

The effect size for the comparison between the players and observers for the difference in maximum time was calculated with *Cohen's d*. Cohen's d was calculated as d = 0.64 (95% *CI*: -21.66, 2.52) This effect size can be seen as small to moderate, suggesting that the performance increase of the players was slightly larger than that of the observers.

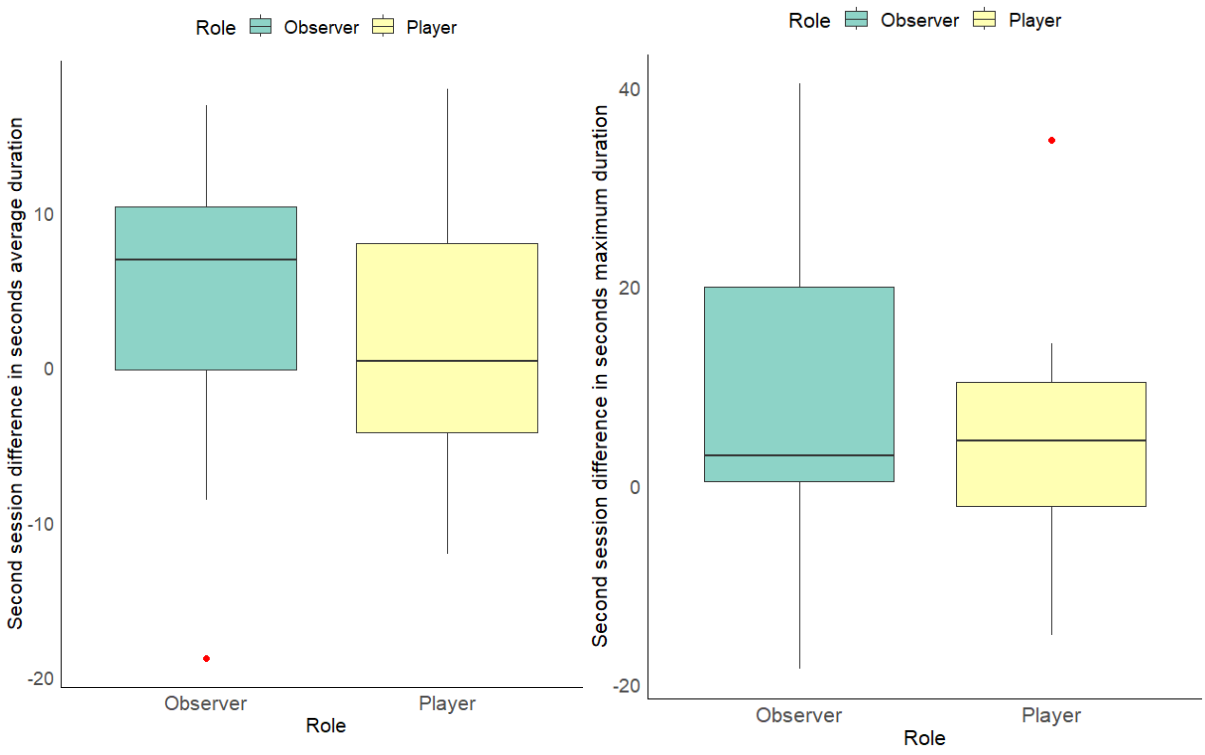
Does observing have benefits for performance: difference baseline to the second session?

As stated earlier, to investigate the difference between the roles, a new variable was created to see the difference in performance between the first and the second session played. For observers, this is the same as the difference variable between the baseline and post-condition. However, for the players, this is the difference between the baseline and the first play sessions. Figure 4 shows the difference in performance, both average duration in Figure 4A and maximum duration in Figure 4B, from the baseline to the second session for both roles. The midline of the boxplot is the mean and the whiskers represent the first and third quartiles. Outliers are represented by a red dot and are one and a half times the IQR. This research wants to investigate whether the different roles of the participant influence the difference in performance from the baseline to the second session played. The results showed that there was no significant difference in performance between the two roles for the performance from the baseline to the second session played.

Figure 4

Comparison of the difference in performance from the baseline to second session for the different roles: (A) Difference in average duration, (B) Difference in maximum duration

A B



A linear mixed model was utilized to investigate the null hypothesis that the roles, either player or observer, are not different in their improvement in average time from baseline to the second session while taking into account the random effects of the individual participants. The model was a good fit, supported by the REML criterion at convergence (179.1). The null hypothesis could not be rejected, $t(24) = -0.88$, $p = .390$. The scaled residuals ranged from -0.95 to 0.69, thus the model captured the variability of the data. In short, the model showed no significant effect of the role on the difference in average time from the first to the second session.

A *Cohen's d* was conducted to calculate the effect size for the difference in average time from the baseline to the second session between the roles. The effect size was d = -0.34 (95% *CI*: -4.24, 10.48), indicating a small effect size in favour of the observers.

A linear mixed model was used to research the effect of the role, player or observer, on the difference in maximum time from the first to second session played with the random effects related to the individual participants. This model also was a good fit, with the REML criterion at convergence (200.8). It was also able to capture the variability of the data, with scaled residuals ranging from -0.72 to 0.81. The analysis showed that the null hypothesis, that the roles are no different in their improvement in this performance variable, could not be rejected, $t(24) = -0.88$, $p = .386$. The analysis of random effects indicated significant variability among the individual participants. The random intercept for the participants had a variance of 175.46 (SD = 113.25), with a residual variance of 28.07 (SD = 5.30). So, the linear mixed model did not show a significant effect for the role, player or observer, on the difference of the maximum time from the first to the second session.

To calculate the effect size comparing the players and observers, *Cohen's d* was -0.35 (95% *CI*: -6.62, 16.50). This effect size can be seen as a small effect in favour of the observers. Thus, there is no difference between the roles for both performance variables, average and maximum time, from the baseline to the second session.

Break data

This research wants to explore what the participants talked about during their breaks and its relation to their performance. Does what they talk about influence the participants' performance? The content of the breaks was divided into three separate categories: unrelated to the game, related to the game and game tactics. It was also possible for the break to be

divided into two categories if the separate categories were found in the break. The transcription of the breaks can be found in the appendices.

The first category was unrelated to the game. The category was assigned to the breaks when the participants did not talk or talk about something unrelated to the game that they were playing. For example, participant three asked participant four the following: “Can you give me my water?”. Another example was from participants one and two.

P1: What kind of study did you do? That you did with virtual reality?

P2: It was like, you had to put your, this thing, and it was basically, you had to complete a task and you can like actually talk with the other characters in the visual reality. So I was supposed to task them questions, so I was like “Hey”. It is actually, you have to move like this, to look around the room.

The second category was related to the game. Breaks categorized in this category had content that was related to the game, but did not talk about tactics that could be used to perform better in the game. This category was mainly about the appearance of the game, discussing the time of their high score or the motion sickness that could occur when playing the game. For example, participants nine and ten talked about motion sickness related to playing the game.

P9: Just close your eyes

P10: Everything is turning. No, it’s not that bad

P10: But it is exhausting. Yes, I think, but I never play, so maybe it’s just like you said.

Participants 13 and 14 talked about the high score and playing the game in general.

P14: Do you feel like you’re getting better?

P13: I’m not. I’m, getting worse because it’s so tedious and frustrating

P13: I’m really bad at such games

The last category was game tactics. Breaks categorized in-game tactics talked about the mechanics of the games and/or different tactics that could be used to perform better at the game. For example, participants 17 and 18 talked about tactics.

P18: I see you do it with both hands. Which is kind of strange. I did it with one

P17: But sometimes you are like not fast enough if it was one, because you have to go to the next direction. Like I had that before.

Participants 19 and 20 also talked about revelations they had regarding a tactic to perform better at the game.

P19: It's basically dodging or standing in one of these lines.

P20: It's so claustrophobic. I could get so, so little space

P19: Yeah, but I mean, the way, you know, if you are in the same space, if you just wanted between these lines that it never intersects them. Usually leaves one of these just fully open. So you can just stand there.

In the first break, three pairs were categorized as unrelated to the game, seven pairs as related to the game and six pairs as game tactics, see Table 2. In the second break, eight pairs were categorized as unrelated to the game, seven related to the game, and two pairs as game tactics. Thus, in the first break, most pairs did talk about talk about the game, either as the category related to the game or game tactics. However, in the second break, more pairs were talking about content unrelated to the game, going from three pairs to eight pairs. In the first break, six pairs talked about game tactics but in the second break, only two pairs talked about game tactics.

Table 4

The number of pairs that were categorized as a certain category

Category	Number of pairs
First break	
Unrelated to game	3
Related to game	7
Tactics	6
Second break	
Unrelated to game	8
Related to game	7
Tactics	2

Most pairs, 11 out of 13, talked about several different topics and were classified within different categories over the two breaks. Only one pair was qualified as unrelated in both breaks. Both participants of this pair were in the first quartile in their difference in average time from baseline to post-condition, with a decrease of 18.84 seconds and 12.08 seconds. For the difference in maximum time, only the observer of this pair was in the first quartile, improving with 0.82 seconds. The player was in the second quartile with an improvement of 10 seconds. Due to the lack of data, it could not be analysed whether people who talked about the game during the breaks performed better than those who did not.

Discussion

Summary of results

This study aimed to assess whether observational learning is an effective method to improve one's gaming skills. The hypothesis stated that observational learning would benefit

performance, but the findings offer partial support. There was no significant difference between the roles, player or observer, for their improvement in maximum time. There was also no significant difference between the roles for the average time from the baseline to the second session played. However, there was a significant difference between the roles for the average time from the baseline to the post-condition. The observers scored significantly less than the players. Thus, when the extra practice sessions of the players are included they perform significantly better than the observers.

As for the secondary purposes, participants engaged in diverse conversations during the breaks. The findings reveal that most pairs of participants talked about several different topics, ranging from unrelated or related to the game played and game tactics. Only one pair talked about content unrelated to the game for both breaks and performed on the first quartile. However, this study could not provide the data to support that people who talk about the game are performing better. There was a switch between what the pairs wanted to talk about from their first and second break, going from talking about the game to unrelated content.

Theoretical implications

The study provides new insights into the effect of observational learning on perceptual motor skills, particularly within the gaming context, an area that has not been extensively explored. In line with existing research on observational learning and skill development across various domains (Bandura & McClelland, 1977; Bandura, 1986; Cumming et al., 2005; Wesch et al., 2007), the findings of this study suggest that observational learning can benefit the development of skills in gaming.

Notably, the results suggest that a combined approach involving both practice and observational learning might be more beneficial for game skill enhancement, similar to the work of Bandura (1977). While observational learning might be beneficial to skill

improvement, combining it with practice is even better (Wulf et al., 2010). This study revealed that players who had more practice sessions significantly outperformed their counterparts in average time. This was not the case when the practice sessions were not included, underscoring the importance of the extra practice sessions.

This research supports the findings of Johanson et al. (2019) study, showcasing the benefits of spaced practice in enhancing participant performance. Unlike their study, which used breaks ranging from two minutes to a day, this research employed shorter breaks of one minute. The findings suggest that breaks as short as one minute can be effective in improving performance. In contrast to their study, which was done online, this study was done in a laboratory. In the study done by Johanson et al. (2019), the mean of the average time of the last session ranged from 4 to 8 seconds. The average time was significantly higher for the participants in this study, with a mean of 26.97 seconds. This could be due to social facilitation. According to social facilitation, participants could perform a simple task better when watched by others instead of being alone (Zajonc, 1965). This is due to the increased arousal and wanting to gain social approval, which positively influences the performance of a simple task. This notion was supported by the research from Kao (2022). This study found that if video game players were observed, especially by someone who was introduced as a researcher, would perform better at several video games.

Practical implications

Improving player skill development has become a major motivator in the context of the growing video game industry, which is always looking for new and exciting methods to engage and inspire players. Even though streaming has been very popular among gamers, on platforms like Twitch, its potential to help improve gamers' skills has been unexplored. This

research sheds light on the advantages of observational learning, showing that watching others can enhance one's gaming skills.

Moreover, observational learning could also be a less intense alternative to improve one's gaming skills. Currently practicing is used as the main method to increase one's skill. Even if it works, the popular strategy of continuous practice can cause frustration or dissatisfaction, especially when negative results like losing are encountered (Breuer et al., 2015). This study indicates that observational learning offers a feasible and less taxing path to skill advancement, which may lessen player frustration and subsequently motivate them.

In addition, there are implications for game design. For skill advancement in games, observational learning could be usefully integrated into games rather than depending only on conventional practice techniques. For example, instead of only practising in the tutorial phase of a game, the player could observe a model who shows how to do certain skills or parts of the game. This alternate learning approach might be helpful for frustrated players who are having trouble moving forward in the game because it lets them watch a model navigate it. Our findings support this method since watching another player perform a game can have a positive effect on the player's skill improvement.

Limitations and future work

Several limitations must be acknowledged. Firstly, the generalizability of the results is limited by the small sample and effect size of this research. There was only a large effect size in favour of the players for the improvement in average time from the baseline to post-condition. The small sample size also resulted in the little variance found in the questionnaire answers. In future research, to investigate the effect of attentional control and sport orientation on performance, a larger sample is needed with more variance in this aspect.

Additionally, the homogeneity of the participants – mostly students of similar age – may have positively influenced the effect of observational learning. As stated earlier, the model and observer being similar has a positive effect on observational learning. However, this research did not take into account other factors of the model that could influence observational learning. This research did not take into account the competence of the model. All participants were novices with the game, potentially affecting the competence of the observed models. Future research should consider the model characteristics, such as competence and similarity, to provide a more comprehensive understanding of the observational learning process.

This study did not include a control condition, to see whether the beneficial effect came from the time not spent with the game or due to the observational learning, to which the effect of observational learning could be compared. However, both roles did not significantly differ in performance at the baseline session. Thus, the development in performance between the roles, either playing or observing, could be compared. Besides, adding the baseline condition as a random effect in the linear mixed model analysis did not result in a different conclusion. Future research should include a control condition so that it can be researched whether the performance improvement is due to observational learning or due to the time not spent playing from the baseline to the post-condition.

Furthermore, the generalizability of the results could be limited due to the game that was used in this research. The *Super Hexagon* clone is easy to understand and play, with the only goal being avoiding the obstacles with the use of two control keys. Research shows that the complexity of the task can influence the effectiveness of both spaced practice and observational learning (Donovan & Radosevich, 1999; Laguna, 2008). While this does clearly show that these methods can be used in skill development, it may not fully capture the effectiveness of the methods in more complex gaming scenarios. Therefore, future research is

needed to investigate the effect of observational learning in more diverse gaming environments to see if the benefits can still be found.

Lastly, because this study was conducted in a laboratory rather than a natural gaming environment, participant behaviour may have been influenced by perceived observation. To better comprehend observational learning's practical implications, it is important to examine its effectiveness in a more realistic context, such as cooperative gaming or streaming. Investigating observational learning in these environments that resemble the actual gaming experience should be the focus of future research.

Conclusion

In conclusion, this study aimed to explore the impact of observational learning on digital game performance, revealing partial support for the hypothesis. While both players and observers demonstrated improvement in maximum time, this was not the case for the average time. There was no difference between the participants who used either spaced practice or observational learning for most performance variables. This suggests that both methods effectively contribute to skill development. However, there was a significant difference in average time between the players and observers from the baseline to the post-condition, contradicting the initial hypothesis. The research also explored what the participants talked about during the breaks.

While the study highlights the potential of observational learning in the gaming industry, we acknowledge several limitations, including a modest sample size and the use of a simple task. More research is needed to address these limitations, especially to determine whether observational learning is still effective in more complex gaming scenarios. Thus, this study represents a first step towards a more thorough understanding of observational learning in the dynamic field of digital gaming.

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Appendix A

Instructions to participants

Welcome and thank you for participating in this study. In this study, you will be playing a game. Before you start with the game you will fill in part of the questionnaires, which you can find on the screen before you. You will fill in the first part of the questionnaires before starting with the game. After you finish the first part, there will be a screen telling you to not continue unless you have finished all the gaming sessions. That is when you will stop with the questionnaire and move on with the game. Do not close the window with the questionnaires, you will move back to fill in the last part after the gaming session.

After the first part of the questionnaires you will both start with the first session of the game, also called the baseline session. This session will take 5 minutes. The game will stop after these 5 minutes. In the game, you will use the left and right arrow keys to move the little triangle. The goal is to avoid the white obstacles and survive as long as possible.

After the baseline session, we will move to the play session. This is where you will have different tasks. One participant, the player, will have three play sessions to practice with the game. The other participant, the observer, will observe the other player during these sessions. In between these practice sessions, there will be a one-minute break. In this, you can do whatever you want. However, for this research, these one-minute breaks will be voice-recorded. Only the researcher will hear these voice recordings and the data will be anonymized.

After the play sessions, both the player and observer will play one last post-session with the game. This will be 5 minutes long again. When this post-session is finished, you can move on to the last part of the questionnaire. There will be two questionnaires that still need to be filled in.

Appendix B

Transcription of breaks participants 1 and 2

Break 1

1: I am really lucky I did not get my mom's motion sickness. She used to like going into rollercoasters and stuff, but if she goes into it now, she will get so dizzy she will be nauseous for days

2. Oh, for days?

1: For days, yeah, she was pretty sick last time she did a rollercoaster

2: With the virtual reality game that I did in the other studio I got really, like, I was so like, I felt like I was like in a car for like 5 hours something like that. I was really nauseous actually

1: Yeah, I can understand

2: Oh we have to start again.

Break 2

1: What kind of study did you do? That you did with virtual reality?

2: It was like, you had to put your, this thing, and it was basically, you had to complete a task and you can like actually talk with the other characters in the visual reality. So I was supposed to ask them questions, so I was like "Hey". It is actually, you have to move like this, to look around the room

1: Oh yeah

2: And it was really

1: Oh yeah I can get that

2: It was like okay, but at the end I was like "I can't anymore". It was tough. Because I was so dizzy, I got really dizzy.

1: Oh, the game

Appendix C

Transcription of breaks participants 3 and 4

Break 1

3: Can you give me my water?

Break 2

4: You got this

Appendix D

Transcription breaks participants 5 and 6

Break 1

6: Okay.

5: Oh. Oh, God. I need to look away from that screen for a minute. Yeah.

5: Oh, understandable. Oh, no.

5: Oh.

6: You okay?

5: Uh huh. I'm fine. It's just like my brain is struggling to keep up at the later stages. Like I know how the sections are at the maze now. Sometimes I just can't keep up the latter stages because I'm not concerned as many times.

6: Yeah.

5: You can just hold the key down.

6: No, like I was a pressing it and I was like, oh, God.

6: Oh. God.

Break 2

5: Will burn me out later. Then show some.

6: Love. Okay, so people.

6: Just trying to balance everything honestly out of your availability. Like suddenly the prompt

5: What's that?

5: Is there another training session after this?

Researcher: The last one.

5: Oh, god.

5: So are you actually learning?

6: I'm getting fucking dizzy looking at your screen.

5: Yeah, yeah. Um.

5: What was the highest score so far?

Appendix E

Transcription breaks participants 7 and 8

Break 1

Researcher: This is the break and now I will record

8: Did you know you can press the keys like long I always get. If That makes sense?

7: Ahhh

7: What was your high score?

8: Oh my God, so bad actually. Like ten.

7: Yeah, I had like 12. And then when I started the second time. Because immediately better.

8: Actually, do you remember where we have to go after, I don't remember.

7: What do we have, theory?

8: Oh, yeah. Sure. Just online. Okay. That session is not the practice exam? The exam is not today. Right?

7 I don't think so.

Break 2

Researcher: Yeah. So this is the second break.

8: Okay.

8: You got better for like half a second.

7: Okay. But after some time, it changes like it is the same all the time, and then it changes that you have really to go like, right and left. And I can't do that. And also I don't like I know it's not better, I just press in one direction.

8: Oh yeah.

7: Because I get confused when I go

8: Yeah, circles.

7: Yeah.

8: It's very fun to watch. Just the one more. The one where we play together in that.

7: Yeah.

8: It's not like it's going to. Be 12 seconds.

7: No, I think you will do 25 as well.

Appendix F

Transcription breaks participants 9 and 10

Break 1

10: I don't know what to talk about. Okay, so. And then after the break there is another?

Researcher: Yeah. You will have two more sessions.

10: First I thought I need to like, I don't know, focus on the white.

9: I thought you were focusing on it.

10: I tried to do both because I wasn't sure what to focus on. Okay, but in the next session, i'll focus on the game.

10: Yeah. Maybe just see the patterns which are coming.

Break 2

10: I think that's hard to follow.

9: It's pretty exhausting for the eyes.

10: Yeah. Yeah. And if it gets lost. Yeah.

9: I... sometimes it's heading for the wrong direction.

9: Just close your eyes.

10: Everything is turning. No, it's not that bad.

10: But it is exhausting. Yes, I think, but I never play, so maybe it's just like you said.

9: What about the Sims?

10: That doesn't count

Appendix G

Transcription break participants 11 and 12

Break 1

11: En dan moet ik zo weer straks?

Researcher: Nog twee keer

12: Mag ik even wat drinken pakken?

Researcher: Ja zeker

11: Daar gaan we weer

Break 2

Researcher: En de laatste pauze.

11: Je raakt er wel in een soort trans van. Je zit echt zo naar dat scherm te staren

Appendix H

Transcription breaks participants 13 and 14

Break 1

13: Can you throw water because my?

13: Thank you

14: Do you feel like you're getting better?

13: I'm not. I'm getting worse because it's so tedious and frustrating.

13: I'm really bad at such games. Also, when I play it on the phone.

14: you know, like the thing with the color where you have to, like, jump through?

13: Yeah.

14: I was like, no, I'm gonna do it again. That's kind of how they tried to play it competitively the other night. And I was like, no, no, no, no.

13: I'm really competitive, but not when it comes to this because then I'm too frustrated. I'm not, like, competitive when it comes to learning

13: Also. My brain is all I can't explain it, but it's all like flowing together at some point. If you are focusing on it, you can't. You see the grey and the white, but you can't really see dimensions, so you don't know where you have to go.

Break 2

14: I certainly really focus on left and right. I'm like, if I go left there will be only like one jump. But I always just press right? So it's like I turn the same direction. That takes longer.

13: Perfect. Oh, I'm going auto spinning.

14: Yeah. Sorry, we cannot enter class and everything's turning.

13: Oh, that would be a pity.

14: Oh, I'm so sad. Do theymiss us?

13: No, they probably are happy we aren't there for one time.

14: I don't think so. I think they're like, yeah, I think we're fine.

13: I don't think that anybody.

14: At least we ask questions. Yeah. In order for them to tell us everything and how to do it.

Appendix I

Transcription breaks participants 15 and 16

Break 1

15: Do you like it?

16: Yes.

16: When I studied game design and everyone was bad at games we did. Like at one presentation a guy that was supposed to present came from my team wasn't even supposed to finish it.

15: Yeah, I'm like confused. How did I not see it? That was fine.

16: I did something good, right?

15: Yeah. Impressive.

151: You won.

Break 2

15: So bad.

16: But you're already doing better.

15: I'm like, looking at it and I'm like, where am I even going? I do understand the dizzy part that you can get.

16: Do you get dizzy?

15: No, but I do have a struggle with looking at it. But I just get lost and I'm like, oh, wait, this is white. Yeah, that's a bit of a problem. And I'm like, nine seconds in and it's. boom.

16: You can do it!

Appendix J

Transcription breaks participants 17 and 18

Break 1

17: First I thought that there were different levels. But then you succeeded.

18: I think the problem was I go too fast, and then I'm going into like the bottom because I want to go to the next field . I don't know why.

17: I see you do it with both hands. Which is kind of strange. I did it with one.

18: But sometimes you are like not fast enough if it was one, because you have to go to the next direction. Like I had that before.

17: I was wondering whether it was intentionally cutting you off and replaying that.

18: Yeah, it's kind of a pattern. It's like always the same.

Break 2

17: Maybe it's intentionally provoking you to get upset.

18: Maybe. So fine. And how is it observing how I play a game

17: You have like, a little improvement, but I don't think it's up to you when it cuts you off, you know.

18: Sometimes if you're, like, in the wrong field and you only have, like, one way out, then it gets like, too fast.

17: But, like, I think your reaction time is going down. Like that goes faster.

18: What if you do that in the project. Just don't do the project. Just game.

17: Yeah.

Appendix K

Transcription breaks participants 19 and 20

Break 1

19: It's trippy

20: You are very good at this.

19: How much did you get?

20: I don't know. I think I was stuck at one point. I couldn't get more than 13 seconds.

19: Oh, really?

20: Yeah.

19: I just need to remember what happens. But your brain gets so scrambled. Scrambled eggs, bro, so much. While at one point I don't even know. I didn't even realize the light shade of gray between the white. You know, maybe I'll hit 100.

20: Huh?

19: Maybe I'll have 100.

20: That would be a lot, actually, because it gets more difficult every time.

19: Also I die randomly sometimes.

Break 2

19: And the 100 is getting closer.

20: But you have a new best time.

19: Yeah.

19: It's basically dodging or standing in one of these lines.

20: It's so claustrophobic. I could get so, so little space.

19: Yeah, but I mean, the way, you know, if you're in the same space, if you just wanted between these lines that it never intersects them. Usually leaves one of these just fully open. So you can just stand there.

20: Interesting stuff.

20: Look away.

Appendix L

Transcription breaks participants 25 and 26

Break 1

26: You really go wrong a lot because of the mistakes of the game.

25: Yes, but it's also real, if you hit even a tiny bit, it goes off and there's no animation to show oh. You went off here or you went off there, so sometimes it is really difficult to see.

25: Yes, it is also easier when you are in the dark side

26: Oh really?

Researcher: I might be able to make the screen a little brighter for you.

26: But you can also simply press the button for a long time instead of tapping it every time.

25: No, then I'm afraid he'll go completely crazy.

26: I don't think it matters at first.

26: You're ready, you're going for that high score. Higher than 25.

Break 2

26: You're such a streamer. Just put a camera on you.

25: That's really interesting.

26: Yes, but people make a lot of money with that, right? Have you ever donated to a streamer?

25: No, you?

26: No

26: I can spend my money better

25: Yes, but if you watch it.

26: Yes, but sometimes people really give an awful lot, right, you can also give subs for me, subscribers, you can subscribe for me or a channel like that. It costs five euros a month or something like that. Sometimes people just give away 100 of those things to other people and

then they raffle them off. I think that chess player actually earns 100,000 euros a month, right?

25: Yes, if you look at it, yes.

26: Television is also expensive.

25: Yes, and going to the cinema too.

Appendix M

Transcription breaks participants 27 and 28

Break 1

28: And after that is that voice recording?

Researcher: No, that is now in this one.

27: I'm getting pissed off that it glitches so often

28: I'm getting dizzy and that's why I can't see anymore

27: I really think that I would be better on the computer than on this laptop, that it is smoother in terms of frame rate or something. Or is that not the case here?

Researcher: Not so bad.

28: Yes, when do you decide to go to the right and when to the left? Or is that purely random?

27: Should we discuss that now?

Researcher: That's allowed

27: Kind of random, just, usually when, yeah, usually when I'm closest to the one, because sometimes you just have to do one little little tap to the left.

Break 2

27: Yes.

28: My eyes.

27: Yes, look away for a moment.

28: They hurt.

27: Oh yes.

27: Would you please text downstairs to ask them to get the herb butter from the refrigerator?

28: Have you heard this before?

27: One more time?

Researcher: One more practice and then both a final session.

28: I want to do that last session on the computer.

Researcher: That's allowed, the other one has to go first and then you can.

28: And then I'm not allowed to watch?

Researcher: Then you are not allowed to watch.

27: And started commenting on me because then I get nervous.

28 I'm not watching like that.

27: No.

28: Yes, I think it really goes faster.

Appendix N

Transcription breaks participants 29 and 30

Break 1

30: Oh now I have to wait, okay. The text above the text is nice. I don't know who came up with that.

29: I only think that if you, um, that part where I always walk, you are cheating there

20: Cheating?

29: You're going all the way, while I thought you had to go back. Yeah, I can't explain it if you haven't seen it.

30: Yes, I try every time. And every time I look at it correctly, I look at where it is next round.

29: Yes, I do that too, but it doesn't work for me, take a look.

30: No, and if that plane goes that way, just definitely don't go that way, but I find it difficult if you go back like this, it turns every time. Then I go off every time.

30: That doesn't really help me every time either. Do you also get a little dizzy?

Break 2

29: Yes, watching is worse than playing.

30: Yes, I have bouts of it too. I'm convinced I won't miss one of these times.

29: I think it's unfair, you should practice more often.

30: But you're watching, right?

29: Yes, but that is different from doing it yourself.

30: But when I was just at twenty seconds, I didn't hit anything at all, right?

29: Well, you moved on too soon. This affected those who were still continuing

30: What colour was it?

29: White, too bad!

30: Too bad

Appendix O

Linear mixed model analysis with baseline condition as a random effect

To test the null hypothesis that there is no difference between the roles for the difference in average time in seconds from the baseline to post condition, a linear mixed model was used. The model included a fixed effect for the role of the participant (player/observer), the random effects of individual participants and the average duration in seconds at the baseline condition. The results showed that the null hypothesis could be rejected, $t(24) = 3.94$, $p > .001$.

To test the null hypothesis that there is no difference between the roles for the difference in maximum time in seconds from the baseline to the post-condition, a linear mixed model was used. The model included a fixed effect for the role of the participant (player/observer), the random effects of the individual participant and the maximum duration in seconds at the baseline condition. The results showed that the null hypothesis could not be rejected, $t(24) = 1.63$, $p = .116$.

A linear mixed model was used to analyse whether there is a difference between the effects of the roles for the difference in average time in seconds from the baseline to the second session played. The model included the role of the participant (player/observer) as a fixed effect and included as random effects both the individual participant and the average duration in seconds at the baseline condition. The results showed that the null hypothesis could not be rejected, $t(24) = -0.88$, $p = .390$.

A linear mixed model was used to test the null hypothesis that there is no difference between the roles and their difference in maximum time in seconds from the baseline to the second session. The model included a fixed effect for the role of the participant (player/observer) and as random effects both the individual participant and the maximum

duration in seconds at the baseline condition. The results showed that the null hypothesis could not be rejected, $t(24) = -0.88$, $p = .386$. Thus, there is no significant difference between the roles for the difference in maximum time from the baseline to the second session.