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Development of an attention assisting game

Bachelor's thesis

Game programming

Bachelor of Engineering

2024

South-Eastern Finland
University of Applied Sciences

South-Eastern Finland University of Applied Sciences

Degree title	Bachelor of Engineering
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Thesis title	Development of an attention assisting game
Commissioned by	Xamk Game Studios
Time	2024
Pages	27 pages, 1 appendix page
Supervisor	Marko Oras

ABSTRACT

The objective of this thesis was to investigate the development of a game that could be played to assist attentiveness during a sustained attention task. For the thesis, a prototype game was designed, developed, and tested. The aim was to design and test a game that could be played during a lecture or lesson.

The thesis was made as a constructive design-based study. In the theoretical framework, multiple design principles were proposed. The prototype game was then developed with a combination of the proposed principles based on general game design theory. Finally, the prototype was tested in a small-scale field test. In the test, the participants were requested to play the game during a lecture and then respond to a survey. In the test, information was collected about participants' experience concerning their attention.

The thesis proposed six different design principles which were used during the prototype development. The principles aimed to limit a game's engagement, reduce task switching cost and take account of different attentional resources.

The resulting prototype was a simple match-tree mobile game. A majority of the participants stated that the game distracted them. Multiple reasons were suggested for the results: the test duration might have been too brief or the game might have been overly engaging or overly difficult. Despite the protype failing to reach its goal, the proposed principles could still be applied in developing games.

Keywords: game design, attention, multitasking, game development

CONTENTS

1 INTRODUCTION

There is general concern about reduced attention span and people's ability to concentrate. Constant access to technology associated with phones has been credited as a reason for widespread difficulty to concentrate. Rapid instant gratification, bright colours and addictive patterns seem to draw people to use their phones and devices. (Ducharme 2024.)

People have different coping strategies for boredom during lectures and lessons, such as doodling or multitasking with phones and computers. While multitasking leads to distraction and inattentiveness, it does reduce boredom (Risko et al. 2013). Videogames have been shown to have different kinds of benefits. Action videogames have been shown to increase adults' attention skills, and educational games are used in teaching. Contrastingly, videogames can also have negatives effects. Highly engaging and even addictive videogames can reduce time spent doing other important activities such as studying, socialising or sleeping. (Hodent 2020, 43–76.) This thesis investigates how to develop a videogame that could assist attentiveness in a typical lecture situation.

2 RESEARCH METHODS AND OBJECTIVES

The objective of this thesis was to design, develop and test a game that could assist attentiveness in situations such as lectures and lessons. While attending lectures, participants are required to listen and occasionally pay attention to complementary visual material. The aim of the thesis is to present a conceptual basis that can be used to help develop new games or help players selecting games that could assist attentiveness. The thesis objective can be presented by the following research questions:

1. What design principles need to be considered for a game that aims o assist attention?
2. How can the design principles be implemented in the game?
3. How does interaction with a game designed by the defined principles affect the experience of attentiveness?

This thesis was made by means of constructive design-based research. In constructive design-based research, something concrete is designed and created, and from the result new design principles can be discovered (Koskinen et al. 2011, 5–6). Design-based research was chosen as the method because the thesis focuses on the designing of a game. In design-based research, iterative cycles of prototypes are tested (Plomp 2013, 35–37), which is similar to the usual process of game prototyping (Kramarzewski & Nucci 2023,147–148). This thesis describes the creation and design of a game, and the process is evaluated against the predetermined objective, which in this case is the improvement of attentiveness.

The game was tested in a lecture in a school setting, instead of a laboratory. In a laboratory setting, the design could be tested in a controlled environment for finding a connection to a theoretical framework. However, since attention and games are complicated and multilayered subjects, it was considered necessary to perform examinations in typical gaming situations.

Field testing requires that subjects are allowed to behave normally and interact with the prototype as they like (Koskinen et al. 2011, 80). In this thesis, participants were given the freedom of choice to play or ignore the game during the test. The game was available in the participants' phones. The test was focused on the subject's experience of attentiveness while interacting with the game. The effects on lecture retention and learning were ignored to reduce the scope of the test. The data was collected with a questionary which the participants filled after having had access to the game. The questions aimed to collect data on the effects of interaction with the game on attention.

The theoretical framework for this thesis comprises of concepts of attention and game development. As for attention, the focus was mainly on multitasking and its effects and studies on atypical attention such as ADHD were ignored. Mainly peer-reviewed articles about attention were used. The sources were limited by the access rights which the South-Eastern Finland University of Applied Sciences

offers to the students. The concept of game development was mainly studied from the perspectives of development methods and principles.

3 CONCEPT OF ATTENTION

The concept of attention consists of multiple different aspects. In simple terms, attention is the activity upon which the mind is focused at a particular moment. Brains receive constant stimulus from different sensory organs, but most of these inputs are ignored in the mind. (Petersen & Posner 2012) Attention can be classified as passive or active depending on the input received. Passive attention can sometimes raise stimulus into the sphere of active attention, as in the classic cocktail-party effect studied by Cherry (1953). According to this effect, even when people are focusing on talking to other people, they will notice their name mentioned in the background noise of a party. In their study, Peterson & Posner (2012) identified three different areas of brain activity depending on how stimulus is perceived. *Alerting* attention notices the stimuli entering the brain. Most of these stimuli are ignored by *orienting* attention which chooses the stimuli mind notices. *Executive control* is the mind's ability to choose where to focus its attention.

Arousal is a broad term used in psychology to measure the brains' general activity state. Generally, active brains are better at processing information. Tired brains are at a low arousal level, and process of information is slow. On the other hand, a high level of arousal can lead into hyper-focusing. As for attention specific terms, *alertness* and *vigilance* are used to describe the brain's ability to attend to stimulus. As with arousal, in a high alert or vigilance state, the brain's ability to attend to stimuli is higher than in a low state. (Oken et al. 2006.)

3.1 Sustained attention

Sustained attention is the brain's ability to keep attention on the same task for a long period. Driving a car and listening to lectures are normal everyday sustained attention tasks. During a sustained attention task, people's alertness decreases over time (Farley et al. 2013). Research seems to be divisive on the reasons of

the decrease. A task can be automated in the brain and eventually require no active attention which leads to a low level of alertness. Another reason can be the fact that the brain become tired of the constant processing of information. (Thomson et al. 2015.)

People constantly perform automatic tasks such as walking or speaking, and usually no active cognitive effort is required for these actions. After repeating a task multiple times, the brain starts to utilize previously learned patterns, and the task becomes automatic. The automatic response is task specific, so each task needs to be learned separately. Simple tasks become more easily automatic since they require less learning and practice. (Servant et al. 2018.)

Mind-wandering is a normal function of the brain. It is explained as the brain employing its unused capacity to process old information. During an easy task, the brain has unused resources, and the mind starts to wander. A wandering mind can be detrimental for the completion of task as unrelated thoughts might disrupt it. However, when related to the task mind-wandering can also be useful for the performance. (Randall et al. 2014.)

Taking breaks from a task negates the decrease of attentiveness during sustained attention task. Breaks allow the brains to rest as the resources for attention are depleted. Breaks can also redirect attention away from the task, which decreases task automation. Decreased task automation can lead to a better focus on new information and fewer mistakes when performing the task. (Ariga & Lleras 2010.)

3.2 Multitasking

Paying attention to multiple stimuli at once is required constantly in everyday life. The attention is not divided, but instead the brain switches between different concurrent tasks. Each switch requires resources from the brain, thus, delaying the response to the task. Task switching cost has been shown to be affected by the complexity and the familiarity of the task. (Rubinstein et al. 2001.)

Brains have limited resources to process information. Wickens's (2008) resource model of attention explains the brain's ability to process different stimuli (Figure 1). The model divides resources required for a task into four dimensions: *code of processing*, *stage of processing*, *modalities,* and *visual channels*. The code of processing dimension describes whether a task requires verbal or spatial processing. The stage of processing dimension determines which brain process is required to attend to stimulus: perception, cognitive or response. The modalities dimension describes whether a task is visual or auditory. Visual perception is further divided into visual channels dimension to define whether a focal or ambient vision is used. According to the model, tasks further from each other require fewer overlapping resources and are, thus, easier to perform at once. The model can be used to analyse how suitable different tasks are for multitasking. A definition of the task difficulty is also required for the analysis as there is always some overlap of the resources. A high-difficulty task can require most of the attentional resources, so even a simple task requiring different resources may prove impossible to be efficiently multitasked.

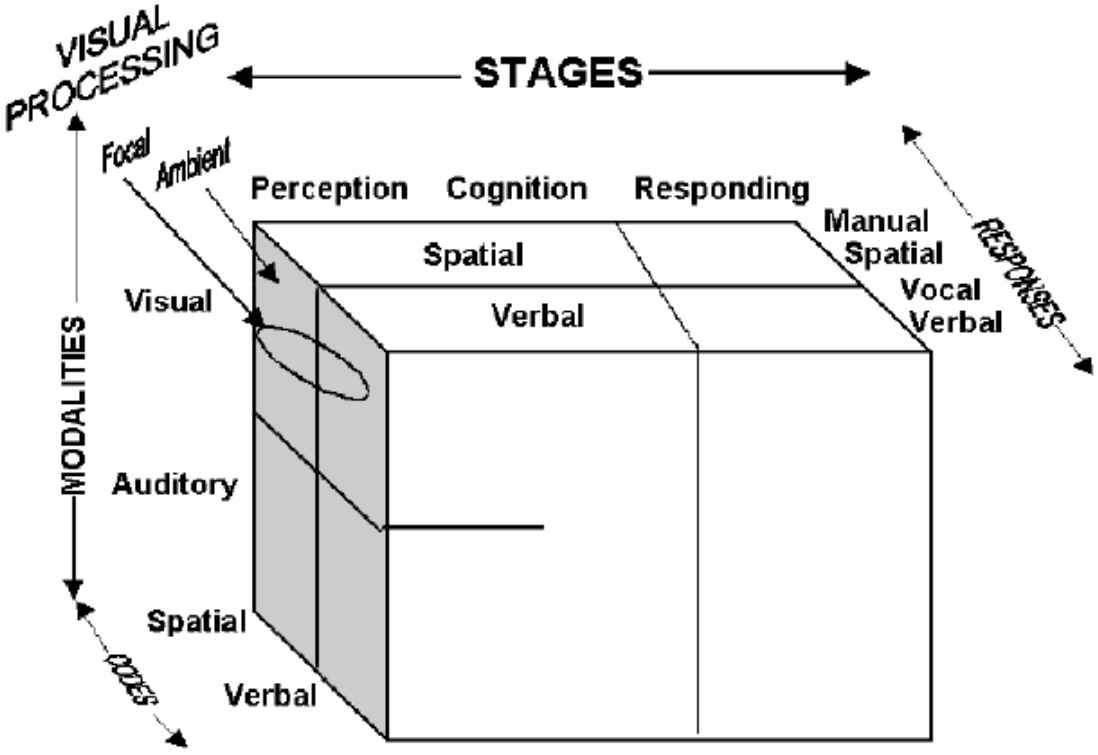

Figure 1. Wickens's resource model (Wickens, 2008)

Constant media-multitasking has been shown to negatively affect people's ability to perform multiple concurrent tasks (Ophir et al. 2009) and lead to decreased ability to discern task-relevant information from non-relevant information (Cain & Mitroff 2011). Graben et al. (2022) studied how playing a simple mobile game affected the accuracy information retained from a video lecture. The game had a timed interaction window of 20 seconds after which the game could not be played for 2 minutes. A group that played and received notifications from their phone scored significantly lower than the control group. The group which had to time their play window themselves, scored only slightly lower than the control group. Grabent et al. suggest that the control of timing interruptions leads to a lower cost of returning to the main task. In the study, there was no difference in participants' subjective experience of performance between the groups. This suggests that the multitaskers did not notice a negative effect when playing a game and listening to a lecture. A study by Sanbonmatsu et al. (2013) also suggests that people overestimate their ability to multitask. Multitaskers think they are being effective, but measuring the effectiveness of a performance reveals that multitasking is inefficient for most. The study also suggests that the people who are best at multitasking can control their attention without requiring multitasking to increase their attentiveness.

While multitasking can lead to inattentiveness, it can also reduce boredom and mind-wandering. Even if multitasking removes resources from the main task, it can be a net positive for the attention in some situations. Talking while driving can lead to less boredom and better attention but is only beneficial at higher levels of boredom (Atchley & Chan 2011).

4 GAME DEVELOPMENT THEORY

Games are generally developed in an iterative cycle of prototypes. Each cycle consists of planning, implementing, and testing features. Each prototype tries to solve a problem with a solution from the pool of ideas. In prototype implementation, risks of the chosen solution should be mitigated. The solution's effectiveness can be evaluated in the testing phase. After the testing phase, the

solution can be approved and then the developers can proceed into the next problem, or a new solution is implemented and tested. (Schell 2019, 115.)

Games can be defined to consist of four elements: *mechanics*, *story*, *aesthetics*, and *technology*. Mechanics are the game's rules, and the way players can interact with it. A game's story can be an abstract non-story or a broad and branching narrative experience. Aesthetics define how the player experiences the game through such as sounds and visuals. Game's technology determines the platform where the game is played, for example paper or a computer. (Schell 2019, 53.)

Schell (2019) categorises game mechanics into seven basic types: *space*, *time*, *objects*, *actions*, *rules*, *skill*, and *chance*. Space mechanics are the mathematical model and boundaries withing which the game is executed and different spaces are connected to each other. Time mechanics define how the game proceeds; in a turn-based game the game proceeds in discrete steps, as opposed to continuous time model where the game proceeds constantly. Time mechanics can modify the rules of time or be used to limit the gameplay. Objects are the things in the game and they might have different attributes such as the position in space. Actions are the inputs the player can do in game, for example move an object in the space. Rules define how mechanics interact with each other and determine the goal of the game. Skill mechanics require different skills from the player, which can be physical, mental, or social. Finally, chance mechanics add unpredictability into the game and can make the game more interesting for the players.

A game's engagement means how much attention it requires from the player. Completely engaged players can be fully immersed in the game and forget the world around them and can be in a flow state (Hodent 2017, 161–160). Players can achieve a flow state if they have clear goals and no distractions, receive direct feedback from the game and encounter continuous challenge (Schell 2019, 145).

Players need to have a motivation for playing the game. Games are designed to engage different player motivations. *Intrinsic motivation* is an internal need for doing things for the pleasure of doing them, while e*xtrinsic motivation* place emphasis on gaining the reward as the result of the task and not the task itself. Games offer both intrinsic and extrinsic motivations by giving players long term goals, showing current progression, and offering fun gameplay. (Hodent 2020, 31–33.)

Games can motivate players by their story. The story allows players to experience different fantasies through the game. The story also creates context and meaning for actions players make in the game. Abstract games such as go and chess contain a weak story and fantasy, but motivate players by giving them engaging puzzles to solve. (Zubek 2020, 134–138.)

A game's difficulty is an important aspect of its engagement. Excessively difficult games can be frustrating to play, and overly easy ones can be boring. Players have different skill levels, and the player motivations have an effect on individual preference of the difficulty. The difficulty is usually designed to rise with the player progression in the game. At the start, the game is easy since the player is still learning to play. The difficulty gradually rises to match the player's current skill as they play more and learn the game. A challenging difficulty requires that the player has a variety of meaningful choices. If the player has only one proper choice, the game starts to become easy. The player's choices also must affect the game since an overly random game can be frustrating to play and out of the player's control. (Schell 2019, 217–225.)

There are multiple types of game structures. Linear games are pre-build and scarcely offer the player choices on how they proceed towards the end of the game. Linear games can be made more open by creating linear branches which all lead to a common or individual end. Nonlinear games allow the player to proceed as they want, and there may be no defined end to the game. Endless and sandbox games are nonlinear with no clear end for the game. Games are

usually hybrids of different structure types, and it might be difficult to accurately define a game's structure. (Kramarzewski & Nucci 2023,40–45.)

The usability of a game indicates how effortlessly and easily the player can interact with the game and is an important part of the players experience. Hodent (2017, 109–133) describes seven usability pillars to be used in designing and evaluating game usability. The pillars are a game design version of Nielsen's (1994) usability heuristics. First, *signs and feedback* allow the player to know what is happening and gain feedback from their interactions with the game. Second, *clarity* makes the signs and feedback clear and easy to read for the player. Clarity can be achieved, for an example, by using colours, shapes, and clear text. Third, *forms follows function* pilar describes how the form of an element in game should convey its function intuitively. Allowing players to intuitively know how the elements are going to react, reduces the need for teaching and the cognitive load required to play the game. Fourth, *consistency* is important in the game, and similar elements should behave in the same way. Giving mixed signals to the player confuses them and lower the usability. Fifth, *minimum workload* should be required from the player by using elements that are not intended to challenge the player. Sixth, *error prevention and error recovery* allow the player to make mistakes and recover from them. Seventh, *flexibility* allows the player to play the game as they like and makes it easier for them to adjust to the game.

Aesthetics affect many aspects of the game but are sometimes ignored as only something that makes the game look pretty. Aesthetics can be used to draw players into the game with interesting stylistic features. By connecting the aesthetics seamlessly into the mechanics of the game, an engaging atmosphere can be created. Aesthetics are also used to increase the usability of games, for example, by giving feedback and enhancing clarity. (Schell 2019, 429–431.)

The technology used to play a game defines its physical interface. Through the physical interface, the player controls and receives feedback from the game. Games can also have virtual interfaces, before the player input affects the game

world, such as menus and buttons. Both physical and virtual interfaces can constrain the player, affect the usability, and have an effect on the engagement of the game. A game played with tactile buttons is significantly different to the games played through a touchscreen. Interfaces can also be connected to the story and the mechanics. With new technologies, player can interact with the game in completely new ways. Designing a game foundationally applying a new technology enables the creation of new types of games, whereas using the technology decoratively merely lead of creating better games. (Schell 2019.)

5 THE DESIGNED GAME

This chapter describes the proposed principles used in designing the game for this thesis and explains how they were implemented into the game. The principles are general guidelines which aim to reduce the negative aspects of multitasking and emphasize its advantages. As the thesis focused on the design of game, most of the technical aspects of the development were not reported.

5.1 Principles

As previously described, multitasking is detrimental to information retention and easily leads to mistakes. Despite harmful effects of multitasking, can also keep the arousal level higher, alleviate boredom and reduce task automation. The benefit of the multitasking seems to be the result of balancing reduced boredom with increased distraction. The following principles are synthesised on the basis of a literature review on attention and game design. They aim to guide to design games that could be played as a secondary task without excessively distracting from the main task.

Use different areas of attention

According to Wicken’s (2008) model, different areas of attention should be used in the game compared to the main task. If the main task is auditory be nature, the game should be visually focused. Similarly, a spatial main task should be paired

with a verbal game. Since games generally require response and cannot be fully perceptive, there will be some overlap in the stages of processing.

The game should be easy enough for the player

For multitasking to be beneficial, the game should not require excessive amount of attentional and cognitive resources. A difficult game can require excessive attention from the player. Contrastingly, if the game is overly easy, it would not be engaging to play and can make the players stop playing it.

Easy games also become more easily automatic. If playing becomes automatic it requires less attentional resources and the distraction from the main task should be lower. The played game can be quickly learned, or the player can be highly familiar with the game.

The game should limit player's engagement

Having players highly immersed in the game is not desired since it can lead to forgetting to pay attention to the main task. Games are often designed to draw the full attention of the player, so unnecessary and overwhelming stimulus should be avoided. The game can also have a slow interaction pace for reduced engagement.

Allow the player to not pay attention to the game

The game should allow the player's attention to wander off from the game and not be punished for it. If the game requires constant attention, it will use more attentional resources and distract the player from the main task. Punishing the player for focusing on the main task encourages them to focus on the game, which is not desirable.

Limit task switching cost

Switching attention from the main task into game should be effortless. The switching cost is dependent on the interval of switching and how much information is needed to recall when returning to the game. If the playing of the game is automatic, the task switching cost is also minimal.

Allow repeated play

The game should be playable for a long time. If the game is short and repetitive, it can become trivial and offer no challenge. Randomized games can offer seemingly infinite unique situations, while prebuild games only offer repetitions of the same gameplay and have no variety. Repeating the same gameplay can be made more engaging by adding extra challenge or changing the game rules for new playthroughs.

5.2 Match-three game

From the previously defined design principles, a simple match-three mobile game was developed (Figure 2). Match-three is a widely used mechanic in puzzle games, which requires spatial cognition (Hunter 2021). In the game, players are given one piece at the time, and they need to drag and drop it into one of the open positions in the play area. The play area consists of three separate towers that grow taller as the player places more pieces. If three pieces of the same kind form a line vertically, horizontally, or diagonally hey are destroyed, and the player is rewarded some points. When some of the pieces are removed, the remaining ones fall to fill empty places.

For this thesis ,the multitasking scenario was a typical lecture which required mainly auditory and verbal attentional resources with occasional visual attention. In order to minimize the overlap of attentional resources, the game uses no sounds and requires visual attention to be played. There is a small amount of text for the scoring, but the game’s focus is on a spatial solving of a puzzle. Since the

game requires some cognition and response, it will somewhat overlap with resources needed for understanding and possibly responding to the lecture.

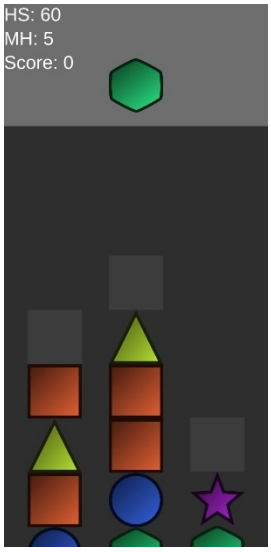

Figure 2, Screen capture of the game protype.

The game is intentionally simple to make it easily learnable and more automatic. For simplicity, the play area is limited to three different towers, but it should still offer meaningful choices for the player. The small play area can also be more quickly perceived and should reduce task switching cost and the cognitive load required for the game. During the development iterations, three towers were considered sufficiently large and fitting in proportion to the target aspect ratio.

Pieces appear at the top of the screen where the player needs to drag them down to an open slot. After a piece is placed, the game checks for matches in cycles of destruction and updates the filled empty places. The next piece will not appear instantly since there is a brief delay to limit the player's interaction pace with the game.

The game will not proceed if the player does not place new pieces. There is no time limit so the player can freely choose to interact with the game when they want. The game can be stopped and resumed seamlessly without requiring much cognitive load from the player. All necessary information is shown on the screen, and the play area is small, which should limit the task switching cost.

In games, the story is generally told with text, visuals, and audio. Since text and audio are heavily overlapping attentional resources, only visuals were used for this game. In order to reduce immersion, the story was ignored in development, and the game was designed to feature abstract content.

The game was designed to be repeatedly playable and not use predetermined levels. The problem with levels is that the player learns to complete a level, it can become trivial to complete it again repeated runs. Also, if levels are predetermined, there can also be only limited number of them. In order to avoid this, the game uses randomization for the game state so there are seemingly infinite states to be played.

Smartphones were chosen as the platform for the game since most people have one. Smartphones allow interaction with multiple ways such as tactile buttons, cameras, gyroscopes, or touchscreens. In order to simplify the development of the game, only the touchscreen was chosen. Using gyroscopes and vibration could have been an alternative but for the sake of easy learning and development they were not utilized in this thesis.

The game has no lose condition to encourage players to play and minimize stress caused by losing. The height of the towers is only limited by the game's technical limitations, which the player should not encounter during a normal play. The player's current score and the highest score are shown to give the player feedback on how many matches they have made. The tower's maximum height is shown to offer the player a sense of scale. The height can serve as a long-term goal allowing the player to maintain it small or large depending on their preference.

The game view is automatically controlled which reduces interaction possibilities of the player. If any of the towers grows out of view, the player can no longer place pieces to it. The game view follows the lowest tower. Not placing pieces into one tower for multiple rounds can lead to a situation where the player has

only one choice to place a piece. This single-choice situation was created in the game to punish players for waiting for the desired piece for a prolonged time.

Weighted chance was implemented for pieces, because during the development iterations the game felt overly simple and random. In total, there are five different pieces that appear. Three pieces have a high chance of appearing, one has a medium chance, and one has only a low chance. Different chances offer more long-term goals and some strategy to otherwise simple mechanics. The occasionally appearing pieces also make the towers higher to keep the playfield constantly evolving. In addition to weighted chances, the game never gives the player two pieces of the same kind in a row.

Each type of piece has a different colour and shape to make it easier to perceive matches and patterns. The colours were chosen from the different parts of the spectrum, but colour-blindness was not considered in the design. The chosen shapes comprised simple geometrical forms of the circle, triangle, square, hexagon and star.

6 THE FIELD TEST PHASE

This chapter describes the methods and the results of the test phase of this thesis. The aim of the test was to investigate how the activity of playing the game affects the participants' attention. The intensity of actual attention or lesson retention was not measured to simplify and limit the scope of the study. Participants were given access to the game and encouraged to freely interact with it during a lesson. After the lesson, they were asked to report their experience with the game and its effects on their attention by responding to a survey either online or on paper.

The test proper was executed in the facilities of South-Eastern Finland University of Applied Sciences. A preliminary test was conducted with voluntary students to collect feedback on the game and the survey. Pretesting a survey offers data on its quality but may not uncover all problems (Tourangeau et al. 2020). Volunteers were given access to the game and encouraged to try it out in suitable classes

and answer the survey. After the preliminary test, the survey was expanded with more questions. For most of the questions, a Likert scale was used. A Likert scale can be used to present close-ended question about people's attitudes with reference to intensity. The method employs either an even or uneven numbered scale where the respondent answer the question in terms of a degree to which they agree or disagree with the question or statement. In an uneven Likert scale, the midpoint is usually neutral answer whereas in an even scale the respondent is required to choose to either agree or disagree. (Nardi 2018, 80–61.) Despite the preliminary test, it failed to register that the online version of the survey did not include the third question of the paper version, so that question had to be ignored in the results.

Purpose of survey was to examine multiple measurable indexes using a five-point Likert scale. An index is a set of questions which aim to measure an underlaying concept (Nardi 2018, 60–61). First, the respondent's general experience in playing games was determined. Since experienced players are expected to master the game faster, they might have an advantage on task automatization. Secondly, the duration of play time and intensity were defined. Finally, the participants were requested to estimate the effect of playing on their attention. See Appendix 1 for the full questionary.

The game was distributed via Google Play. Using an official store allowed for participants to effortlessly install the game into their own phones. However, the fact that only Android phones were supported slightly reduced the number of volunteering participants.

The test was conducted on a limited scale of nine participants due to limited time resources. Most of the participants only had a single session of testing. Due to small sample size, The data was analysed by median values and using scatterplots. Scatter plots are used to visually analyse a connection between variables where clear patterns of dots implicate a correlation in the values (Nardi 2018, 177–180). No participant reported noticeable improvement in attention during the test. The majority of participants stated that playing the game had

either neutral or negative effect on their ability to pay attention, and only one claimed that playing of the game had improved their attention. Most respondents also stated that they would have paid more attention had they not been testing the game. Figure 3 shows all the answers to the Likert scale questions presented in the survey.

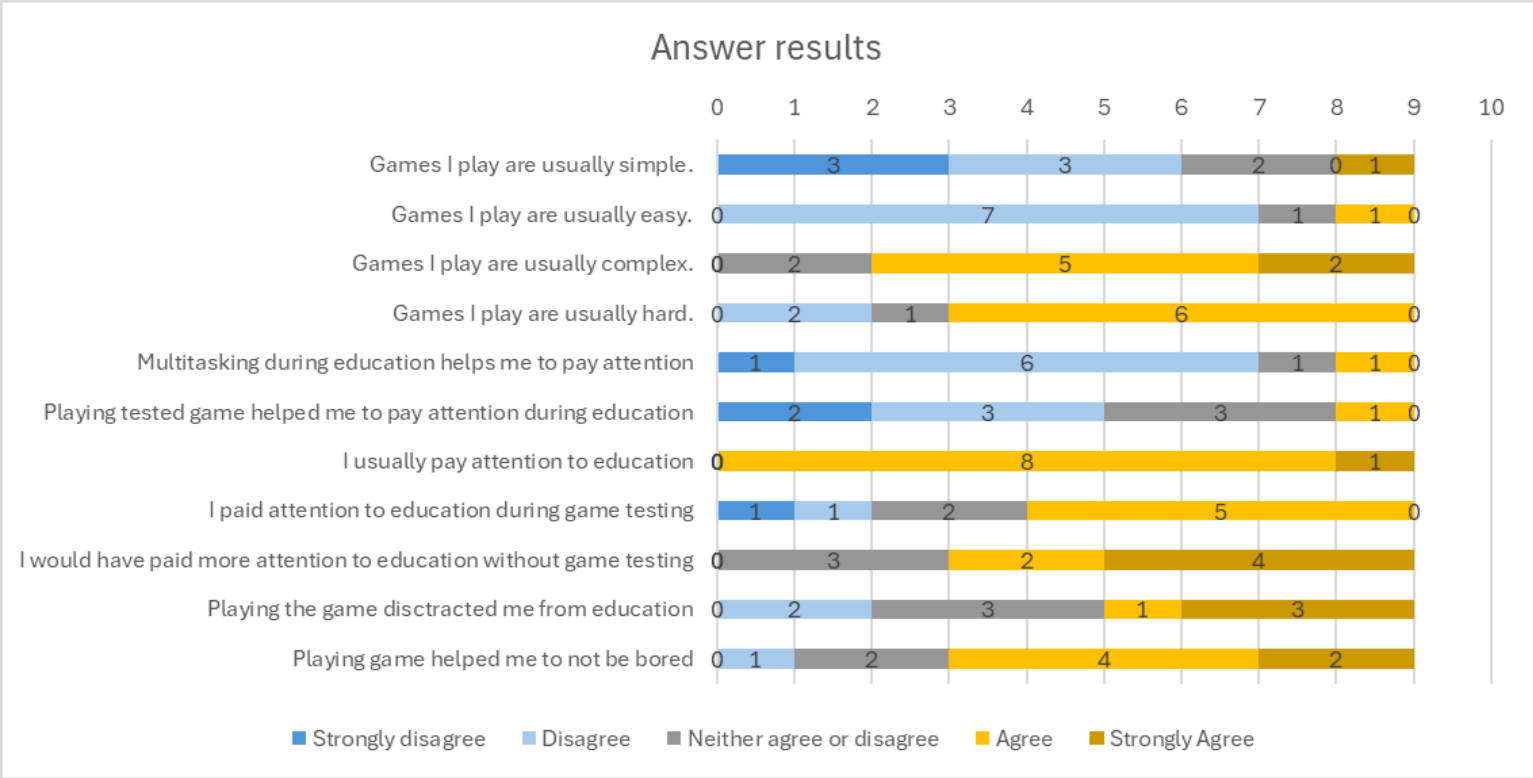

Figure 3, Survey results on Likert scale.

Respondents were evaluated on the basis of their general experience with gaming. Each answer for the question about the types of games they usually play was assessed with a five-point Likert scale. Simple and easy games were regarded as negative answers ,and complex and difficult games as positive answers. To the calculated value, a value of value of 1–4 was added to indicate frequency of game playing. The values are a relative description of the participants' experience with games. Ranging from -2 to 9 with the median being at 6, and a higher value suggesting regular gaming or experience with more challenging games.

The attention differences between the testers were evaluated by questions about their attention during the test. This value was then subtracted from the value for

the usual level of attention during lessons. All respondents agreed or strongly agreed on usually paying attention to the education, which may bias the results. The calculated values ranged from -3 to 0 with the median value being at -1 and lower values suggesting that the test had distracted the participant. Figure 4 presents the results of the calculated attention difference, play time and the general experience of the test.

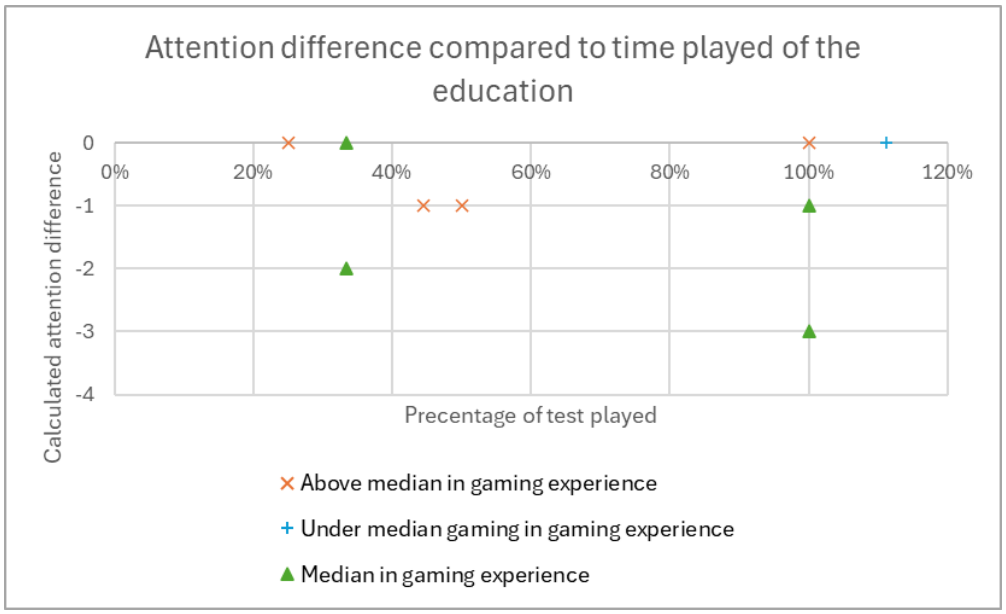

Figure 4. Experienced attention difference and time played.

There was a significant variance in the test durations. The shortest time reported was 15 minutes, and longest time was 50 minutes. The percentage of lesson time during which the game was played also varied significantly, from 25% to 110%. One respondent played the game longer than the test duration. In Figure 5, the percentage of lesson time spent playing is compared to the calculated attention difference. The results are grouped by the calculated value of gaming experience to illustrate its effect. The attention difference appeared to be unaffected by the gaming experience. Contrastingly, the participant who rated themselves as playing simple and easy games, reported that playing had helped sustain attention.

A majority of respondents stated that the test helped them to fight boredom (Figure 3, p. 20), which implies that the game was entertaining and successfully engaged the players. In fact, the game seems to have been overly engaging

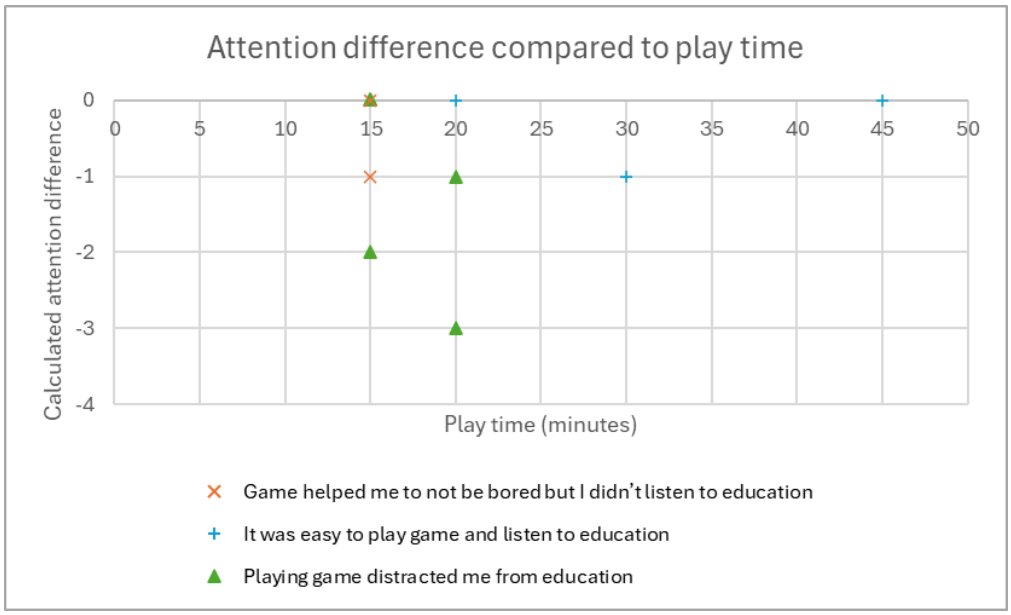

Figure 5. Experienced attention difference compared to time played of education.

since most testers felt it was distracting them. Most of the feedback given on the test also suggests that testers enjoyed playing the game, but it distracted them.

Most of the respondents also claimed that multitasking does not usually help them to pay attention (Figure 3, p. 20). These results suggest that majority of respondents usually are sufficiently motivated to listen to the lecture and do not become bored. Alse, many of the respondents may not have been used to multitasking, which might have caused them to be distracted during the test.

7 DISCUSSION

The purpose of the thesis was to design, develop and test a game that could assist in sustaining attention. From the literature, review six principles were proposed, and a prototype game was developed applying the principles. The game was then subjected to a small-scale field test.

The results of the test show that, generally, the game either had a negative or neutral effect on the participants' attention. There are multiple possible reasons for the results. The game might have been excessively engaging despite the design aiming to limit the level of engagement. The duration of the test was brief, and the players could have still been in the learning phase. Furthermore, the

proposed principles could be incorrect and lead to the development of a distracting game.

The game's goal of balancing engagement with distraction might be a more difficult task than expected. Since individual players have different general gaming skills and preference concerning games, the optimal game design for improving attention may require a highly individual and preference-based approach. One of the reasons proposed for the benefit of multitasking was the low difficulty of secondary task. As the game was designed to be playable for a long time, the participants might have been only learning the game when the test ended. The game's general difficulty level may also have been excessively high. The proposition of the game being challenging is supported by a majority of respondents stating that the game was engaging to play.

The proposed principles aim to adhere to the theoretical discussion about attention. As attention is a complex and constantly investigated subject, they are probably highly incomplete, and further study needs to be made about their accuracy.

There are many alternative ways to implement the proposed principles. As previously described, the game could have been designed to require less visual attention by utilizing different technologies or mechanics. Alternatively, a different genre could have been chosen. By fully following the principles the games genre was restricted to turn based games. There could be benefits in having the game run more passively in the background and only sometimes requiring the player's input instead of only proceeding if the player interacts with it. It might also be beneficial to investigate the prospects of dynamically combining game playing with the ongoing main task and even using common attentional resources,

The results of thesis were limited in multiple ways. Due to the scope of the topic, the results only narrowly investigated the effects of multitasking on attention and ways to make multitasking beneficial with a game. The design principles represent the author's interpretation of the reference literature, as the literature

review provided no clear guidelines for the design. The most commonly used game design methods were described in the theoretical framework. As designing a game is a highly individual process, the unique combination of the chosen features and the proposed principles affect the findings of this study. The testing of the game had to be scaled down due to a small number of participants and limited time resources. Due to a small sample size, the reliability of the test is low.

Despite the limiting factors of the thesis, it successfully experimented in developing and testing an attention assisting game. The resulting principles can be used to further investigate the potential of games in facilitating performance in a multitasking situation. Despite the test results clearly showing that the game did not improve the testers' ability to sustain attention, the general concept should not be discarded, and further research into the topic should be done. Also, further studies could be conducted with relation to developing and testing different types of games with the aim of assisting attention. Especially, long-duration tests where the players become highly familiar with the game should be carried out. Finaly, it could be investigated how playing games in general affects players' attention, even in scenarios where the game is complex and difficult, but the player is extremely skilful in playing it.

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Survey as it was printed.

How often you play or have played video games?

1. Never / Almost never
2. Occasional
3. Regular
4. Daily

How would you describe your experience with the game?

1. Playing game distracted me from education
2. It was easy to play game and listen to education
3. Game helped me to not be bored but I didn't listen to education
4. I did not play it

How would you describe your interaction with the game during the test?

1. None
2. I tried it
3. I played it but then stopped
4. I played it on and off
5. I constantly played it

Approximately how long did you play? ____hours _____ mins

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Games I play are usually simple.	1	2	3	4	5
Games I play are usually easy.	1	2	3	4	5
Games I play are usually complex.	1	2	3	4	5
Games I play are usually hard.	1	2	3	4	5
Multitasking during education helps me to pay attention.	1	2	3	4	5
Playing tested game helped me to pay attention during education	1	2	3	4	5
I usually pay attention to education.	1	2	3	4	5
I paid attention to education during game testing.	1	2	3	4	5
I would have paid more attention to education without game testing.	1	2	3	4	5
Playing game distracted me from education.	1	2	3	4	5
Playing game helped me to not be bored.	1	2	3	4	5

How long did you test the game?

1. 1 lecture session of length_____ (minutes)
2. Specify (approximately) _____ lecture sessions of length _____ (minutes)

Open comments: