All Work and No Play Makes Jack an Inefficient Employee – a Study on Video Games' Effects on Sustained Attention

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ABSTRACT

Taking short breaks throughout long work hours is proven to be beneficial to our attention spans and work efficiency. How we choose to fill that break time, however, can have a big effect on our performance. This research aims to measure whether video games, which have proven to induce flow and train our minds in numerous ways, can help boost sustained attention and therefore improve work performance if used as part of so-called 'microbreaks'. A total of 36 participants took part in an online experiment measuring their performance in sustained attention tests before and after playing video games compared to the control group activity of browsing "BuzzFeed Quizzes", an entertainment website. Results of the study show that no significant improvements were measured in terms of attention, indicating that the potential of video games to induce flow does not translate to a playing a beneficial role in microbreaks. Future research is needed to investigate how and when video games should be applied to maximise the potential benefits.

INTRODUCTION

The origin of this study came through an exchange with a friend, after seeing him drop his important and focus demanding task to grab his phone and play a few rounds of "Call of Duty", meanwhile complaining that all his teammates are noobs. After being completely immersed in 3-4 rounds of the game, he bragged about his above average results and then proceeded to carry on with his work. Gaming seems to be something that is generally viewed as a tactic to procrastinate or sometimes causes addictive behaviours that keeps one hooked for hours on end, but in this case, it seemed to be the exact kind of break that was needed to keep working on a task that became overwhelming. From asking a series of unprompted questions about this, he did not know how to describe it exactly, simply stating that allowing himself to immerse in the game during work, he could limit himself to playing it for about 10-15 minutes. This in turn helped gather his thoughts and focus on the important task at hand. On his days off, however, the addictive side of the game takes over and he can spend hours on the game if given the chance. This prompted an interaction to start

looking into this as something that could be a method utilised to help being more productive.

In order to fully explore the topic in depth, we should first analyse the role of 21st century technology on the state of our minds and our current work culture. The first part of the study will address theories that are linked to analysing changes within attention spans and how current technology is used to shape one's behaviour and presents a lot of addictive tendencies. Even though there are a lot of effective solutions offered, following them requires long term commitments and consistency. Analysing the current work culture, it has become clear that breaking up longer work tasks by using microbreaks show that short term solutions are proven to be efficient [1-3]. This study prompts the question of which activities can be used to address these problems.

Furthermore, it is important to understand the role of games in our society and how the still widespread belief of them being just a tool to waste our time should have been long disregarded. Previous research shows video games having a number of cognitive benefits and having elements that make them an activity that effectively induces states of flow [4-7]. This is provided that the games are following the development of current standards of complexity and that they do not include addictive tendencies. Most importantly, video games have become more accessible and are enjoyed by more people than ever before [8,9], making them a perfect candidate for boosting efficiency for work.

Concluding the theoretical framework, we would like to analyse the effects that games can have on our minds in terms of sustained attention and flow and run a short experiment to see if the theory of incorporating games to helping us work better has any viable results. This then prompts the research question: Does playing video games as part of microbreaks increase sustained attention and efficiency in subsequent tasks?

Based on previously conducted research, theories and statistics, the following hypothesis is proposed: Playing video games as part of breaks between tasks increase sustained attention and efficiency.

An experiment is set up to test this hypothesis by offering an activity to imitate work tasks and measure changes in the levels of attention. The tasks will be broken up by offering the participants to play a video game or browse an entertainment website as a form of a microbreak and an analysis will be drawn based on the effectiveness of the two activities.

THEORETICAL FRAMEWORK

21st Century Problem – Technology and Attention Spans

Nicholas Carr starts off his book "The Shallows" [10] by describing a recent phenomenon that he has noticed in his own behaviour. He reminisces of a time when he remembers being able to fully immerse himself into books – the way hours could pass by while he was reading without his mind starting to wander or getting distracted by any outside stimuli. Now, however, being able to reach a similar state of mind seems to be near impossible and he does not seem to be alone with this problem. Whether this should really be referred to a as a problem is also questioned by the author himself – perhaps it is just a natural change in how our brain works due to the

development of technology and shifts in our daily habits, the same way it has been happening with any technological development for centuries – from inventing the written word to introducing print publications to having all of our information being presented to us on screens. With each invention our minds have had to adapt to the new normal and therefore we also see changes in our overall behaviour and habits. This is therefore not a new phenomenon of people suddenly adapting to the new technology presented to us in the 21st century and abandoning old habits - these shifts however are happening a lot quicker and therefore could present us with the feeling that it there is no hope for us to ever be able to read books the old fashioned way ever again [10, 11].

Bringing this into a more current context, Tristan Harris recently starred in a documentary on Netflix called "The Social Dilemma" [12] discussing the currently highly topical subject of technology being designed to be addictive to us as users and orchestrating shifts in our attention in the smartest of ways. Besides the documentary presenting the topic in a slightly over dramatized way, the main point was to show how technology, mostly social media apps, all have one goal – to compete for the user's attention. According to Harris, the most common social media apps do not compete with each other, but they compete with the amount of time and attention that a user is willing to give to them, with every update to these platforms introducing a new way to keep the user interacting with it for as long as possible – whether it is sending out push notifications and emails to pique our curiosity to open the app to introducing subtler updates such as showing when someone is typing in the chat function or serving us with specially curated and never-ending timelines to keep our attention going for longer periods of time. How could anyone then resist a notification from their phone when these companies have invested so much research into not only constantly grabbing our attention but also keeping it on their apps?

Surely, as many self-help guides and books point out, for example Nir Eyal's ''Indistractable''[13], we could just put away our devices and carry on with our lives, completely uninterrupted and undistracted. This seems like a sensible argument until we realise that the same devices that constantly distract us are also tools that have been integrated into our everyday lives to help perform many necessary functions and, more importantly, tools we use to do our jobs. Ironically, one of the biggest distractors in our work life is the one communication tool that office jobs rely on the most – email [14]. So, even if we manage to put our phones with all the highly distracting apps and pop ups away, we still have constant notifications appearing that keep shifting our attention and perhaps even present us with an easy way to procrastinate from what really needs to be addressed.

With this kind of technology being present in almost anything that we do, many people have started to follow programs designed to help us "disconnect" and "focus". Meditation and mindfulness being some of the more popular practices to help with training our ability to preserve attention and focus. Studies support this by showing significant improvement on performing numerous tasks [15, 16]. This and many other lifestyle changes from having better sleep schedules [17] to following certain diets [18] to increasing physical exercise [19] and many other things have also shown various improved results, however, these are all long-term solutions that require commitment and consistency. Sadly, this is also something that people have proven not to be very good at doing, especially when it relates to overall health [20]. One way to address these problems with sustained attention and focus could therefore be to find alternative options that would help in the short-term instead. These kinds of solutions would not aim to improve overall quality of life or have any other long-term effects, but could be applied in specific everyday situations – such as being able to focus on the work task at hand. Many programs now come with special focus mode

options, which also help address this ever-occurring problem by decreasing or eliminating certain distractors. This helps adjust to a potentially more suitable working environment, however, our ability to keep sustained attention is not infinite and before we know it, our mind starts to wander like Nicholas Carr described from his own experience before. Therefore, we must also address how the work should be approached and what habits we can develop to help us be more efficient.

Microbreaks and Attention Recovery

Taking breaks is common practice at most places of work, whether it is a legal requirement or not. A large number of studies have focused on the effects of longer breaks in the middle of the day (for example lunch breaks) or taking time off work in the form of a holiday. In recent years, the importance of taking numerous smaller breaks throughout the work day has also started to become a more relevant topic of discussion. These breaks are mostly referred to as microbreaks, even though by definition there is no set length or specific activity associated with it as long as the activity of working on a specific task is somehow broken. Even though microbreaks are not always legally required and sometimes can even be condoned by employers, the benefits of these small breaks have been proven to outweigh the potential time lost to non-work related tasks due to the effect on one's attention span.

A previous study conducted by Bennett [1] examined how different microbreak lengths and activities affected attention spans. The tested durations were 1-, 5- and 9-minutes and all of them showed improved results in attention, vigour and fatigue compared to the control group without any breaks between tasks, showing that even minimal breaks can increase job performance. Between the detachment (watching an entertaining video clip), relaxation (meditation) and task switching (Stroop test) activities, detachment was the activity consistently showing improved results. Overall, the best microbreak recovery strategy was found to be with the 9-minute detachment condition as the individuals reported lower fatigue, higher vigour and higher attention.

Another study by Cheng [2] aimed to analyse the effects of different activities on hospitality workers and similarly to the previously mentioned study found that specifically relaxation and cognitive activities had the strongest effect on at-work recovery experiences, such as nutrition-intake, social media use and other social activities. Not only did these activities aid with recovery during the work day, but this also showed a correlation between overall job satisfaction and even life satisfaction. A separate study done over 10 days analysing the effect of microbreaks in an office environment had similar findings and reported that, out of the voluntarily chosen activities, relaxation, socialization, and caffeine-intake operate as successful stress buffers against work demands [3].

Even though there is little research done that analyse specific break activities or timings and their effect on performance, the general conclusion seems to be that microbreaks are beneficial for performing higher quality work. These are just as important as off-work breaks after work, during weekends and holidays that help regain energy and improve performance.

Effectiveness of Video Games

As much as it sometimes seems that society has reached a consensus that our new media and technology have acted as a tool to make us dumber [21]. Noticing that people tend to have less of an attention span and focusing capabilities is often also linked to this statement and is blamed on the overall quality and structure of everything we consume [22]. However, many have argued that the current media that we consume is instead making us as a society smarter or at least, if nothing else, it is an everchanging thing that we just have to accept. For example, Steven Johnson makes a case in "Everything Bad is Good for You" [23] in favour of current technology and media, stating that even though the subject matter has shifted, the complexity of television programs, films, video games and media on the internet have also risen and have done so at a very quick pace. According to his theory, it takes the audience a lot more processing power to be able to decipher what is happening on screen when compared to media from just one or two decades ago.

Johnson is also one of the many authors to make a strong statement about video games having had more positive effects on our brain, for example advancing our problem solving and logic skills, as opposed to what seems to be frequently reported in the media about games being a source of empty or even damaging distraction. Not only are games becoming more complex in terms of their structure and narrative, but Johnson also noted how users have started approaching games in a way that does not involve using any tutorials meaning that the user will have to figure out not only how the game works and interacts in general but will take the time to solve the challenges within them without any outside help. It might also be obvious to point out that in just a few decades, we have gone from basic logic games such as "Tetris" [24] (which has also been shown to have many positive effects on players [25]) to the complex worlds that are presented to us in titles such as "The Legend of Zelda: Breath of the Wild" [26]. Even though each time it seems that we have finally reached a "peak technological advancement", evolving of games does not stop there, if anything, the games keep getting more complex and always find new ways to challenge the users.

According to flow theory, as formulated by Mihaly Csikszentmihalyi [4], the challenge element is key to experiencing this state of continuous focus and productivity. Within his theory, he explains how by entering the state of flow, we can be our most productive and perform tasks with ease. Being able to enter this kind of state also takes our mind off of any unwanted distractions and helps us focus for long periods of time. However, we are unable to consciously enter this kind of state, as according to Csikszentmihalyi, the activity to trigger this needs to be a balance of the right amount of challenge that the task presents us with. If the challenge presented to us is too low for our skillset, we experience boredom and on the contrary, if the challenge is too difficult, we experience anxiety. He has presented several other emotions that relate to the different stages of this balance; however, flow can only be experienced when the balance is maintained. A graph illustrating the different stages is included in Figure 1.

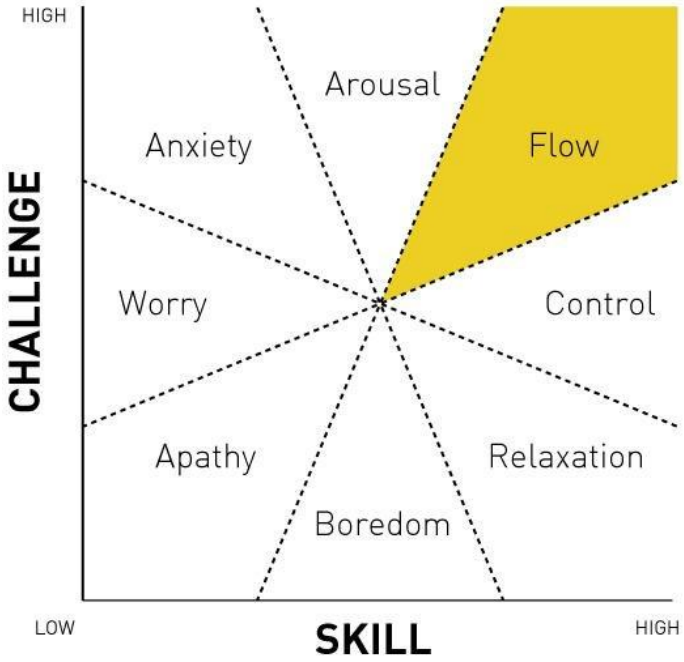


Figure 1: Mental state in terms of challenge level and skill level according to flow model.

Keeping this theory in mind, when applied to our daily lives, it might be hard to imagine moments when we do enter this kind of state. Csikszentmihalyi presents that most common triggers for flow come from our daily jobs and when spending time on our hobbies, hence why the term "time flies when you're having fun" could be applied here. However, he states that our activities can be divided into passive and active hobbies. Watching TV or reading, however entertaining the story or program is, will not keep us engaged as much as a more active hobby that demands our attention on multiple levels. Whether we choose to paint, play an instrument, dance or engage in any other multisensory activity that we enjoy doing, we seem to enter a state of flow easily. Provided of course that the activity still falls within the challenge and skill set balance.

Games, and especially video games, fall within an active leisure category due to the same reason – they demand our constant attention on multiple levels within the game, whether it is requiring fast reaction speeds, high spatial attention, multitasking or any other cognitive abilities. This combined with the conscious design for games to be able to present the user with just the right amount of challenge and curiosity makes it an activity that can most often put us in the desired state of flow.

As with any current engaging technology, there is a delicate balance between having it work for us and having it work against us. Adam Alter addresses this in the book ''Irresistible'' [27], where he describes the motivation of these technologies and the companies behind them having shifted. The motivation to create a video game when it was just beginning seemed to be to be able to push the limits of technology, introducing new ideas, expressing one's creativity and many other arguably genuine reasons to contribute to this new form of art and technology. However, over the last few decades the general motivation has shifted to being able to generate as much revenue as possible, which can only be achieved if the game manages to get as much

of the user's attention as possible [28]. In order to achieve that, many games have now started to implement techniques that can cause addictive behaviour towards the game [29]. It can be as simple as using a certain mix of aesthetics such as bright colours, sounds, flashing lights that could be compared to slot machines (for example "Candy Crush Saga" [30]) that keep us hooked, to more subtle adjustments such as games removing any attention breaking points to keep the user engaged for as long as possible (for example "Flappy Bird" [31]). Expanding this sort of motivation to all popular video games would be unjust as there still are a vast number of games that present us with more complex types of engagement, however they have to compete with the more easily accessible addictive games. In addition to potentially causing more serious complications related to addiction [32], these sort of effects have also started to give games a negative reputation as they demand so much of our attention with very little long lasting satisfaction, they are simply seen as a waste of time [33].

This type of motivation is not only present in games, but in any newer technology in general – from social media, apps, television programs and so on. The general message from the research that has been done on this topic [34] is not that technology is inherently bad for us and that the applications or programs themselves only have negative effects on the users, it poses the question – how could we make this technology work for us instead of against us?

Relating this back to Csikszentmihalyi's theory of flow – if games have the ability induce high levels of positive effects in the form of enjoyment, engagement and focus, they can clearly be used to work for us. While there are numerous games that have set goals to generate the absolute maximum amounts of profit, there are also a lot of games that arguably have different moral values and have not included deliberate addictive elements. Instead, they offer compelling stories and visuals and create characters that players can connect with. Several different metrics can be applied to determine the effects of these games, one of them being the GameFlow model which will also be used for the purpose of this study. The GameFlow model [35] was developed by combining heuristics found in literature describing player enjoyment of games and have been compiled into a model which is structured by flow. The model consists of eight elements - concentration, challenge, skills, control, clear goals, feedback, immersion, and social interaction. This model can therefore be used to review games to determine the level of enjoyment. Additionally, research by Wan and Chiou [36], found that there is a negative correlation between higher states of flow in games and addictive inclinations towards them, showing them to be part of healthy gaming habits instead.

To further argue the case, in addition to games having the ability to bring enjoyment and induce states of flow in players, a lot of game research focus has been on studying potential long term effects of regular game playing to one's cognitive, emotional, motivational and social skills [5]. A study by Dye et al. [6] measured attention skills in video game players and non-video game players aged 7-22. The study revealed that video game players responded to stimuli quicker without having an accuracy trade off, indicating the presence of enhanced attentional resources. A meta-analysis conducted by Uttal et al. [7] showed that spatial skills improvements, which are comparable to formal courses aimed at enhancing these skills, can be trained with video games in a relatively brief period. Additionally, these training benefits last over an extended period of time, and these skills transfer to other spatial tasks outside the video game context. Furthermore, a recent study by Ramos and Melo [37] studied the effects of having school children play games before the start of a school day. This study concluded that children who played games for 15 minutes before the start of their classes reported having better attention spans throughout the day. The research suggests that this links to behavioural training to pay attention to

the activity on the tablet while ignoring the normal distractors in the classroom, which carries on for the rest of the day. However, it is important to note that these studies all involve playing video games for longer periods of time, hence offering the participant to train specific skillsets and cognitive abilities.

While the general image people get when thinking about gaming might be a teenage boy playing first person shooter games [8], current demographics draw a different picture – in 2019 the average video game player age was 34, it is almost equally divided between both genders and the estimated number of players in the world is around 2.5 billion [9]. With these statistics in mind, games are not targeting a niche audience anymore and the industry has expanded enough to find something that potentially appeals to every type of consumer and are more accessible than ever.

RESEARCH METHOD

In order to gain some insight into this potential effect of games, an experiment is set up to test the theory. The experiment consists of four different parts: an Attention Network Test, a preselected activity, a second identical Attention Network Test and a short questionnaire (Figure 2.). The overall time expected to complete this is on average between 25 to 30 minutes, depending on the speed of completing the attention tests and questionnaire.

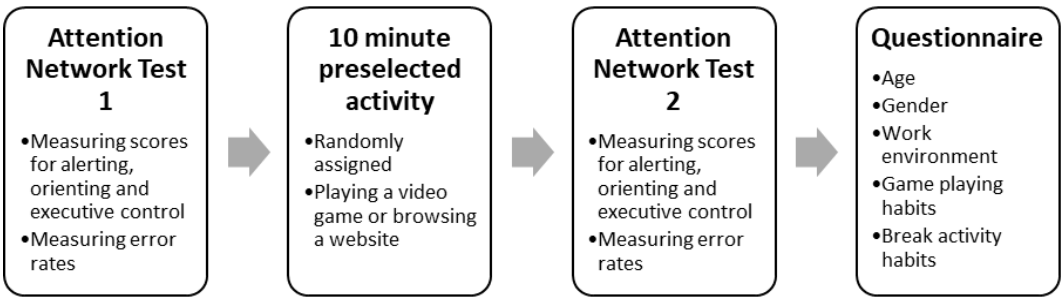


Figure 2: Experiment set up.

Participant Sample

The experiment is carried out using the Leiden University's Qualtrics platform and is distributed remotely through online channels, such as Survey Circle [38] and using snowball sampling. The set criteria includes participants being of working or higher education age (roughly between 18 and 65) and completing the experiment using a computer or laptop.

In order to determine the number of participants needed for the experiment to show any statistically significant results, G*Power [39] software was used to analyse research experiments using the same Attention Network Test results as data. However, due to this experiment using an adapted version of the original test, the number of research papers to help determine this was limited and therefore did not

provide any conclusive figures. This being a complicated figure to determine on its own, it was decided to follow a similar number of participants as in other studies using the Attention Network Test or CRSD-ANT and researching overall standards for sample sizes [40]. As a result, it was decided that for this experiment a minimum on 30 participants would be required, with a goal to reach as many participants as possible in addition to this.

Attention Network Test

The overall set up of the experiment intends to imitate a regular work scenario. The attention test that is used is an adaptation of The Attention Network Test (ANT) that was developed by Fan and Posner [41]. The adapted version is called the CRSD-ANT, programmed by Docksteader and Scott [42], with the length of the test being shortened to 10 minutes. It is used with minimal applied changes, only affecting the initial set up and wording of instructions. This test, by design, is divided into 3 parts, consisting of a short test run and two separate blocks of tests. Overall this process lasts between 9-10 minutes, depending on the reaction speed of the participant. Screenshots of the test are included in Appendix 1. A graph showing the set up of the Attention Network Test is included in Figure 3.

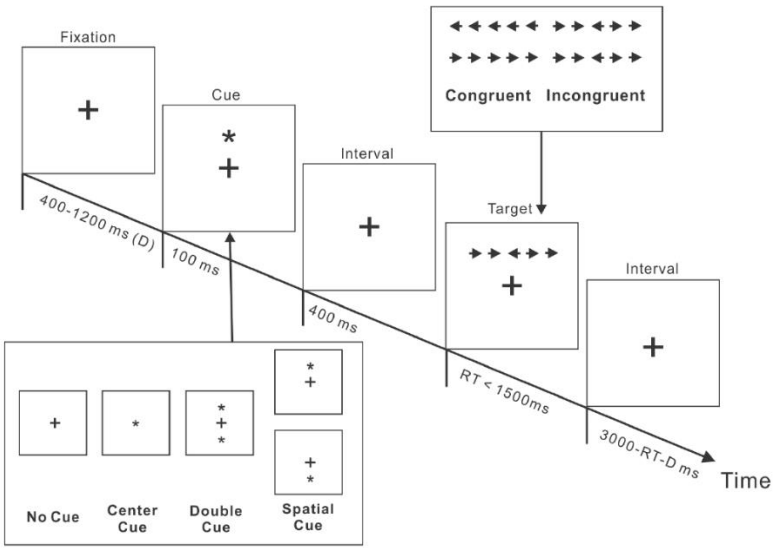


Figure 3: Attention Network Test set up.

The attention network model is a neurocognitive model that describes attention as a multifaceted construct which consists of three disparate brain networks. Each brain network supports one of the three distinct functions of attention: alerting, orienting, and executive control. In short, alerting is defined as achieving and maintaining an alert state, orienting is the selection of information from sensory input, and executive control is defined as resolving conflict among responses [43, 44]. In summary, on the CRSD-ANT, the alert score represents the difference in reaction times between a cued and a no cued condition, therefore a higher score indicates improvements in performance. The orient score represents the difference in reaction times with a

spatial cue and an increase suggests a change in attention to the spatially loaded cue. The executive control score represents the difference in mean reaction times of congruent from incongruent tasks, reflective of a cost that occurs within an executive system. Therefore, a decrease demonstrates increased efficiency [44]. These are also the three elements that are measured for the analysis of the experiment. An overview of the formula used to generate the scores is included in Figure 4.

Alerting efficiency = Response Time (no-cue) – Response Time (double-cue)

Orienting efficiency = Response Time (center-cue) – Response Time (spatial-cue)

Executive Control efficiency = Response Time (incongruent) – Response Time (congruent)

Figure 4: Calculations for alerting, orienting and executive control scores.

Activity A: Game Group

The next step is a preselected activity, which is either a 10-minute session of playing a game or browsing a website, with a set timer limiting the ability to progress further before the time is up. The selected game is titled "Keep Your Distance!" and was developed as part of the Leiden University Introduction to Video Game Making course by a group of students [45]. The aim of the game is to navigate through a city with a given character to reach selected locations. The obstacle is to avoid any other characters by keeping to social distancing guides. The game meets the criteria as set by the GameFlow model and an analysis of this is included in Appendix 2. A screenshot of the game at play is included in Figure 5 with additional screenshots in Appendix 3.

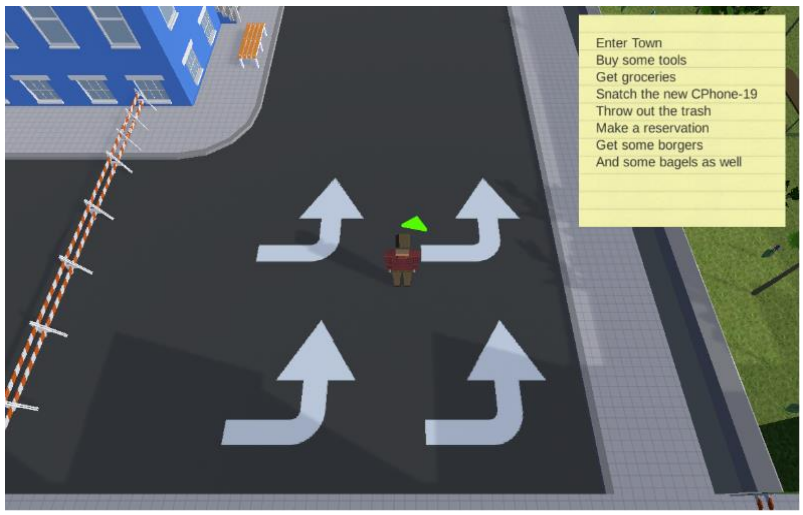


Figure 5: Screenshot of "Keep Your Distance!" game play.

Activity B: Control Group

The control group is given a selected website for this activity, which is BuzzFeed Quizzes [46], screenshots of an overview of the website are included in Figure 6. Selecting Buzzfeed Quizzes is meant to represent an accessible website that is addictive in nature and provides a similar amount of stimuli as common social media websites that people would choose to fill their time with if given the opportunity of a short break. Participants receiving this activity will act as the control group in this experiment. These activities are followed by another CSRD-ANT test, set up in the same exact way as the first session, with the purpose of measuring any changes in results that relate to the given activity.

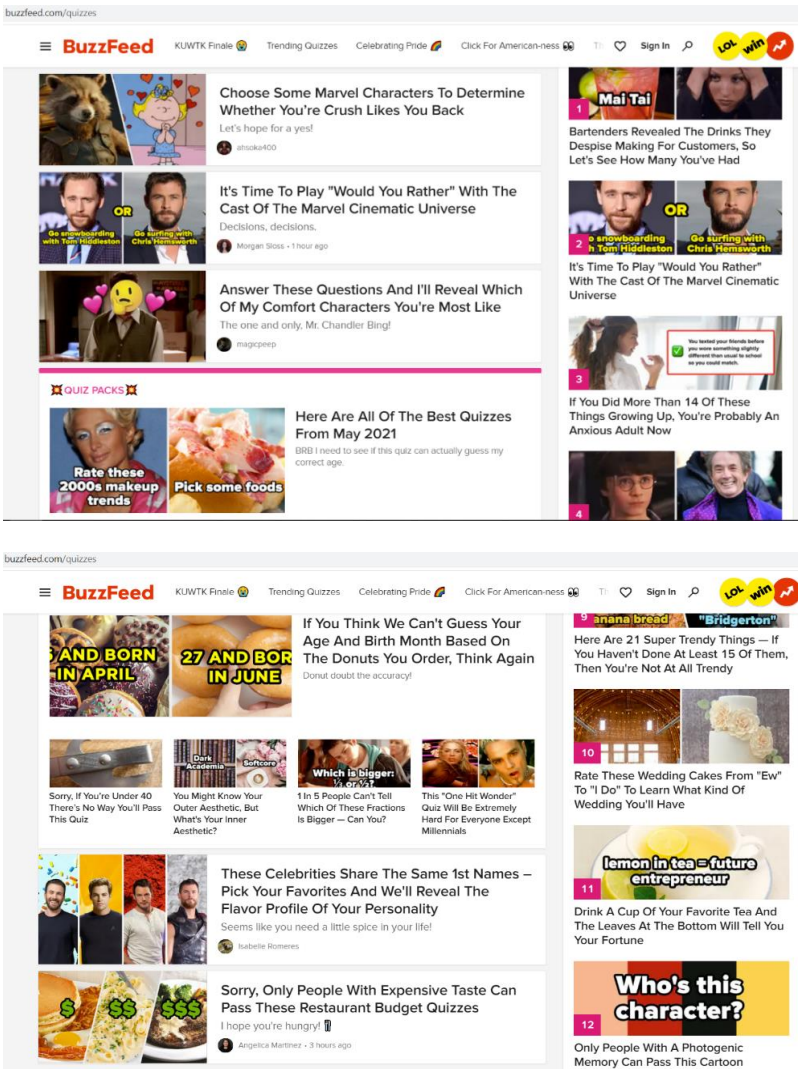


Figure 6: Screenshots of Buzzfeed Quizzes website [Accessed on 14.06.2021]

Questionnaire

The final activity to follow is a short questionnaire, asking for the participants age, gender and questions about their work environment, game playing habits and break activity habits. This is done in order to get an understanding of the demographics of the participants in terms of age and gender. The three remaining questions are asked to get an overview of the participants' lifestyles and habits, which can be factors in the experiment results. An overview of the questionnaire is included in Appendix 4.

PROCEDURE

In order to proceed with the experiment, it was required to seek approval from the Ethics Board at Leiden Institute of Advanced Computer Sciences. Once this was granted, the experiment was set up on the Leiden University's Qualtrics platform. All parts of the experiment were carried out on the platform, with the exception of Buzzfeed Quizzes for which the participants were directed to the hosting website directly with the use of a hyperlink.

The website link to the platform was then distributed among personal and professional social contacts and uploaded on the Survey Circle website. All participants were informed of the terms relating to the experiment and asked to consent to it before proceeding.

The CRSD-ANT data was captured through an external server, resulting in two files per participant – one for each of the tests. The data files were only generated once the participant completed the test, meaning that if either of the tests were incomplete, it would not be used as a sample. As a result, a significant amount of participant data could not be used on this occasion.

Overall, the experiment had 36 participants (12 male, 23 female; age range 18-55; average age 28, standard deviation 8.4). Participants were assigned at random to have one of the two activities between the attention tests, with 16 playing the game and 20 browsing the website. The participants answers were taken into account providing that they completed both attention tests to the end and the error rate was at 15% or below. The error rate was limited to this due to the CSRD-ANT only providing data on correct responses.

Even though the files included all the data captured by the test, four points were used for the analysis: scores for alerting, orienting, executive control and error rates. These results were organised into separate tables between the test groups and analysed through classical and Bayesian paired samples T-Tests using the JASP [47] software. Additionally, an analysis was done on a combined data set with both groups using classical and Bayesian independent samples T-Tests.

RESULTS

Game Group

The game playing group was assigned at random by the survey and included playing a preselected game with a 10-minute timer, limiting the option to progress with the survey. An Attention Network Test was taken before (ANT 1) and after (ANT 2) this activity.

The game playing group results are presented in Table 1, showing the mean times, standard deviation and standard error for alerting, orienting and executive control in both of the Attention Network Tests. A slight difference in scores can be observed between the two Attention Network Tests, however, as presented in the paired samples T-Test in Table 2, we can conclude that the p-values attached to these scores show no significant effects ($p > 0.05$ in all cases). The same can be deterred from the VS-MPR scores, which do not indicate any significant effects. VS-MPR stands for Vovk-Sellke Maximum p-Ratio: the maximum diagnosticity of a two-sided p-value [48], showing the likelihood of that particular p-value occurring under the alternative hypothesis versus the null hypothesis.

Presenting the same scores in Table 3 as descriptive plots, we can see a slight trending increase in alerting and trending decreases in both orienting and executive control. Based on this, it can be indicated that there was no increased efficiency in terms of the alerting, orienting or executive control scores. However, it should be noted that the element showing the biggest difference in scores, which was a trending decrease in orienting, can indicate a decrease in overall efficiency.

To further analyse the scores, Table 4 presents the same results as part of the Bayesian inference method, indicating the probability of the results showing any significant effects if there are any changes in the amount of data presented. In the case of alerting and executive control, the probability of any significant effects being present are very low. In the case of orienting, the sequential analysis indicates that there is a chance of significant effects being revealed if there were more data points presented.

Game Group Results Overview				
	N	**Mean**	**SD**	**SE**
Alerting ANT 1	16	35.875	34.320	8.580
Alerting ANT 2	16	39.938	20.564	5.141
Orienting ANT 1	16	40.313	31.656	7.914
Orienting ANT 2	16	28.500	24.279	6.070
Executive Control ANT 1	16	119.063	26.579	6.645
Executive Control ANT 2	16	113.188	30.614	7.654

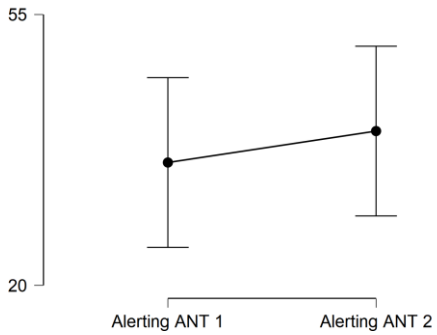
Table 1: Game Group Results Overview

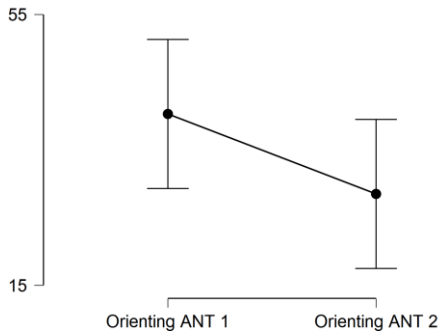
Game Group Paired Samples T-Test						
Measure 1		**Measure 2**	**t**	**df**	**p**	**VS-MPR***
Alerting ANT 1	-	Alerting ANT 2	-0.558	15	0.585	1.000
Orienting ANT 1	-	Orienting ANT 2	1.617	15	0.127	1.405
Executive Control ANT 1	-	Executive Control ANT 2	0.808	15	0.432	1.000

** Vovk-Sellke Maximum p -Ratio: Based on a two-sided p -value,the maximum possible odds in favor of H_1 over H_0 equals 1/(-e p log(p)) for p ≤ .37 (Sellke, Bayarri, & Berger, 2001).*

Table 2: Game Group Paired Samples T-Test

Game Group Descriptive Plots





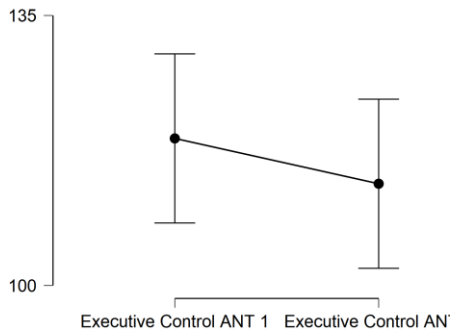
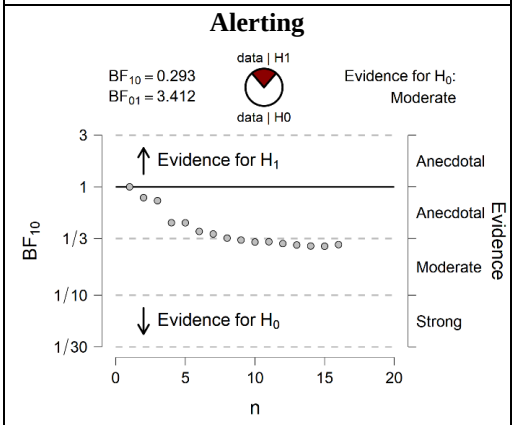
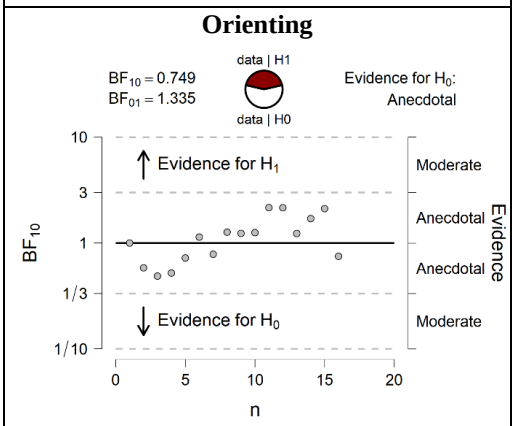


Table 3: Game Group Descriptive Plots

Game Group Bayesian Inferential Plot – Sequential Analysis





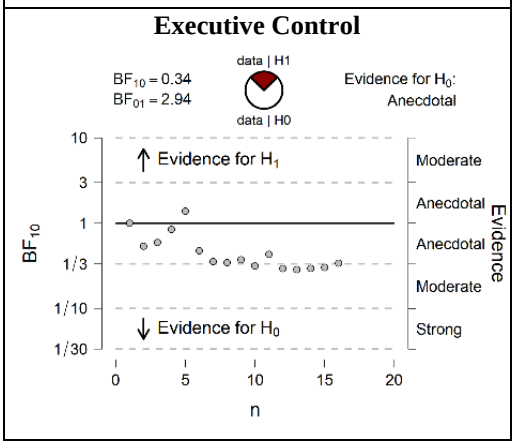


Table 4: Game Group Bayesian Inferential Plot – Sequential Analysis

Control Group

The control group was assigned at random by the survey and included browsing a preselected website (BuzzFeed Quizzes) with a 10-minute timer, limiting the option to progress with the survey. An Attention Network Test was taken before (ANT 1) and after (ANT 2) this activity.

Similar to the game group results, the control group results shown in Table 5 as the overview, show small changes in the mean scores between the three functions. When compared as part of a paired samples T-Test, the differences in scores do not show any significant difference in any of the categories. Executive control does show a trending decrease in the numbers in Table 6 (p=0.037, VS-MPR =2.998), indicating that the participants' performance did show signs of improvement, which is also visualised in Table 7. Using the same data as part of a Bayesian Inferential Plot shown in Table 8, all three elements indicate a low chance of significant effects being revealed if there were more data points presented.

Control Group Results Overview				
	N	**Mean**	**SD**	**SE**
Alerting ANT 1	20	28.100	29.838	6.672
Alerting ANT 2	20	29.500	19.766	4.420
Orienting ANT 1	20	26.950	29.756	6.654
Orienting ANT 2	20	30.950	24.761	5.537
Executive Control ANT 1	20	114.250	48.885	10.931
Executive Control ANT 2	20	101.950	38.226	8.548

Table 5: Control Group Results Overview

Control Group Paired Samples T-Test						
Measure 1		**Measure 2**	**t**	**df**	**p**	**VS-MPR***
Alerting ANT 1	-	Alerting ANT 2	-0.192	19	0.849	1.000
Orienting ANT 1	-	Orienting ANT 2	-0.649	19	0.524	1.000
Executive Control ANT 1	-	Executive Control ANT 2	2.239	19	0.037	2.998

** Vovk-Sellke Maximum p -Ratio: Based on a two-sided p -value,the maximum possible odds in favor of H_1 over H_0 equals 1/(-e p log(p)) for p ≤ .37 (Sellke, Bayarri, & Berger, 2001).*

Table 6: Control Group Paired Samples T-Test

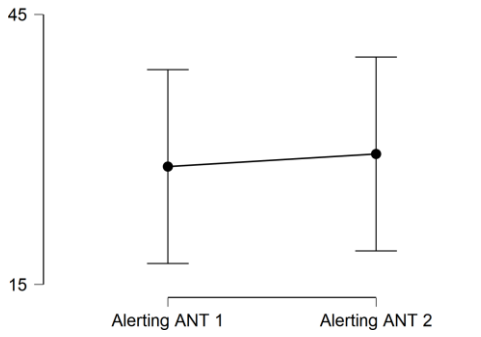
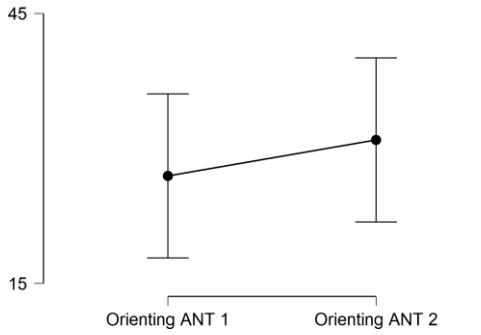
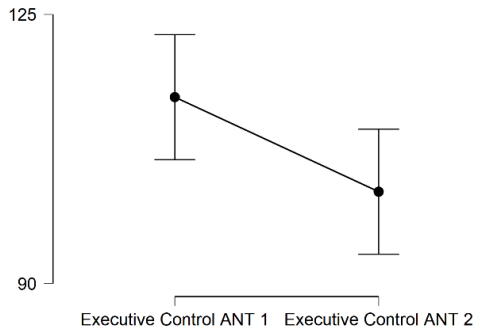
Control Group Descriptive Plots




Table 7: Control Group Descriptive Plots

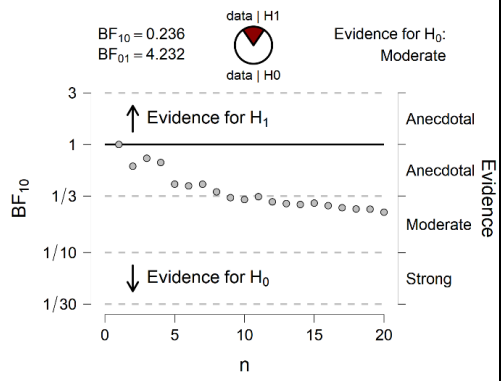
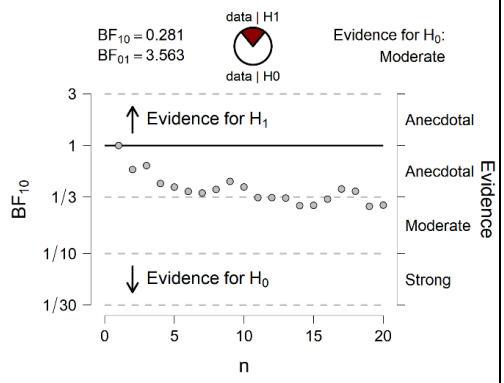
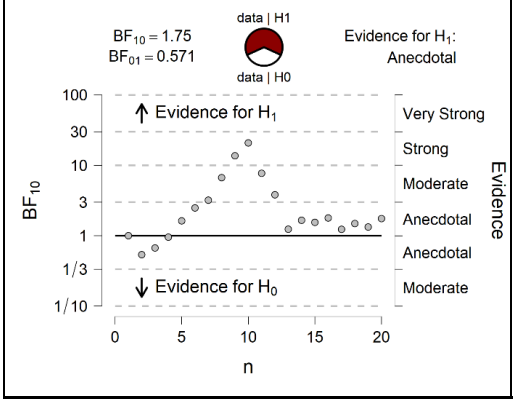
Control Group Bayesian Inferential Plot – Sequential Analysis
Alerting 
Orienting 
Executive Control 

Table 8: Control Group Bayesian Inferential Plot – Sequential Analysis

Combined Data Analysis

In order to compare the results between the two groups, the difference between the first and second attention test result (x Delta = x ANT 2 – x ANT 1 for alerting, orienting and executive control respectively) was used to run an independent samples T-Test and an overview is presented in Table 9. There seems to be little difference between alerting (p=0.800) and executive control (p=0.477) scores, but orienting (p=0.105) shows a trend towards having gained an improved result within the control group, which can also be seen in the descriptive plots in Table 10. None of these differences in scores show to be significant however. Analysing the same figures within a Bayesian Inferential Plot in Table 11, it can also be concluded that increasing the sample sizes will likely not provide more evidence for significant effects with any of the three factors.

Combined Group T-Test Results Overview								
	t	**df**	**p**	**Group**	**N**	**Mean**	**SD**	**SE**
Alerting Delta	0.255	34	0.800	Game	16	4.063	29.112	7.278
				Control	20	1.400	32.545	7.277
Orienting Delta	-1.666	34	0.105	Game	16	-11.813	29.221	7.305
				Control	20	4.000	27.543	6.159
Executive Control Delta	0.719	34	0.477	Game	16	-5.875	29.093	7.273
				Control	20	-12.300	24.568	5.494
**x Delta = x ANT 2 – x ANT 1 for Alerting, Orienting and Executive Control respectively.*								

Table 9: Combined Group T-Test Results Overview

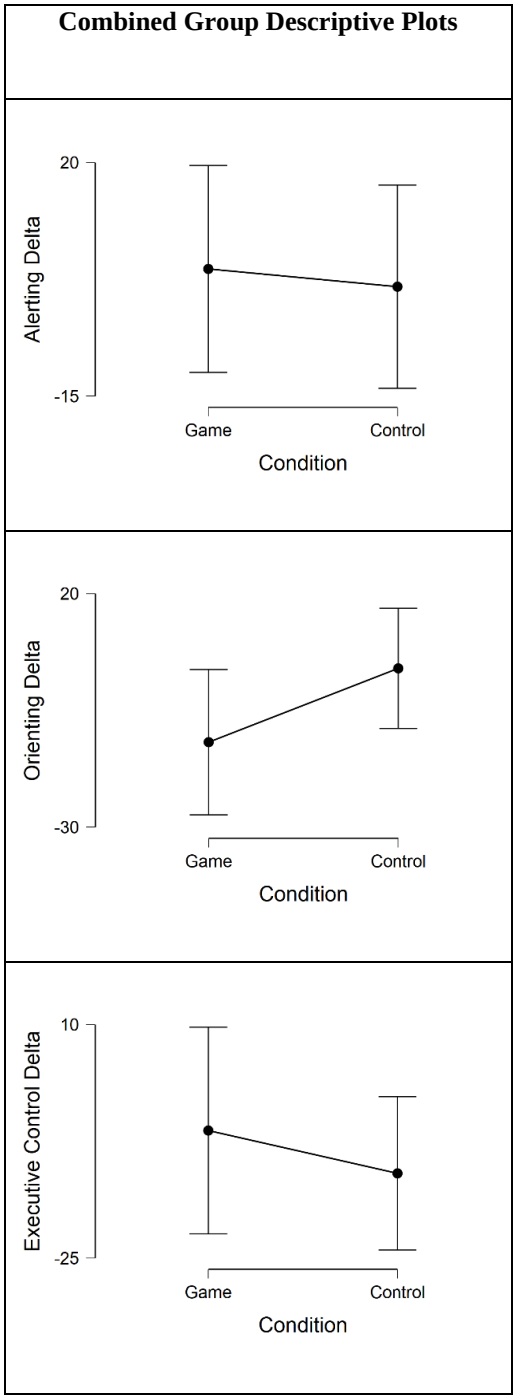


Table 10: Combined Group Descriptive Plots

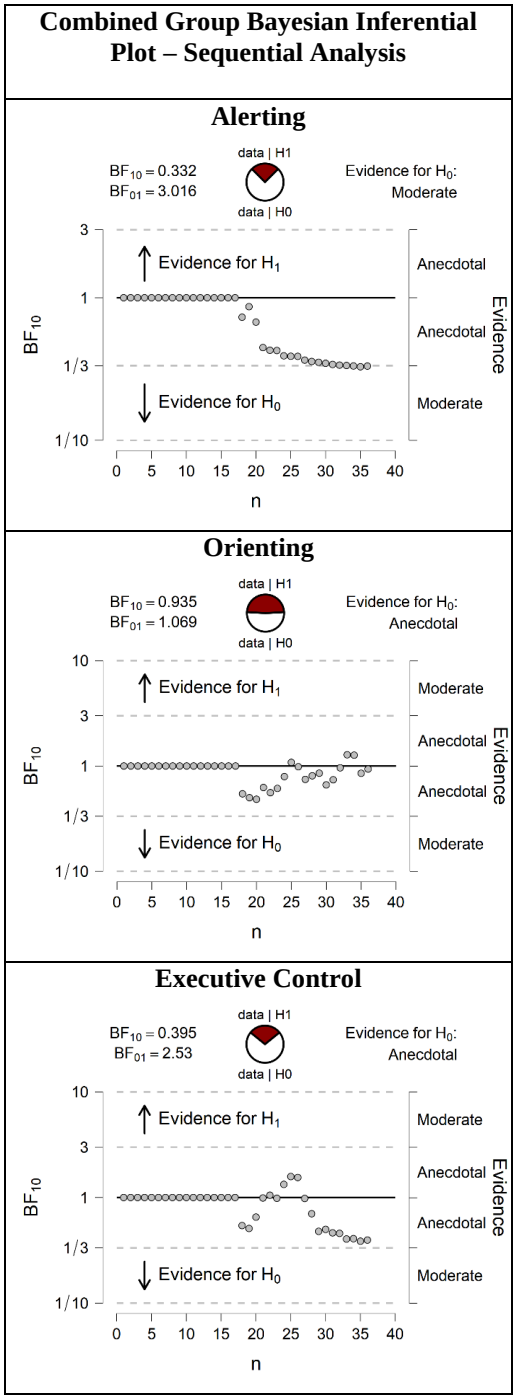


Table 11: Combined Group Bayesian Inferential Plot – Sequential Analysis

Questionnaire

The final questionnaire asked three questions relating to work, break and gaming habits. The results show that 21 participants have a desk job, 8 participants have a non-desk job and 7 participants are not in paid employment. When asked about gaming habits, which include any video games, 9 participants indicated that they play games every day and 3 participants indicated that they never play games. The rest of the participants have almost equally indicated to playing within a range between a few hours a week to a few hours a year. When asked to indicate a preferred method

when taking a microbreak from a task, 16 participants responded that they most commonly engage in passive activities, which include social media scrolling, watching videos, listening to music and other similar activities. Social activities, which include messaging apps or socialising with co-workers, are the most common for 8 participants and the three remaining options – relaxing, active entertainment, task switching – were divided almost equally among the remaining participants. An overview of the results can be found in Appendix 5.

DISCUSSION

The goal of this research was to see whether playing video games could help with sustained attention while working on a task. Even though the existing research and theories could support this idea, this current experiment did not yield any statistically significant results to support the hypothesis.

As mentioned before, the Attention Network Test measures three functions of attention – alerting, orienting, executive control. If there is an increase in the score of the first two elements, that would indicate a better sustained attention, as it would if the score of executive control decreases. Analysing the experiment results seen in both game playing and website browsing cases, we can see that there were some elements that were trending in either direction. The two most prevalent trending elements were orienting in the game group, which declined during the second attention test, indicating a poorer result, and executive control in the control group which also declined, indicating an improved result.

Video games definitely are not everyone's choice of entertainment, which is also indicated in the questionnaire results and this could have had an effect as the participant could have felt it being more of a chore rather than a fun and engaging activity. Another possibility could have been technical difficulties with getting the game to play smoothly or participants being unclear about the instructions and goals of the game, which could have also affected the latter scores. Playing video games also counts as active entertainment, which most participants do not claim as their first choice of activity for a break. An active break between demanding tasks might be overwhelming for some and explain the lack of improvement, or in one case, a possibility of even decreased efficiency. As the test environment was also out of our control, there is a possibility of external distractions, the participants' unfavourable mental conditions (for example tiredness or stress) or if the experiment activities were properly fulfilled.

The control group's preselected activity was browsing the BuzzFeed Quizzes website. It was acknowledged that this website is not deemed as popular when compared to a number of years ago, it was still a suitable option to draw parallels with browsing social media. An argument can be made that people using social media have the ability to curate their feeds as opposed to a website that provides content for everyone, however, the biggest platforms (TikTok [49], Instagram [50], YouTube [51]) still offer a lot of new content to the user to try and keep their interest piqued. Buzzfeed Quizzes also uses similar tactics to social media websites by offering a lot of visual stimuli and attempting to keep the visitor on the website for as long as possible with numerous provocative headlines, calls to action and other similar tactics. The act of browsing this website would be a passive activity and the three functions of attention would not be actively used, indicating that the participant could relax during the break activity. The majority of the participants indicated in the questionnaire that this is their most preferred method to spend time during

microbreaks, which might explain why comparatively between the test groups some of the functions were trending towards better results and why there was a trending improvement in executive control within the test group. As with the game group, the test environment was out of our control and some participants have indicated that instead of browsing the website, they decided to fill the 10 minutes in their own preferred way, which might also have had an effect on the results.

As presented in the background research, the results may vary dependent on whether the participants have gaming experience and when they do not. Additionally, the games that are most often referenced are first person shooter games and game players associated with these. These kind of games offer a more fast pace environment with a lot of added stimuli, and require practice from the player to have the desired effects. This research focused on potential beneficial effects regardless of the level of gaming experience and interest. This hypothesis also suggests that video games could be used as a temporary solution to regain sustained attention. However, previous research also suggests that if games were to be used for longer periods of time as part of behavioural training, there could be more significant changes in attention over time.

Some further research into this topic would be needed to see if there still could be a link between using video games as efficiency boosting microbreaks. Reflecting on the survey results, one way might be to see whether this is something that could work for people who enjoy games versus people who never play games, offering a choice of different games, performing a similar test in a controlled environment or even testing it out in real life scenarios, for example in an actual work office. In addition to this, applying video games in situations where a participant would indicate a need for better sustained attention or focus could generate more improved results.

CONCLUSION

Overall, the hypothesis was not supported on this occasion. Previous research, however, shows that video games have a lot of hidden and potentially still undiscovered benefits and most importantly, people seem to enjoy playing video games more than ever. More research is needed to find ways on how, when and which video games can be used to boost one's work performance, but based on the research data presented in this study, it can be concluded that it is not a simple and universal solution. Even though this solution will not work for everyone, personal observations and anecdotal data suggest that it could still work on an individual level and therefore it is something that should be explored further.

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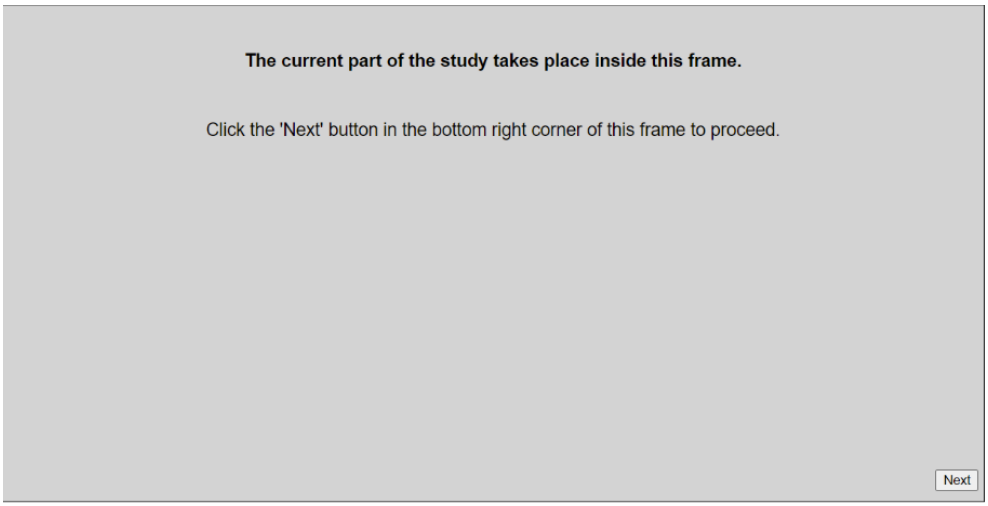
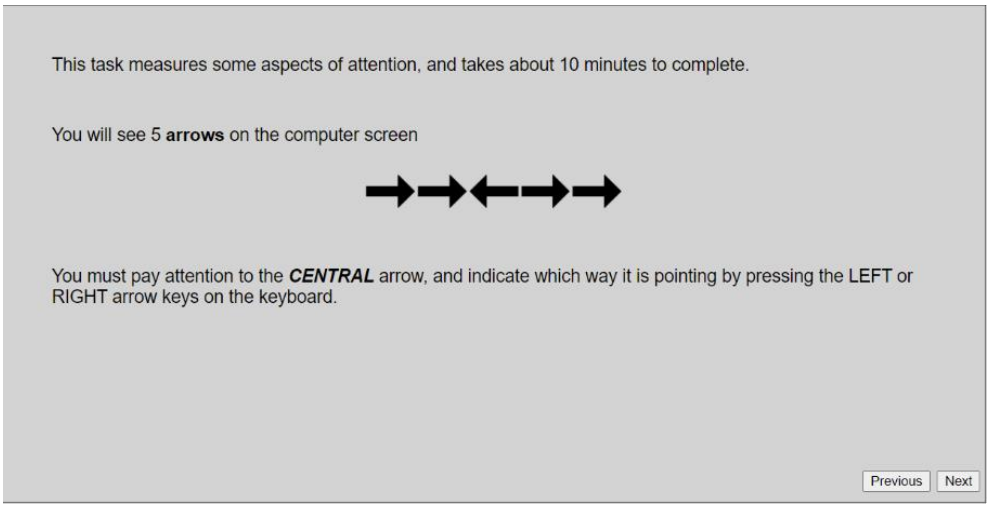
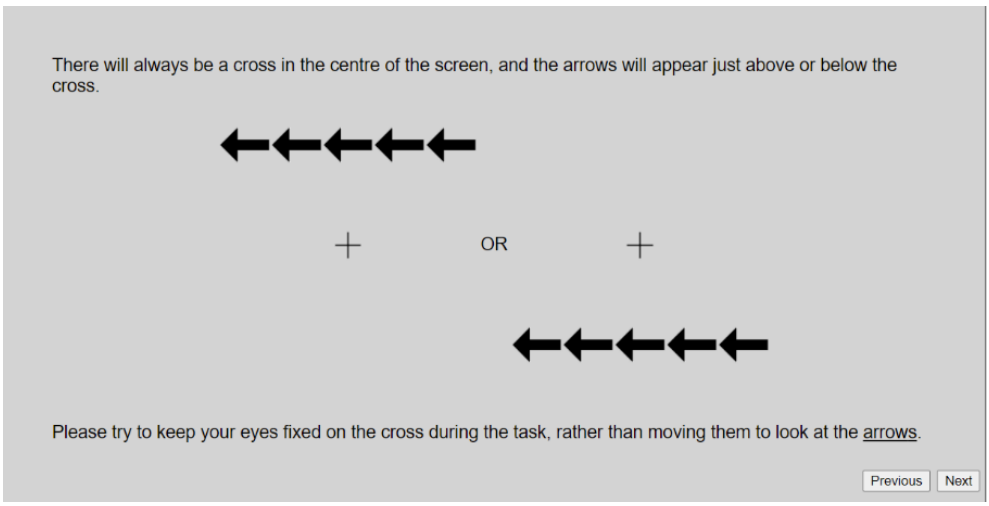
APPENDICES

Appendix 1

CSRD-ANT Instructions as presented to the participant.







Sometimes, one or more asterisks  will appear shortly before the arrows.

When they are presented, the asterisks always appear exactly one half second before the arrows.

If only one asterisk appears, and it is above or below the cross, it also tells you the location in which the arrows will appear.

Previous Next

As mentioned earlier, you must pay attention to the central arrow, and indicate which way it is pointing by pressing the LEFT or RIGHT arrow keys on the keyboard.

This task measures both your reaction time and your accuracy, so it is important to respond as quickly as you can, but without making too many errors.

Previous Next

There are 3 blocks of activity in this task.

The first block is for practice, and takes about 2 minutes.

If you make a mistake during the practice block, an error message will appear. If no error message appears, you will know that you responded correctly.

No feedback is given during the 2 task blocks.

Previous Next

Appendix 2

GameFlow criteria assessment for ''Keep Your Distance!''.

Concentration – The game provides a number of stimuli, most notably a sound effect that includes sneezing and coughing sounds that match the theme of the game and encourage the player to learn more about how to interact with this. There is also a to-do list provided immediately encouraging the player to start exploring how to complete these challenges and keeps the attention on the game as a constant reminder of what needs to be done next. The first few seconds also provides extra visual stimuli in the form of red circles around the other characters, leaving room for the player to explore and interact with the environment. The workload remains high with a number of things to monitor throughout the game but does not become over-stimulating. The game also does not have a trial limit or does not end before the player completes the final challenge, instead if the character fails in the challenge, they are immediately placed back to the last saving point. This keeps the game pace up and the player focused on tackling the challenges.

Challenge – ''Keep your distance'' meets most of the challenge criteria, as the game becomes increasingly more difficult as it progresses. The first few levels provide hints of the distance that the game characters need to keep, which will be removed as the game progresses. It also introduces extra characters that will chase the player, presenting an extra challenge. Also, the number of people that need to be passed with the required distance becomes increasingly difficult. There are times that the levels progress too quickly, but the set up of a previous saving point helps to learn and tackle this quickly. However, the game is designed to be for beginner levels and therefore does not provide any options for any advance levels. This is not part of the game design as it is meant to be an accessible and short game.

Player Skills – Even though the game provides an intial overview of the controls, they are quite common ones that players with previous gaming experience would be able to easily figure out. As the game is limited to only a number of functions, such as moving in different directions, it is also made easy for the player to associate this with the arrow keys. As mentioned before, the game starts by providing a guideline of how to avoid obstacles by drawing red circles around the interacting characters in the game. These will later disappear once the player has been taught how they can interact with the environment. There is also a green guiding arrow provided for the character to help navigate through the environment towards the goals. However, the tutorial mentions a slowing down function which is not a common feature for all games and therefore might be forgotten by the player later as the game progresses and this feature could need to be applied to be able to progress. In terms of player rewards, there is a challenges list provided on the screen at all times and the only stimuli given as the player progresses is a quick sound effect and the appropriate item being crossed off from the list.

Control – The player is easily made to feel in control of the game as they only have to move around one character in the environment. The character does not have that many functions, it is only limited to being able to move in all directions and slowing down the moving pace, and they can not interact with the environment in any way, only the other characters. The game does not allow any control of the view of the environment, only adapting it based on the movement of the character, which at times might stop the player from discovering different paths to use to complete the challenges. The game provides an option for pausing, but does not offer an option to save and return to the same point again once the game is closed. Also, the saving

points within the game session are determined by the game itself and not by the player.

Clear Goals – The game presents a clear set of goals that are humorous and potentially relatable to the player. The given challenges list is always clearly visible (unless the player themselves choose to hide it) and keeps track of the progress. There are no intermediate or overriding goals present in this game by design.

Feedback – The game provides immediate feedback when the player completes a goal. There is always a list of challenges present (or if hidden by the player, it is easily accessible at all times) that keeps track of the progress and crosses out the challenges that have been completed. It also provides a sound effect and once the players reaches the challenge end goal, the green circle marking it disappears. However, there is no separate message, popup, animation or similar to state this.

Immersion – It is easy to become immersed in the game as it is quick paced and requires concentrating on several things at once, such as monitoring the movement of other characters, assessing the level of damage that the character receives, moving fast enough to escape the character that follows the player around, following the green arrow that indicates the player is moving in the right direction and so on. At the same time the player is made uncomfortable by the sound effects of the other characters sneezing and coughing, making the player want to escape this environment as quickly as possible. This is drawing direct parallels with the real life pandemic situation that all players have experienced as well, making it a potentially relatable situation.

Social Interaction – The game is not designed to be multiplayer or include any other sort of (live) social interaction among players. However, since the game also does not provide a score or keep track of time or any other measure, it does not encourage social interaction amongst players. This is simply due to players not being able to compare their game statistics, therefore not providing an environment for competing with others.

0 – N/A, 1 – not at all, 2 – below average, 3 – average, 4 – above average, 5 – well done

Element	**Criteria**	**Grade**
Concentration	- games should provide a lot of stimuli from different sources	4
Games should require concentration and the player should be able to concentrate on the game	- games must provide stimuli that are worth attending to	4
	- games should quickly grab the players' attention and maintain their focus throughout the game	4
	- players shouldn't be burdened with tasks that don't feel important	5
	- games should have a high workload, while still being appropriate for the players' perceptual, cognitive, and memory limits	5
	- players should not be distracted from tasks that they want or need to concentrate on	5

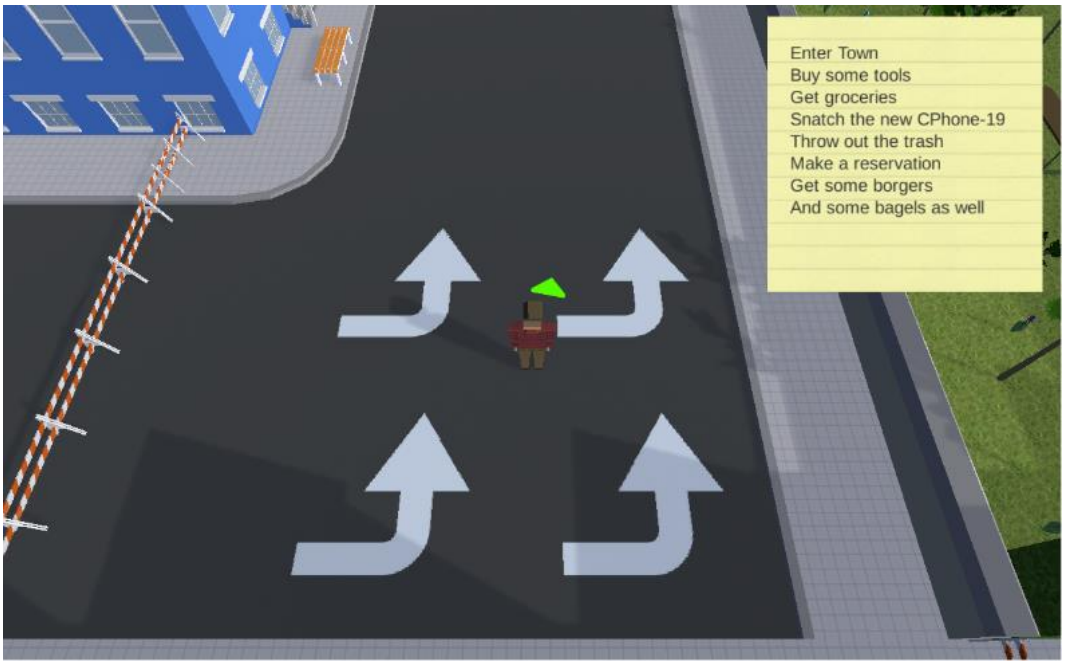
Challenge	- challenges in games must match the players' skill levels	3
Games should be sufficiently challenging and match the player's skill level	- games should provide different levels of challenge for different players	0
	- the level of challenge should increase as the player progresses through the game and increases their skill level	5
	- games should provide new challenges at an appropriate pace	5
Player Skills	- players should be able to start playing the game without reading the manual	5
Games must support player skill development and mastery	- learning the game should not be boring, but be part of the fun	4
	- games should include online help so players don't need to exit the game	0
	- players should be taught to play the game through tutorials or initial levels that feel like playing the game	4
	- games should increase the players' skills at an appropriate pace as they progress through the game	5
	- players should be rewarded appropriately for their effort and skill development	3
	- game interfaces and mechanics should be easy to learn and use	5
Control	- players should feel a sense of control over their characters or units and their movements and interactions in the game world	4
Players should feel a sense of control over their actions in the game	- players should feel a sense of control over the game interface and input devices	3
	- players should feel a sense of control over the game shell(starting, stopping, saving, etc.)	5
	- players should not be able to make errors that are detrimental to the game and should be supported in recovering from errors	5
	- players should feel a sense of control and impact onto the game world (like their actions matter and they are shaping the game world)	4
	- players should feel a sense of control over the actions that they take and the strategies that they use and that they are free to play the game the way that they want (not simply discovering actions and strategies planned by the game developers)	3
Clear Goals	- overriding goals should be clear and presented early	1
Games should provide the player with clear goals at appropriate times	- intermediate goals should be clear and presented at appropriate times	1

Feedback	- players should receive feedback on progress toward their goals	4
Players must receive appropriate feedback at appropriate times	- players should receive immediate feedback on their actions	5
	- players should always know their status or score	5
Immersion	- players should become less aware of their surroundings	4
Players should experience deep but effortless involvement in the game	- players should become less self-aware and less worried about everyday life or self	3
	- players should experience an altered sense of time	3
	- players should feel emotionally involved in the game	5
	- players should feel viscerally involved in the game	5
Social Interaction	- games should support competition and cooperation between players	1
Games should support and create opportunities for social interaction	- games should support social interaction between players(chat, etc.)	0
	- games should support social communities inside and outside the game	0
	Overall:	**4**

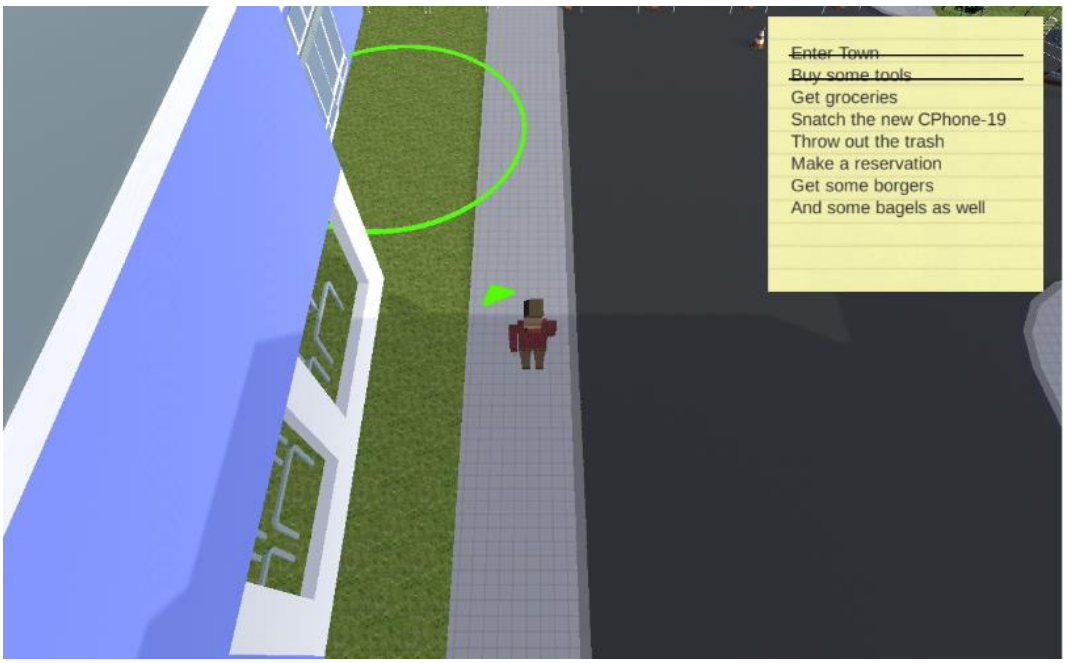
0 – N/A, 1 – not at all, 2 – below average, 3 – average, 4 – above average, 5 – well done

Appendix 3

Screenshots of ''Keep Your Distance!'' gameplay.




Enter Town
Buy some tools
Get groceries
Snatch the new CPhone-19
Throw out the trash
Make a reservation
Get some borgers
And some bagels as well


Enter Town
Buy some tools
Get groceries
Snatch the new CPhone-19
Throw out the trash
Make a reservation
Get some borgers
And some bagels as well

Appendix 4

Overview of survey questionnaire.

What is your age? _____

What is your gender?

- Male
- Female
- Non-binary/unlisted gender

How would you best describe your work environment (outside of the pandemic)?

- Office (desk job)
- Home (desk job)
- Non-office work (non-desk job)
- Not in paid employment

How often do you play video games in your spare time (including mobile, web, computer and console games)?

- Every day
- Few hours a week
- Few hours a month
- Few hours a year
- Never

What is your most preferred method of taking a quick recovery break (microbreak) from work? If multiple apply, pick the one that applies most.

- Passive entertainment – social media scrolling, watching a video/TV, listening to music, etc.
- Active entertainment – reading, playing a game, solving a puzzle, etc.
- Social activity – messaging apps, phonecalls, socialising with coworkers, etc.
- Relaxing – nap, meditation, yoga, stretching, walking, etc.
- Task switching – working on another task, running personal errands, etc.

Any further comments?_____

Appendix 5

Survey questionnaire results overview.