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ABSTRACT

First-person shooter (FPS) games are one of the most popular yet notorious genres of digital games. They contain visceral emotional content and require intense visual attention from players, leading some people to appreciate and others to resent these types of games. This thesis investigated individual differences in the game experience of FPS games by exploring how preferences for violent game dynamics (e.g., preferences for shooting, killing, and exploding) affect players' emotions and perceptions of curiosity, vitality, and self-efficacy. In addition, the thesis explored how visual attention skills affect the viewing of FPS games as indexed by viewers' eye movements.

In Study I, the role of visual attention skills in viewing FPS gameplay videos was explored. The results showed that viewers' eye movements tended to progress from a diffuse scanning mode towards a more focal and central viewing mode as time passed. Visual qualities and saliency of events also guided eye movements. Individual differences in visual attention skills (namely, the ability to track multiple objects, perform a visual search for targets, and to see rapidly appearing serial targets) were related to what was attended to in the screen. The role of visual attention skills on eye movements was more prominent during visually distinct events. In sum, the results showed that specific visual attention skills predicted eye movement patterns during FPS gameplay video viewing.

Study II explored whether game dynamics preferences and emotion-related responses to an FPS game are connected. Participants' heart rate, electrodermal activity, and electric activity of facial muscles were recorded as indexes of emotion-related responses both during playing (active participation) and gameplay video viewing (passive watching). The participants also rated their level of experienced arousal and valence. The results showed that there were individual differences in physiological emotion-related responses as a function of dynamics preferences, especially in measures of physiological arousal. Those who liked violent dynamics showed a rather stable level of physiological arousal state both when playing and when viewing the game. In contrast, participants who disliked violent dynamics showed an overall higher level of physiological arousal during playing than when viewing, and the level of arousal increased across time in both conditions. The results on facial muscle activity likewise showed that activity differed between people who liked versus disliked violent dynamics. However, the results were somewhat conflicting: those who liked violent game dynamics showed a steep increase in the activity of the *corrugator supercilii* muscle, an index of negative valence. Instead, those who disliked the dynamics showed less increase in *corrugator supercilii* activity. The dynamics preferences did not affect self-reported emotional valence or arousal. Thus, the results highlight that game dynamics preferences were associated with physiological signals, although they may not be a straightforward index of emotions in a gaming context.

In Study III, associations between game dynamics preferences and self-reported experiences of vitality, self-efficacy, and curiosity were explored both in association with life in general and with playing an FPS video game. The results showed that players who were neutral or mildly positive towards violent content experienced stable levels of vitality, curiosity, and emotional valence both in life in general and when playing. They also experienced a slight decline in self-efficacy in the playing context. Conversely, those who disliked violent dynamics experienced a clear decline in all of these measures in the playing context. Thus, game dynamics preferences were connected with wider experiential reflections related to playing.

Overall, the results of all three studies showed why there is individual variation in the playing experience: players and viewers have differing skills and preferences. These skills and preferences affect how players and viewers pay attention to the game, and what kind of emotional reactions and experiences they have. This is valuable for understanding the psychological outcomes of FPS games, as well as why people hold differing opinions about these types of games. Likewise, the results have importance for game design, as they show that players respond in different ways to game contents. Thus, it may be fruitful to personalize and tailor game contents based on players' preferences and visual attention skills.

KEYWORDS: Video game, digital game, first-person shooter, emotion, motivation, visual attention, curiosity, vitality, self-efficacy, game experience, user experience, games user research, game dynamics, game content, preferences, electromyography, electrodermal activity, heart rate, eye tracking

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TIIVISTELMÄ

Ensimmäisen persoonan ammuntapelit (FPS-pelit) ovat sekä yksi suosituimmista että pahamaineisimmista digitaalisten pelien genreistä. Ne sisältävät voimakasta tunnepitoista sisältöä ja vaativat äärimmäistä näönvaraista tarkkaavuutta. Näiden seikkojen takia toiset arvostavat ja toiset paheksuvat kyseisiä pelejä. Tässä väitöskirjassa tutkittiin yksilöllisiä eroja FPS-pelien pelikokemuksessa selvittämällä, kuinka mieltymykset väkivaltaisiin pelidynamiikkoihin (esimerkiksi mieltymykset ampumiseen, tappamiseen ja räjäyttämiseen) vaikuttavat pelaajien tunnetiloihin ja kokemuksiin uteliaisuudesta, elinvoimaisuudesta ja minäpystyvyydestä. Tämän lisäksi väitöskirjassa tutkittiin silmänliikkeitä tarkastelemalla kuinka näönvaraisen tarkkaavuuden taidot ovat yhteydessä FPS-pelivideoiden katseluun.

Tutkimuksessa I tarkasteltiin, miten näönvaraisen tarkkaavuuden taidot vaikuttavat FPS-pelivideoiden katseluun. Tutkimuksessa havaittiin, että silmänliikkeet etenivät laajemmasta ja hajaantuneemmasta silmäilystä kohti pinta-alaltaan pienempää ja lähempänä näytön keskustaa olevaa aluetta. Lisäksi erilaisten pelitapahtumien visuaaliset ominaisuudet ja huomiota herättävyys suuntasivat silmänliikkeitä. Yksilölliset erot näönvaraisen tarkkaavuuden taidoissa (tässä tutkimuksessa taidot seurata useita liikkuvia kohteita, etsiä kohteita ja nähdä nopeasti peräkkäin ilmestyviä kohteita) olivat yhteydessä siihen, miten katselija tarkasteli pelinäkymää. Näönvaraisen tarkkaavuuden taitojen yhteys silmänliikkeisiin tuli esiin etenkin visuaalisesti toisistaan erottuvien pelitapahtumien aikana. Yhteenvetona tutkimuksen tulokset osoittivat, että tietyt näönvaraisen tarkkaavuuden taidot ennustavat silmänliikkeitä FPS-pelivideon katselun aikana.

Tutkimuksessa II selvitettiin, ovatko pelidynamiikkamieltymykset ja FPS-peliin liittyvät tunnereaktiot yhteydessä toisiinsa. Tutkimukseen osallistujien sykettä, ihon sähkönjohtavuutta ja kasvolihasten sähköistä aktiivisuutta mitattiin indikaatioina tunnereaktioista sekä pelaamisen (aktiivinen osallistuminen) että pelivideon katselun (passiivinen tarkkailu) aikana. Osallistujat myös arvioivat oman tunnetilansa koettua virittävyyttä ja valenssia. Tulokset osoittivat, että yksilöiden välillä oli eroja fysiologisissa tunteisiin liittyvissä reaktioissa riippuen siitä, millaiset pelidynamiikkamieltymykset heillä oli. Tämä näkyi erityisesti fysiologisissa autonomisen hermoston tilaa kuvaavissa mittareissa. Väkivaltaisista dynamiikoista pitävillä osallistujilla oli suhteellisen tasainen fysiologisen aktivaation taso sekä pelatessa että

pelivideota katsellessa. Sen sijaan niillä osallistujilla jotka eivät pitäneet väkivaltaisista dynamiikoista oli kaiken kaikkiaan korkeampi fysiologisen aktivaation taso pelatessa kuin pelivideota katsellessa, ja aktivaation taso kasvoi ajan kuluessa molemmissa tilanteissa. Kasvojen lihasten sähköiseen toimintaan liittyvät tulokset niin ikään osoittivat, että väkivaltaisista dynamiikoista pitävien ja niitä vieroksuvien henkilöiden välillä oli eroja. Tulokset olivat kuitenkin jossain määrin ristiriitaisia: väkivaltaisista dynamiikoista pitävillä osallistujilla negatiivista valenssia indikoiva *corrugator supercilii* -lihaksen aktiivisuus lisääntyi ajan kuluessa huomattavasti. Sen sijaan osallistujilla jotka eivät pitäneet väkivaltaisista dynamiikoista *corrugator supercilii* -lihaksen aktiivisuuden lisääntyminen oli lievempää. Pelidynamiikkamieltymykset eivät olleet yhteydessä osallistujien omiin arvioihin tunnekokemuksen virittävyydestä ja valenssista. Täten tulokset osoittivat, että pelidynamiikkamieltymykset olivat yhteydessä fysiologisiin vasteisiin, mutta niitä ei voida käyttää täysin mutkattomina mittareina tunteista pelikontekstissa.

Tutkimuksessa III tarkasteltiin pelidynamiikkamieltymysten yhteyttä uteliaisuuden, elinvoimaisuuden ja minäpystyvyyden kokemuksiin elämässä ylipäätään ja FPS-pelin pelaamiseen liittyen. Tutkimuksessa havaittiin, että uteliaisuus, elinvoimaisuus ja tunteen valenssi olivat samankaltaiset sekä elämässä ylipäätään että pelatessa mikäli pelaaja suhtautui väkivaltaisiin dynamiikkoihin neutraalisti tai jonkin verran positiivisesti. Tällaisilla pelaajilla minäpystyvyys oli kuitenkin jonkin verran alhaisempi pelitilanteessa verrattuna elämään ylipäätään. Sen sijaan pelaajat jotka eivät pitäneet väkivaltaisista dynamiikoista arvioivat kaikkien näiden kokemusten olevan selvästi huonompia pelatessa. Pelidynamiikkamieltymykset olivat siis yhteydessä laajempiin reflektiivisiin kokemuksiin pelaamisesta.

Väitöstutkimuksen tulokset auttavat ymmärtämään, miksi pelikokemuksessa on yksilöllistä vaihtelua: pelaajat ja katsojat eroavat taidoiltaan ja mieltymyksiltään. Nämä taidot ja mieltymykset ovat yhteydessä siihen, millä tavoin pelaajat ja katselijat kiinnittävät huomiota peliin ja minkälaisia tunnereaktioita ja kokemuksia heillä on. Näiden seikkojen huomioiminen on tärkeää FPS-pelien psykologisten vaikutusten ja peleihin liittyvien eriävien mielipiteiden ymmärtämiseksi. Tuloksilla on lisäksi merkitystä pelisuunnittelulle, sillä ne osoittavat, että pelaajat reagoivat eri tavoin pelisisältöihin. Tämän vuoksi voisi olla hyödyllistä muovata pelisisältöjä yksilöllisesti pelaajien mieltymysten ja näönvaraisen tarkkaavuuden taitojen mukaan.

ASIASANAT: Videopeli, digitaalinen peli, ensimmäisen persoonan ammuntapeli, tunne, motivaatio, visuaalinen tarkkaavuus, uteliaisuus, elinvoimaisuus, minäpystyvyys, pelikokemus, käyttäjäkokemus, pelien käytettävyystutkimus, pelidynamiikat, pelin sisältö, mieltymykset, elektromyografia, ihon sähkönjohtavuus, syke, katseenseuranta

Acknowledgments

It is a commonly known fact that the most read part of any given PhD thesis is the acknowledgments section. People either want to know whether they have been mentioned or want to get a glimpse into the life of the defendant. With this in mind, I will start by apologizing – I will without a doubt fail on both accounts. It is an impossible task to mention all the people who were influential either in my life or directly for this thesis, as I have been surrounded by so many people I hold dear. Baring my soul to the reader is likely just as difficult. Nevertheless, I will try.

I have spent many days dreaming of writing this section, of being able to say how much the whole process meant to me and to thank everyone who helped me get through it. In fact, at some point it became almost a coping mechanism. When I felt that my studies were doomed, I often found myself writing this acknowledgment section in my brain. I fantasized about the day I could write down every sentimental thing I was thinking of, and especially thank all the people I felt grateful to. It feels both celebratory as well as daunting to actually put these words on paper.

When I started my PhD studies, I was given an office, inside which the faculty kept an archive of all the PhD theses that had been published. During my first months as a brand new PhD student, I leafed through the theses, building a feeling of simultaneous admiration and fear for the overwhelming yet exciting task ahead. I glimpsed into some truly beautiful journeys from those who had left their notes before me. From the acknowledgment sections it quickly became clear to me how much of a spiritual experience getting a PhD seemed to be. It also surprised me that so many people were involved in getting a single person through the PhD process. In my naïve state, I had assumed doing a PhD was merely about conducting a few studies and writing papers about them. In fact, I was so convinced that the task would not affect me emotionally or be in any way difficult that I openly called getting my PhD a "downshifting project." Oh what an annoying brat I was! I had earned my Master's degree at the ripe age of 23, worked for a little while as a psychologist, gotten married by the time I was 24 and become a parent when I was 25. I had kept myself busy. When I announced my "retirement from all the hassle," I earned a lot of eye rolling from senior PhD students. Someone ought to have smacked me with a book. Preferably a thick statistics book, in the hopes that I might have absorbed some of its knowledge via the impact it made on my head.

Even though I was sorely proven wrong about the easiness of this task by the end of my studies, it is true that the first years were almost euphoric. I immersed myself in reading, seminars, conferences, voluntary work, and experiments that did not contribute much to my PhD thesis. I also took my academic freedom very seriously. I used to go to lunches that would last for hours with my fellow PhD students. We frequented the fanciest cafés in Turku using way too much of the little money we had. I used to dream of the black top hat and sword I would eventually receive as symbols of being a PhD. I wandered around Turku Cathedral, where Finland’s first school (the Cathedral School of Åbo, established in 1276) and Finland’s first university were founded. I had clichéd daydreams of academia while walking on the same ground as those key Finnish academic figures who had already passed centuries ago. While I traced those footsteps, I imagined the famous historical figure, teacher and scholar Mikael Agricola trying to herd his flock of untamed schoolboys. I wanted to be part of that continuum. I do believe I was – not as Mikael Agricola, but as one of his unruly pupils prone to hedonism and too much self-confidence.

Luckily I had a living academic figure to guide me, namely my supervisor, associate professor Johanna Kaakinen. Johanna indeed had to shepherd me in much the same way as Agricola might have done. However, she has also been a truly wild and fun supervisor. I do not think I have ever met a more free-spirited yet ambitious person. Johanna, you are a true role model of a strong intellectual woman who takes on difficult tasks and completes them seemingly without fear. You are also extremely quick-witted and intellectually curious. Thank you for all your guidance.

I would also like to thank my other supervisor, professor Veikko Surakka. While Johanna gave me a lot of freedom to explore and grow as a person, Veikko tended to focus more on providing technical knowledge and asking me specific questions that ensured that I learned what I needed to learn in terms of scientific knowledge. He also always made sure to keep my personal goals in mind and to ensure that I made progress. I truly appreciate his pragmatic attitude in supervising this thesis, as it helped me not get lost in the process. Johanna and Veikko, I am grateful for your patience with me and all the work hours you poured into helping me.

I would like to thank the reviewers of this thesis, associate professor Elisa Mekler and professor Lennart Nacke. You two have been academic role models for me throughout my studies. I met both of you for the first time in Amsterdam at the CHI PLAY conference in 2017. I was an extremely green PhD student who literally knew no one at the conference. I was attending a doctoral consortium which Elisa had joined as a senior mentor. Elisa, you immediately made an impression on me as someone warm, kind, and truly willing to help others in order to progress the games research field. Afterwards, we have run into each other at other conferences, and it has always taken me by surprise that you have remembered me and always had time to chat with me. That meant a lot, and shows how thoughtful you are toward students and junior researchers. Needless to say, you are also one of the brightest people I have met during my studies, and your academic papers have been of particular interest to me because of your background in psychology.

As I said, I also made my acquaintance with Lennart during the 2017 CHI PLAY conference. In true fan-girl fashion, I just marched up to him and told him I had read most of his papers, and that it was unreal to see him in person. It was true, though. Lennart's papers have been very influential on my work, as he has written many of them on first-person shooter games, and used physiological measures to boot. At that point in my studies, I was mostly focused on game dynamics preferences, and testing whether they are connected to players' emotions. I had just recently realized that many of his papers were extremely relevant to what I was about to do. Lennart, you were very friendly and understanding of me as a poor lost PhD student attending a conference all alone, and introduced me to several people. I really appreciated that. We have since met every now and then at different conferences around the world, and you have always had time to have a conversation with me despite your busy schedule. You have asked me several insightful questions that have helped me improve my research. You and Elisa have made the academic games research field feel very accepting and inclusive of newbies like me.

In general, during my studies, I have felt like my academic home was spread out across the world, with some of my most important colleagues being those I met at international conferences. Those conferences have been the highlight of my PhD journey. I have met truly incredible people, especially at the doctoral consortiums I have attended. I will always cherish the memory of simultaneous nervousness, excitement, and wonder experienced during those days – and especially during the after-parties and get-togethers. One should not take for granted that one gets to go on adventures around the world with amazingly talented people representing several nationalities. That is one of the things I am most grateful about in this whole journey, and I want to send thanks to everyone I met at said conferences. I am afraid to list specific people in fear of forgetting to mention others, but I hope you know who you are.

At the start of my studies, I worked on a multidisciplinary project focused on what a rewarding game experience consists of and how this experience could be utilized in serious games, such as games focused on rehabilitating traumatic brain injuries (TBI). Thank you to all the people who worked on that project – I learned a lot from it and it sparked my inspiration for the studies presented in this thesis. I am especially appreciative of getting to work with Jukka Vahlo and Aki Koponen. Jukka, Aki, Johanna, and I wrote a paper on game dynamics preferences that greatly influenced my desire to study further how these preferences affect game experience.

More than that, we have collaborated and shared ideas for many years, and had many inspiring, challenging, and eye-opening discussions along the way. Jukka, I appreciate your dedication, determination, thoroughness and general knowledge on all things related to digital games. You are always ready to turn every stone to answer a research question, and have a disposition of steadfastness that I can only dream of. Aki, I like and respect your intelligence, your ability to get a job done, your social skills, and your tongue-in-cheek attitude. People always have fun when you are around, me included.

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I must have had at least six different offices during my studies. In most of them, I had room mates. One of them was Anna Kautto. Anna, I want to tell you just how much I appreciated your company! You are simply so much fun, and your lively personality and enthusiasm for coding and all things STEM-related are always a joy to witness. You are extremely easy to talk to, always offering warm words and solid advice, spiced with a lot of laughter. You contributed immensely to the fun factor of these studies, and gave me some much-needed tips on many things.

I wish I could express how grateful I am for how much Timo Heikkilä has supported me emotionally during this journey. During the time we shared an office you were many times the sole reason I managed to drag myself to work. You are one of the kindest people I know. The world will miss your talents as a counselor if you choose to continue as a researcher, but will gain the nicest, most generous person to have ever willingly chosen academia. You have also helped me in many practical matters, such as R-related problems, and were part of the TBI research team during the start of my studies. Thus, you were an integral part of my journey, and I owe you a lot.

Likewise, sharing an office and teaching group supervision courses with Otso Rantonen has been one of the best parts of the whole PhD journey. You are extremely empathic and have taught me so much about how to be a human being to another human being. Your ability to get excited managed to spark my own motivation countless times. More than that, though, I will always remember that you were a person I could really share my authentic self with, and, well, to just have fun like a kid. So thanks, buddy.

Seppo Vainio was also one of those unfortunate people who had to share an office with me and be subjected to my constant blabbering – but I have to say, he gave me a true challenge for taking the first spot in being the most talkative in the room! Seppo, you are absolutely hilarious and I love your down-to-earth attitude. Thanks for turning on the light therapy lamp, both metaphorically and in real life. That helped a lot in times of darkness.

Henri Olkoniemi was always there for me during the first few years of my studies, being one of those seasoned PhD students (now postdocs) who gave me advice on so many things, including but not limited to which meetings I should attend, which courses would be most useful, how to use R, who is who, which are the best academic joke sites, how to set up a gym routine (I did not take his advice on this), how to mischievously interrupt people when they are busy, and how to make them laugh and forgive you. I have to admit I clung to him like a baby during the first few years, but he was always very patient and tolerant of me, for which I am extremely grateful. Henri, you instilled in me a feeling that while everyone's PhD journey is unique, there is also a similarity in the psychological side of it that is shared by most of us. I always felt validated and reassured by you, and your support was of great importance to me.

Nils Sandman also served as a prime example of a wise old PhD student – now postdoc. Nils was instrumental in making me feel welcome and teaching me the ropes of PhD student life during the start of my studies (and long after that). You introduced me to awesome people and truly took me under your wing, inviting me to various get-togethers. You organized, among other things, "shadow" PhD seminars where everyone was free to discuss their work in a peer group without supervisors. I really admire your gentle, elegant, and amicable personality, as well as your passion for science and your adventurous side that takes you on trips around the world. Thank you for all the stories and laughs we have shared, and for always being there to tell me what would happen next – you were always correct, and that advice was always needed.

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no wonder to me that your whole family is as awesome as you are. I'm deeply grateful to your wife Irene for all the long walks and bike rides, and the even longer discussions about the psychological underpinnings of life. They have meant the world to me during this process.

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What did I learn from all this, then? I learned that doing a PhD really is an emotional journey that is hardly ever smooth sailing from start to finish. I learned a

great deal about humility and perseverance. I learned what it means to struggle, but I also learned that one is always stronger than one thinks, and never alone. I learned how to role-play an engineer when trying to figure out how to use various pieces of lab equipment. I learned how to understand statistics a little bit better. I learned how to write scientific papers. In short, I became a less unruly, more disciplined pupil of academia. Ultimately, though, most of my key memories of this part of my life are about the people I met and the adventures I had. I could never have had those experiences elsewhere, or with other people. Hopefully, this personal odyssey will contribute to science as well, at least a little bit. Maybe I will eventually become a true scholar, someone like Agricola, instead of one of his pupils. If not, I will settle for being a cheerful student endlessly seeking knowledge just for the joy of it.

Congratulations to everyone who made it through all this self-indulgent sentimentality, and my deepest apologies to those who I forgot or was too shy to mention. Happy reading.

Turku, 2 May, 2023
Suvi K. Holm

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List of Original Publications

This thesis is based on the following original peer-reviewed publications, referred to in the text by their Roman numerals I-III.

I Holm, S. K., Häikiö, T., Olli, K., & Kaakinen, J. K. (2021). Eye movements during dynamic scene viewing are affected by visual attention skills and events of the scene: Evidence from first-person shooter gameplay videos. *Journal of Eye Movement Research, 14*(2), Article 3. https://doi.org/10.16910/jemr.14.2.3[1]

II Holm, S. K., Kaakinen, J. K., Forsström, S., & Surakka, V. (2021). Self-reported playing preferences resonate with emotion-related physiological reactions during playing and watching of first-person shooter videogames. *International Journal of Human-Computer Studies*, *155*, Article 102690. https://doi.org/10.1016/j.ijhcs.2021.102690[1]

III Holm, S. K., & Kaakinen, J. K. (2021). Game dynamics preferences are connected with experiences derived from first-person shooters. *2021 IEEE Conference on Games (CoG)*. https://doi.org/10.1109/CoG52621.2021.9619138[2]

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[2] © 2021 IEEE. Reprinted, with permission, from Holm, S. K., & Kaakinen, J. K., Game Dynamics Preferences Are Connected with Experiences Derived from First-Person Shooters, IEEE Conference on Games (CoG), August 2021.

1 Introduction

Let us imagine the following scenario. Two friends are playing a war-themed video game for the first time – one playing, one watching. As blood splatters from their enemies, the person playing the game grins just as their friend shudders in horror. Eventually, the players' character dies. "That was awesome!" says the one who played with a smile. "That was horrible!" says their friend. Both seem to be at odds as to why the other reacted the way they did.

While it is commonly known that players have different preferences when it comes to video games, the phenomenon has not been researched extensively so far. Some of the questions that need answers include, for example: Do players experience a particular game in the same way if they say they like the same content? If they say they like different content, does this show up as differing responses? How does the playing experience differ from just watching the game? As the effects of playing may be different for different subgroups of people, these questions are important when scrutinizing evidence of the psychological pros and cons of video games. They are likewise relevant from a user experience point of view when designing and marketing games. Importantly, answering these questions is also rewarding for players themselves, as the results can help foster discussions about video games.

This thesis aims to shed light on how personal preferences are connected to players' affective responses and experiences of curiosity, vitality, and self-efficacy. The thesis also considers how visual attention skills are linked to video game viewing. As a whole, the thesis aims to advance knowledge on the role of emotions and visual attention in video gaming, with particular focus on first-person shooter games – hereby known as FPS games.

According to The Finnish Player Barometer 2022 (Kinnunen et al., 2022), 80.3% of the Finnish population play digital games at least occasionally, and 65.1% are active players. The popularity of video games calls for a better understanding of the phenomenon. Earlier psychological research has mostly focused on both the benefits (e.g. Bediou et al., 2018; Ferguson, 2007) and risks (e.g. Anderson & Bushman, 2001; Sherry, 2001) of video gaming. FPS games in particular have been of special interest to psychologists because of both their violent content and their visual qualities. In the late 1990s it was noted that these types of games tended to place a particularly strong load upon perceptual, attentional, and cognitive functions, which led to an interest in whether FPS games could train the human visual system (Dale et al., 2020). Moreover, the strong violent content has led into research on the emotional effects of these games, and especially on whether violent games cause aggression (see for example Ferguson, 2007 for a meta-analysis). In short, it seems that most research so far has focused on whether gaming is beneficial or detrimental for the human psyche, but has only more recently begun to explore why people play in the first place and how individuals' playing experiences vary. What this means is that while video gaming has become an established part of everyday life, psychological research is to an extent lagging behind by still wondering whether people should or should not play. Moreover, even though there are plenty of studies investigating the direct visual attention skills and well-being effects of FPS games, the literature is currently not very detailed on moderating factors that might affect these results. For example, studies on individual differences in preferences for violent content and how different individuals tend to visually process games are still emerging.

It is not just playing of video games that has become common. Esports, gameplay streaming, and videos of games in general (such as highlight reels or "let's play" videos) are becoming more and more popular (Burroughs & Rama, 2015; Hamari & Sjöblom, 2017). In fact, watching others play has become a major form of entertainment. For example, Twitch, the leading gaming video streaming service, has over a hundred million regular viewers and a market value of around one billion USD (Woodcock & Johnson, 2019). Live streaming of games has become such a big part of culture that it rivals many television channels and is comparable with traditional sports broadcasts (Woodcock & Johnson, 2019). Some scholars, such as Taylor (2020), have pointed out that gaming has always been a spectator activity, whether games are viewed in the same room with the player or not. Spectating practices and reasons for them vary from spending time with friends, educating oneself about a game, watching competitive eSports, enjoying the personality of the player commentating on a game and so on (Taylor, 2020). Despite the popularity of gaming videos, however, not much is currently known about the psychological factors behind or effects of gameplay video viewing. For example, academic literature is lacking on what types of features viewers focus on while watching gameplay or how viewing compares emotionally to playing games. In this thesis, gameplay video viewing is approached from the perspective of how visual attention skills affect eye movements during viewing, as well as what kind of physiological changes gameplay viewing may lead to. Emotional reactions related to gameplay viewing are also compared to playing in the hopes of giving insight into why playing may lead to certain emotional reactions – for example, what is the role of undertaking actions yourself versus only watching actions happening? This is fruitful for understanding the effect of violent themes in video games, namely whether the violent content itself leads to certain emotion-related responses when playing FPS games, or whether other factors such as the cognitive demands, competitiveness, and hecticness of playing affect these responses (Adachi & Willoughby, 2011). As for eye movements, this kind of basic information is important when trying to build a comprehensive knowledge base on why FPS games might potentially train certain visual attention skills, as studies on eye movements of both players and gameplay viewers are still in their infancy.

The current research is situated at the intersection of psychology and human-computer interaction, more specifically Games User Research, hereby known by its abbreviation, GUR. GUR aims to provide insight for game development, especially from the viewpoint of finding out what constitutes a good player experience (Drachen et al., 2018). Player experience, in turn, is often studied in terms of game enjoyment (Mekler et al., 2014). However, the definition of player experience is somewhat elusive, and tends to include several overlapping psychological concepts (Mekler et al., 2014). In this thesis, I will use a broader definition of game experience and look into attentional, emotion-related, and reflective experiences and reactions. I will use the term game experience instead of player experience because the studies focused on both the playing and the viewing experience. Next, I will look into previous results regarding emotion-related psychological responses to violent FPS games.

1.1 Out for Blood: Psychological Research on First-Person Shooter Video Games

FPS games, as the name implies, involve taking the role of a shooter, such as a soldier. The player has a first-person view of the environment, meaning that they "look through the eyes" of their character instead of seeing the entire playable character. FPS games typically follow a pattern or plot with repeating actions, such as looking for opponents, killing them, and, if successful, repeating the cycle by engaging in further combat (Weber et al., 2009). While there are FPS games that are not violent, most of them have violent content. Because of this violent content, historically the bulk of psychological research on video gaming has focused on FPS games because of a fear that there could be potential repercussions from playing such games.

Violent games have been noted to increase aggressive ideation and actions in real life as well as causing stress responses in players (Anderson & Bushman, 2001; Prescott et al., 2018; Sherry, 2001). Another reported short-term effect of violent video game playing is initial heightened physiological arousal which over time turns into decreased physiological arousal toward violent content (e.g., Carnagey et al., 2007; Staude-Müller et al., 2008). One of the key terms used in these studies is desensitization, a concept which postulates that when players see and carry out aggressive actions in a virtual world, they get desensitized, that is, they no longer react as strongly to aggressive actions in real life. Desensitization is part of the General Aggression Model (Bushman & Anderson, 2002), in which physiological arousal is one of the building blocks of aggressive behavior. More specifically, it is hypothesized that repeated exposure to violent imagery eventually tones down emotional responding. This can be seen, among other aspects, in the attenuation of physiological arousal to violent content over time.

Some researchers, conversely, have critiqued these media effects studies, finding that the effect sizes are small to insignificant or that there might be publication bias for studies that show increased harmful effects (Ferguson, 2007; Ferguson, 2015), or commenting that players are not just passive consumers of video games who get “sucked into” the violence without internal filters. In fact, whole books have been dedicated to the topic of the effects of these types of games on aggression and the ensuing debate (Ferguson, 2018). Recently, a review of meta-analyses concluded that there seems to be a small effect of increased aggression for those who play violent video games (Mathur & VanderWeele, 2019). What is behind this small increase in aggression, on the other hand, is up to debate. Some studies have pointed out that instead of violent content per se, there might be other underlying causes. For example, FPS games tend to be challenging and competitive, and thus cause frustration (Adachi & Willoughby, 2011). Gentile (2016) has attempted to blow the whistle on these video game violence debates by expressing that while video games that incorporate aggressive actions do have a small overall effect on real-life aggression, the phenomenon is very complex and violent video games should not be either vilified or lionized. Instead, Gentile (2016) claims that both proponents and critics of video games have legitimate points but base their results on different methodologies and strands of research.

What is clear from the studies regarding the potential adverse effects of these games is that they carry visceral emotional content that has the ability to create responses such as anxiety, aggression, or frustration. It is likely that these games have historically been of interest to psychological research precisely because of this ability to generate strong emotional responses. While the topic of this thesis is not aggression or the long-term effects of violent video games, I am likewise interested in the emotional responses (both positive and negative) of players and viewers of FPS games. Instead of aggression, this thesis focuses on immediate affect responses during or immediately after playing and viewing an FPS game, as well as on self-reflections about playing. Next, I will give a short description of the game used in the studies presented in this thesis.

1.2 Call of Duty: Modern Warfare 2

The game Call of Duty: Modern Warfare 2 (PlayStation 3 version, Activision, 2009) was used in all of the three studies presented in this thesis. This game represents a typical and popular war-themed FPS. It contains features of interest for the studies presented in this thesis, such as visceral emotional content and a visual environment that strains the attention. For the curious reader, I will describe the missions ("levels") of the game used in the studies in the Appendix. Meanwhile, I will give a short overview of the game itself as well as events that are typical of such FPS games in general.

The game has three modes: single player, multiplayer, and special operations. In the studies presented here the participants played and watched videos of the single player mode, more specifically the campaign or "story mode." In the campaign mode, the world is at imagined war against terrorism in modern times. The storyline of the campaign is about multinational English-speaking forces who try to take down a Russian enemy. The events of the game take place in multiple locations across the world, such as the USA, Russia, and Afghanistan. The campaign mode consists of missions, which can be thought of as "levels" of the game, that is, short chapters with a plot (please see the Appendix for descriptions of the missions used). The campaign mode was chosen in order to have relative stability of the stimulus between participants. What this means is that there are key events that happen regardless of player choices to drive the plot. The player must follow their troop's leader and undertake the tasks they order. The player is assisted by non-playable teammates. When the player dies in the game, they start again from the last completed plot point inside the mission they were currently in. Naturally, even though there is relative similarity in what the players must do, the players also make their own decisions and the non-playable characters act accordingly. Nevertheless, the storyline establishes that a relatively large part of the content is similar across participants.

Besides the story and milieu of the game, one should also note the structural content of these types of FPS games. Väliaho (2014) describes the content of the game's sequel, Call of Duty: Modern Warfare 3 as having a rhythmic structure around episodes of combat and moving around. Modern Warfare 2, the game used in the studies of this thesis, is very similar to this sequel in both its themes and structure. Moreover, there are some typically reoccurring events in FPS games that can be considered in order to further understand the content and structure of these types of games. For example, according to Nacke et al. (2008), the three most meaningful events in an FPS game are the player firing a gun, the player getting hurt, and the player dying. Ravaja et al. (2008) also similarly suggest that the most important events are wounding the opponent, killing the opponent, the player's character being wounded, and the player getting killed. Lang et al. (2013) identify a "Hunting phase vs. killing phase," that is, whether the protagonist is looking for enemies or is engaged in a firefight with them (see also Weber et al., 2009). Besides these events, Lopes et al. (2017) consider the player entering a room to be a key event. Most of the categorizations imply that there seems to be a sort of wave-like tendency, in that players are either in active battle (shooting at enemies or getting shot at), or there is a somewhat calmer stage during which enemies are not present and the player is exploring.

In Study I, a more extensive listing of key events was created to assess eye movements during these events. The final classification consisted of seven events: (1) Advancing (self), (2) Advancing (teammate), (3), Start of firing, (4) Aiming at a target, (5) Protagonist gets hit (bloodied visor), (6) Unexpected salient events, and (7) Change of environment. I will give a short description of these events, as I consider them to be of importance for understanding the content of the game.

During "Advancing (self)," the protagonist (player) moves forward and is not engaged in active battle. Rather, they are looking for enemies, often turning their head to scan the environment. During "Advancing (teammate)," the player does not move but members of their team move toward a new area, running past the player once an area has been cleared of enemies. Both "Advancing (self)" and "Advancing (teammate)" roughly correspond with Lang et al.'s (2013) hunting phase. However, a division was made between these events because they represent different processes in the game and are visually very different. When the player moves, the whole environment is in flux, which is not the case if the player stays put.

"Aiming at a target" is an event in which the player looks through the sight of their gun, which creates a distinct-looking crosshair pattern on the screen. Aiming was almost always followed by shooting, which often led to either wounding or killing the enemy. In the videos in Study I, the player hardly ever fires their gun without aiming, making this event essentially identical with shooting or at least having an intention of shooting the enemy. "Aiming at a target" corresponds to an extent with Lang et al.'s (2013) killing phase, Nacke et al.'s (2008) firing a gun event, and Ravaja et al.'s (2008) wounding and killing the opponent events.

The "Protagonist gets hit (bloodied visor)" event corresponds to some degree with Lang et al.'s (2013) killing phase, Nacke et al.'s (2008) player getting hurt event, and Ravaja et al.'s (2008) player's character being wounded event. During this event, the screen fills with various amounts of blood, and the player flinches and sometimes gets blurry vision for a while.

"Change of environment" corresponds somewhat with Lopes et al.'s (2017) player entering a room event. However, in our classification, these events also consisted of other new environments, such as leaving a house, entering a tunnel, or the like.

"Start of firing" was an event in which the hunting phase (Lang et al., 2013) ended by the player hearing gunshots or seeing movement after a calm period.

Importantly, the battle had not yet been initiated by the player. In this sense, the event did not directly correspond with any of the previously noted events.

Likewise, “Unexpected salient events” was a new category of events that was mainly created because it was expected that visually salient events such as big explosions, blinking screens or large vehicles such as tanks appearing in the scene would affect where visual attention was directed.

All in all, the general content as well as the events highlight that the game contained stimuli that tended to repeat and move in waves. Moreover, the content tended to require switching of attention between the periphery of the screen (such as when spotting enemies) and central locations of the screen (such as when aiming at enemies). The general feeling of the game tended to be hectic as there were multiple enemies and teammates moving about, and there was a constant sense of dread accentuated by sounds of gunshots and yelling. The visual environment was challenging in the sense that the shapes and colors of various objects and characters tended to blend into the background. For example, human characters were dressed in camouflage suits and often took cover behind obstacles. The color tone tended to be either beige (muddy ground, dust, beige buildings) or white-gray (snowy environments, lack of light during winter scenes, industrial-looking gray buildings, smoke). This reflects the efforts to make spotting enemies harder and to represent a realistic environment. For these reasons, the videos can be considered quite straining on the visual attention. Moreover, the game depicts realistic violence and thus the emotional content of the game was well-suited for exploring affective responses and self-reflective experiences.

The game was also chosen because the dynamics of the game tended to be rather specific: it mostly contained violent dynamics such as shooting, killing, and exploding. In contrast, the game did not contain a lot of other types of dynamics, such as taking care of pets, planning and building a city, or dancing. This was important because I was interested in exploring how players with different preferences for particular dynamics would respond to the game. With that in mind, I will next discuss player preferences for game dynamics.

2 Player Preferences

Players' personal content preferences may have a significant effect on their game experience. Violent FPS games contain content that may be distasteful to some players, while others may enjoy participating in such activities. Thus, the game experience of these players may differ completely. In this thesis, I aim to shed light on this matter by examining the relationship between game dynamics preferences and emotion-related responses when playing and watching a game that incorporates violent FPS dynamics.

Players of video games are not a homogeneous group. Instead, there is evidence that players differ in their backgrounds (Griffiths et al., 2004; Terlecki et al., 2011) as well as their preferences for game features and content (Hamari & Tuunanen, 2014). Players also have differences in what kind of actions they tend to take during playing (Ahmed et al., 2014; Bartle, 1996; Drachen et al., 2009), as well as in their personality and motivations (Bateman et al., 2011; Lazzaro, 2004; Nacke et al., 2014; Tseng, 2011; Whang & Chang, 2004; Yee, 2006; Yee et al., 2012). These differences have been explored in studies that focus on identifying player types (Hamari & Tuunanen, 2014). It is assumed that player types have utility for designers who seek to tailor their games or gameful systems (Altmeyer et al., 2020). However, research is still somewhat lacking on how player types affect the game experience as indexed by, for example, the emotion-related physiological responses of players.

Recently, differences in players' game dynamics preferences have been of interest to scholars (Tondello et al., 2017; Tondello & Nacke, 2019; Vahlo et al., 2017). Game dynamics refer to player-game interaction modes (Vahlo et al., 2017), such as killing, dancing, or taking care of pets. In short, dynamics preferences may be appropriated with preferences for particular content the player can act in. In earlier research, the focus was on broader and more complex concepts such as players' personality or motivation (Bateman et al., 2011; Lazzaro, 2004; Tseng, 2011; Whang & Chang, 2004; Yee, 2006; Yee et al., 2012). Instead, in this thesis, I wanted to explore how players' game dynamics preferences were connected to their game experience.

Vahlo et al. (2017) created a game dynamics preference scale that forms the basis of the dynamics preference scale used in the current studies. They went through 700 contemporary digital game reviews to identify various game dynamics that appear in commercial video games. Then, 1,717 respondents answered a survey on how much they preferred the identified dynamics. Exploratory factor analysis was used to classify dynamics preference categories. This resulted in five main types of game dynamics, which Vahlo et al. (2017) coined "Assault," "Manage," "Journey," "Care," and "Coordinate," based on what they thought the dynamics mostly represented. After this, cluster analysis was used to identify player types with differing preferences for these game dynamics categories. Both liked as well as disliked dynamics were considered instead of only preferred ones. Seven main player types were identified: "The Mercenary," "The Companion," "The Commander," "The Adventurer," "The Patterner," "The Daredevil," and "The Explorer."

Vahlo et al. (2018) have since iterated and validated their scale by adding dynamics that were missing and named the new scale "the Gameplay Activity Inventory" (GAIN). Studies II and III utilized further iterations of the GAIN scale (Vahlo et al., personal communication). In Study II, the version of the GAIN scale is reported in its entirety in Appendix 2. The items used in Study III are reported under the Methods section of Study III.

As I was interested in how these game dynamics preferences might affect emotion-related responses to an FPS game, I will next turn to discussing how emotions are conceptualized and measured.

3 Models and Measures of Emotions

Emotions are fast-evolving immediate responses to meaningful internal and/or external stimuli (Ellsworth & Scherer, 2003). While there are several models of emotions, it is generally acknowledged that emotions can be conceptualized as changes in subjective experience, physiology, and behavior (Mauss & Robinson, 2009). Two of the most prominent lines of theories about emotions hold different positions on whether emotions should be considered as dimensional or discrete (Mauss & Robinson, 2009). Proponents of discrete emotions view emotions, such as fear and joy, as having unique physiological, subjective, and behavioral profiles. This theory argues that different emotions are independent from each other (Ekman, 1999). In contrast, proponents of dimensional models contend that emotions should be described on a continuum in a limited set of dimensions, such as valence and arousal (i.e. pleasantness and activation; Bradley & Lang, 1994; Plutchik, 1980; Russell, 1980; Schlosberg, 1952). For example, in one of these dimensional models, the circumplex model (Russell, 1980), being alarmed is represented in a two-dimensional space as an emotion of high arousal and negative valence, whereas relaxedness is described as an emotion of low arousal and positive valence.

Most models note the temporary nature of emotions: they are prone to change (Ellsworth & Scherer, 2003). Emotional reactions are thought of as ongoing processes, in which an initial affect response may be reappraised (Ellsworth & Scherer, 2003), and hence can lead to another emotion. This represents somewhat of a challenge for research, as the time perspective of emotional responses and their evaluations needs to be considered. In a video game context, for example, it has been shown that initial frustration, sadness or other types of negative affect may be thought of as being appreciated and rewarding after playing has ceased and the players have moved onto an evaluation phase (Bopp et al., 2016; Bopp et al., 2018). This sort of awareness and appraisal of initial emotions and the emotions procured after this processing is known as meta-emotions (Bartsch et al., 2008; Oliver, 1993).

When studying emotion-related responses to video games, both initial affect and how emotions develop and potentially affect general well-being have been of interest. Johannes et al. (2022) call for further studies on media effects that evaluate the time perspective of psychological effects. They also note that most effects of media, such as video games, are likely to be observed in the short-term, and particularly in the domain of affective responses.

In this thesis, I will focus on what could be described as short-term effects on emotions. The quantification of emotion-related responses covered the time periods of both during playing and viewing of a video of gameplay and immediately after playing and viewing the video. Next, I will discuss how emotions are typically investigated in human-computer interaction research (such as GUR) from the viewpoint that emotions consist of experiential, behavioral, and physiological components (Mauss & Robinson, 2009).

3.1 Experiential Measures

Experiential measures of emotions in games research typically consist of, for example, responses to questions and scales, as well as think-alouds (Drachen et al., 2018). One commonly used method in emotion research is a pictorial tool known as the Self-Assessment Manikin (Bradley & Lang, 1994), abbreviated as the SAM. It is a pictorial rating scale tool for assessing the valence, arousal, and dominance associated with reactions to various stimuli. In the SAM, responders select an image that corresponds with their experience (Bradley & Lang, 1994). The images are drawn figures that represent humans ("manikins"). For example, in the SAM scale used for measuring valence, the manikins range from a very unhappy-looking manikin to a very happy-looking manikin. The middle figure of the scale represents a rating of a neutral experience; that is, neither unpleasant nor pleasant. The benefit of the SAM is that the tool enables fast rating that is not dependent on language. It is widely used in general, and also used in the context of GUR (Brühlmann & Mekler, 2018; Mekler et al., 2014).

In Studies II and III of this thesis, the participants rated their emotion-related experiences using the SAM. Using this method, I measured the experiential component of emotions especially along two dimensions, valence and arousal. I wanted to explore self-reported valence and arousal because most dimensional theories of emotions contend that emotions can be described on a continuum consisting of these two components (Plutchik, 1980; Russell, 1980; Schlosberg, 1952). Moreover, using the arousal and valence scales of the SAM provided a possibility to compare whether the participants' experiences correlated with their physiological responses, as the physiological measures I used also had to do with arousal and valence. Next, I will turn to discussing how the behavioral component is typically measured in GUR.

3.2 Behavioral Measures

Behavioral measures of emotions consist of, for example, vocal characteristics such as amplitude and pitch, body behavior such as running to avoid something, and facial behavior such as smiling to convey an emotion (Mauss & Robinson, 2009). In short, behavioral measures of emotions can be understood as outward expressions of emotions.

Behavioral measures of emotions as defined by Mauss and Robinson (2009) do not seem to be commonly used when studying the experience of video game players, with the exception of facial expressions, which I will discuss in the next section on physiological measures. However, indirect behavioral measures are utilized to understand what happens during playing to infer why players are feeling the way they are (Drachen, 2015). For example, behavioral data can be acquired from vast populations of players of commercial games using telemetry data and player analytics such as game logs (Drachen, 2015; Drachen et al., 2018). Of interest in these datasets are measures such as progression in the game, time spent playing in-game actions, et cetera (Drachen, 2015, Su et al., 2021). This type of data can then be used to analyze player behaviors that are connected to, for example, frustration (Canossa et al., 2011). There is a further aim to compare behavioral player data such as log files and progression in a game to experiential data such as self-reports of players (Abeele et al., 2020).

In the studies of this thesis, I did not focus on players' behavioral data such as in-game actions, but instead focused on the subjective experiences of the players and viewers, as well as their physiological responses. As Mauss and Robinson (2009) count facial expressions in their classification of behavioral measures, I would like to note that I measured these behaviors using physiological measures. In the next section, I will discuss facial expressions further, along with discussing how the physiological component is typically measured in a gaming context.

3.3 Physiological Measures

There is a growing body of research using physiological measures such as electrodermal activity (EDA), heart rate (HR), and electric activity of facial muscles registered with electromyography (EMG) as indicators of emotion-related reactions during playing of video games (e.g., Christy & Kuncheva, 2014; Drachen et al., 2010; Kivikangas et al., 2011; Mandryk & Klarkowski, 2008; Ravaja et al., 2008). These measures have been shown to correspond with the dimensions of arousal and valence (Ravaja, 2004). In Study II, I used these physiological measures to scope emotion-related responses to playing and viewing a gameplay video.

Facial muscle activation is commonly measured using EMG, in which electrodes are placed on the face on top of selected muscles to record changes in their electrical activity (Bradley & Lang, 2007). Activation of the *corrugator supercilii* muscle is usually interpreted as frowning, indicating negative valence. Activation of the *zygomaticus major* is involved in smiling and thus interpreted as an indication of positive valence (Bradley & Lang, 2007).

As for arousal, the autonomic nervous system controls the amount of physiological arousal (Appelhans & Luecken, 2006). It is generally divided into an excitatory sympathetic nervous system and an inhibitory parasympathetic nervous system (Appelhans & Luecken, 2006). These systems work to regulate the amount of arousal induced by different events – either to up-regulate it or to down-regulate it (Appelhans & Luecken, 2006). Changes in the level of autonomic arousal can be measured from changes in electrodermal activity (EDA) and heart rate (HR) (Appelhans & Luecken, 2006; Dawson et al., 2007). Both EDA and HR can be used as indexes of increases in emotion-related arousal via activation of the autonomic nervous system (Appelhans & Luecken, 2006).

EDA refers to electrical conductance of the skin, which varies according to sweat secretion (Posada-Quintero & Chon, 2020). EDA is typically measured by placing electrodes on the hands or feet, which tend to be places where sweat secretion is sufficient for the measurements (Posada-Quintero & Chon, 2020). The neurological basis of the EDA response is complex, but it is generally agreed to be mostly controlled by the sympathetic nervous system, and to be particularly responsive to emotion-inducing stimuli in an automatic way (Dawson et al., 2007). Increases in EDA activity tend to happen a little bit after encountering an arousal-inducing stimulus, between 1.5 s and 6.5 s (Setz et al., 2009) and then to decrease gradually.

Physiological signals, and in particular the EDA signal, are often segregated into tonic and phasic components (Braithwaite et al., 2015; Ravaja, 2004). Tonic refers to changes in overall state during a longer stimulus, such as an entire playing session. This, in turn, is commonly known as a tonic state or a skin conductance level (SCL) (Braithwaite et al., 2015; Ravaja, 2004). In turn, phasic refers to relatively fast changes linked with a particular stimulus such as an event in a game. This is often called a phasic response or a skin conductance response (SCR) (Ravaja, 2004).

Heart rate (HR) is similarly an index of arousal and autonomic nervous system activation (Appelhans & Luecken, 2006). The cardiovascular system in general is highly susceptible to emotion-related stimuli, and HR is one of the most frequently used psychophysiological indexes of the functioning of this system (Berntson et al., 2007). It is generally agreed that EDA tends to reflect sympathetic responses of the autonomous nervous system, whereas HR is more connected to both the parasympathetic and sympathetic response (Berntson et al., 2007; Dawson et al., 2007). Some gaming scholars have explicated that changes in HR tend to be quicker than with EDA, but also more ambiguous because HR has been connected with many factors that are not strictly emotion-related (such as cognitive effort) during media viewing (Kivikangas et al., 2011; Ravaja, 2004).

Facial muscle activation measures are often combined with measures of autonomic nervous system arousal (EDA, HR). This is because it is thought that facial muscle activation is associated with valence and autonomic nervous system activation with arousal. The advantage of using physiological measures in a gaming context is that they provide a way to record emotion-related responses uninterruptedly during playing or viewing of games. Constantly interrupting players or viewers by asking them to report their emotions may lead to interruptions in immersion when playing, and, in a worst-case scenario, to changes in emotional responses as attention is given to reporting and self-reflection rather than to playing/viewing. Physiological measures are also not prone to socially desirable responding or political correctness, which is an important point when using stimulus material that contains sensitive topics, such as violence (Ravaja, 2004). They are also highly time-sensitive and contain multiple data points, which enables analysis methods that take into account how responses develop and change as time passes (Ravaja, 2004). Given these points, there are also some pitfalls involved in relying solely on physiological responses. One of them is assuming that physiological responses are isomorphic – meaning that one measure corresponds to a particular psychological state such as an emotion one-to-one, which is not the case (Cacioppo & Tassinary, 1990). Instead, physiological responses and emotions are often multiply determined (Cacioppo & Tassinary, 1990). For example, it has been known for a long time that electrical conductance of the skin may be affected by mental effort, respiratory changes, sensory stimuli such as pain, and so on, meaning that a measured change is not necessarily an emotion-related response (Landis, 1930). These problems can be compensated by adding other measures that look into different components of emotion, namely experiential or behavioral measures (Mauss & Robinson, 2009). Because recording EDA, HR, and facial muscle activity has informative utility, physiological reactions to playing FPS games have received accumulating attention in the research literature. I will discuss these results next.

3.4 Physiological Responses to FPS Games

A handful of studies on FPS games have utilized physiological signals as measures of emotion. For example, players have been noted to have phasic physiological responses to different game events, and tonic signals have been used to explore connections between different self-reported emotions (e.g., Drachen et al., 2010; Lang et al., 2013; Ravaja et al., 2006; Ravaja et al., 2008).

Ravaja et al. (2008) studied players’ emotion-related responses to different types of events in a violent FPS game with EMG and EDA recordings. The results showed that violent events induced high arousal as indexed by increased EDA activity. The facial EMG recordings showed somewhat perplexing trends. While some violent events expectedly led to facial muscle activation that communicated negative valence, some violent events did not. Namely, when the players' character died or was wounded, *zygomaticus major* activity increased and *corrugator supercilii* activity decreased, indicating positive valence (Ravaja et al., 2008).

Lang et al. (2013) also studied responses to particular events in an FPS game, focusing on phasic signals. They noted that events that contained violence increased arousal as indexed by players' HR and EDA activity and were rated as positive experiences. Instead, exploring and finding enemies decreased arousal. Lang et al.'s (2013) results thus suggest that arousal fluctuates across different events in an FPS game.

Drachen et al. (2010) chose to focus on tonic long-term averages in physiological signals as they aimed to examine correlations between EDA and HR recordings during playing of FPS games with subjective reports of positive and negative emotions. They noted that low mean HR was correlated with positive emotion and high overall EDA level with negative emotion.

Besides studies that focus directly on FPS games, there is a line of research that focuses on physiological reactions to violent media in general or in combination with playing video games (such as Carnagey et al, 2007; Linz et al., 1989; Thomas et al., 1977; Read et al., 2016; Staude-Müller et al., 2008). These studies aim at detecting desensitization following exposure to violent media. In these studies, participants play or watch violent content and afterwards their physiological reactions to subsequent stimuli, such as violent images or staged violence, are recorded. Thus, the recordings are made only after playing or watching violent media, not during it. While these types of studies have ecological validity for studying effects of media violence, they follow a noncomparable methodology to the studies I carried out and I have thus mostly left these studies out of the scope of this thesis.

3.5 Active versus Passive Participation and the Time Course of Physiological Responses

It is likely that the role of active versus passive participation in video games moderates emotion-related responses. When talking about violent FPS games in particular, it should be acknowledged that games, especially hectic ones, may be stressful because of their pace and not solely their emotional content (Adachi & Willoughby, 2011). This, in turn, can show up in arousal measures. In fact, many factors could affect physiological signals during playing besides emotion-related responses – for example, cognitive effort (Ravaja, 2004). Therefore, there is a need for more information about how the passive viewing of gameplay content differs from participating in it, as passive viewing eliminates some of these factors. Despite the need to distinguish violent content from the act of playing, comparisons between playing and merely viewing a game are still rare.

Two studies have shown that physiological reactions to playing a game are different to merely viewing the game. These studies utilized a methodology in which players first played a game and then rewatched their own gameplay. Ravaja et al. (2006) found that negative game events such as the death of the player's own character in a platformer game induced increased arousal as indexed by EDA, and, curiously, positively valenced facial muscle activation as indexed by EMG recordings. However, when watching a replay of the death event, a negatively valenced emotional expression was noted (as indexed by EMG). Similarly, Kätsyri et al. (2013) found in a brain imaging study that watching a video of the death of the player's own character induced different neurocognitive processes than actually playing through the event.

Based on earlier findings, it is hard to say how only watching a game compares to playing it, as the repetition of watching one's own gameplay is likely to induce different psychological processes than seeing a video that presents new material. At the time of writing this thesis, I could not find studies that compared playing versus viewing a pre-recorded gameplay video. This is problematic in the sense that it is generally assumed that the violent content of certain video games leads to physiological arousal and desensitization (Carnagey et al., 2007; Read et al., 2016; Staude-Müller et al., 2008). Instead, or in addition to this, playing may be physiologically arousing because active participation in the game requires cognitive effort that is not related to violent content per se (Adachi & Willoughby, 2011; Ravaja, 2004). Thus, exploring the differences between playing versus viewing the same violent content could help in understanding the roles of active versus passive participation and give new information about how violent content as such affects emotions. In general, early studies have indicated that adolescents report more arousal related to video game play than to watching TV (Kubey & Larson, 1990), but it is not certain how playing a game compares to viewing a gameplay video. In Study II, comparisons in physiological responses were made directly between playing a game and viewing a pre-recorded gameplay video of the same game to get a glimpse into this phenomenon.

Besides the role of active versus passive participation, another factor that has been largely ignored in the current literature is the time course of physiological responses. Earlier studies on FPS playing have mainly focused on event-related responses or looked at tonic levels of EDA and HR by using a single average over the entire playing session (e.g., Drachen et al., 2010; Lang et al., 2013; Ravaja et al., 2008). However, less is known about how the emotional experience evolves across a longer period of time. Thus, it would be important to look at changes over the entire session by using multiple data points and comparing changes across time. For example, while it is generally known that orientation and habituation to the stimulus may affect physiological data (Ravaja, 2004), the time course is unknown when it comes to games. This is an interesting topic in the sense that hectic games such as FPS games often contain constant new input, which may not show up as traditional habituation. Moreover, violent games have been suggested to cause "numbing" or desensitization; that is, an initial increase in physiological arousal that turns into decreased physiological arousal if one is exposed to violent content over a long time period or for several instances (Bushman & Anderson, 2002). It would be fruitful to gather more information about the proposed time course of this physiological responding. For example, do some players have strong initial responses that fade away over time, in keeping with the desensitization hypothesis (Bushman & Anderson, 2002; Lazarus et al., 1962)? Or do players experience a stable or rising tendency in arousal across time? Moreover, does this ebb and flow in the tonic signal differ between gameplay video viewing and playing? In Study II, I chose a somewhat novel way to explore physiological signals to better understand how physiological responses evolve across time during a playing or viewing session. Namely, I used analysis methods that focused on linear changes in the tonic signals of HR, EDA, and facial EMG across time instead of using, for example, averages of the entire playing session or focusing on event-related responses.

The results regarding aggression and violent video games may lead to an impression that violent games affect users in a universal way. However, there is reason to assume that there is also individual variation in responses to violent content. Next, I will discuss findings relating to individual differences in physiological responses to video games.

3.6 Individual Differences in Emotion-Related Responses to Video Games

While it is known that players report differing preferences, less is known about whether these players have differing emotion-related physiological responses to games. This knowledge would be important for interpreting results about violent video games in particular, as they may have either similar or differing effects for different players.

Early findings such as those by Murphy et al. (1988) found that children reacted differently to a non-violent challenging arcade video game – some children had low physiological reactivity as indexed by low HR and blood pressure (hyporeactivity) whereas other children had high physiological reactivity (hyperreactivity). Results such as these suggest that players not only differ in their self-reports and reflections, but in their physiological responses.

Few studies investigating individual differences have directly touched on FPS games, however, and those that have have mostly compared habitual players of violent video games to habitual players of non-violent video games. For example, Gentile et al. (2016) found that when playing violent video games, those who played them habitually showed suppressed activity in parts of the brain that are involved in processing emotions, something that Gentile et al. (2016) took as a desensitization effect, an attenuation of physiological arousal caused by frequent exposure to media violence. On the other hand, those who were not used to playing violent games showed increased activity in parts of the brain involved in processing emotions. What this particular study highlights is that there seem to be individual differences between players; that is, the same game did not lead to similar responses in all players.

In a similar vein, Ivarsson et al. (2013) recruited adolescent players of violent and non-violent games and had them play a non-violent and a violent game on consecutive evenings. Ivarsson et al. (2013) measured average HR during playing. They found that those players who were not used to playing violent games tended to have elevated average HR during playing of violent games as compared to their average HR during non-violent games. In contrast, players who were used to violent games did not have a difference in average HR when playing violent compared to non-violent games.

I was interested in whether individual differences in game dynamics preferences would moderate emotion-related physiological responses when viewing and playing FPS games. Besides emotions, I was also interested in broader self-reflections of players that might affect motivation and thus the game experience. Next, I will discuss some psychological concepts related to motivation that could be key for the game experience.

4 Motivational Factors Associated with Video Game Play

There is accumulating evidence that playing video games not only leads to short-term emotion-related responses, but may affect broader psychological functioning, such as recovery processes and psychological well-being in general (Reinecke, 2009a; Reinecke et al., 2011). Because of this, academic research on video games is more and more concerned with broad psychological concepts such as the motivations and self-reflections of players.

A great deal of the research on the psychology of video game playing has focused on why people play – that is, motivational factors associated with playing. These motivations often revolve around fun, pleasure, excitement, entertainment, challenge, competition, or social factors such as interaction with others, belonging to a group, or impressing others (Chou & Tsai, 2007; Chumbley & Griffiths, 2006; Colwell, 2007; Connolly et al., 2007; Ferguson & Olson, 2013; Greenberg et al., 2010; Griffiths & Hunt, 1995; Griffiths et al., 2004; Karakus et al., 2008; King & Delfabbro, 2009; Lucas & Sherry, 2004; Sherry et al., 2006; Xu et al., 2012; Yee et al., 2012). In general, Lucas and Sherry (2004) note six key motivations for playing: competition, challenge, social interaction, diversion, fantasy, and arousal. Abeele et al. (2020) summarize motivational reasons for video game playing into three main categories: self-regulation and need satisfaction, gratifications sought and obtained, and hedonism. When looking directly into the game experience, IJsselstein et al. (2007) recognize flow and immersion as some of the most commonly used psychological concepts in video game research, indicating that they are considered important for the playing experience. Experiences of flow and immersion during playing may in turn provide a rewarding experience that motivates people to start playing or continue playing. When it comes to FPS games in particular, the most committed players of multiplayer online FPS games tend to name challenge and competition as their main motivations, and social interaction motives predict time spent playing (Jansz & Tanis, 2007).

Besides gaming being motivating as such, some scholars have expressed views that gaming may sometimes serve as a coping mechanism or self-regulation method for controlling stress or negatively perceived mood, or to compensate for psychosocial or personal issues (e.g., Colwell, 2007; Ferguson & Olson, 2013; Funk et al., 2006, Longman et al., 2009; Olson, 2010; Reinecke, 2009a, 2009b). This may be because games offer a sense of control over one's actions (Klimmt et al., 2007; Vorderer et al., 2003) and potential for achievement (Funk et al., 2006), besides the noted motivational factors of, for example, providing fun.

Another often expressed view is that games may answer psychological needs of players (Przybylski et al., 2010; Wan and Chiou, 2006; Yee, 2006). More specifically, games are thought to satisfy real-life needs for competence, autonomy, and relatedness (Przybylski et al., 2010).

What is clear from all of the aforementioned studies is that gaming likely has an effect on more than just short-term affect. Video game playing includes various components of motivation, well-being, and need satisfaction, and may thus affect perceptions of well-being overall. I wanted to include measures in my studies that would also grasp these broader reflections related to playing that happen slightly later across time than initial emotion-related reactions during playing. Moreover, I wanted to acknowledge that game content and dynamics vary vastly between different genres and games, and players may also influence the content by their selections, thus creating an environment that answers to their personal needs. Because of this, I wanted to look into preferences for game dynamics as well, and to see how they relate to motivational factors. In addition to the formerly discussed motivations, there is evidence that curiosity, vitality, and self-efficacy may be central factors to gaming motivation. In Study III, I explored associations between game dynamics preferences and these three motivational concepts both in life in general and in a playing context. Next, I will discuss these concepts in more detail.

4.1 Curiosity, Vitality, and Self-Efficacy

Motivational experiences of curiosity, vitality and self-efficacy may alter before and after playing and affect how motivating games are. Moreover, the interplay between player preferences and game content might affect the game experience as indexed by curiosity, vitality and self-efficacy. Previously, changes in similar measures before and after playing have been explored by Ryan et al. (2006), who focused on changes in vitality, state self-esteem, and mood. Ryan et al. (2006) found that vitality was sapped by playing, but the players' mood stayed rather stable, and there were mixed effects on self-esteem. The players' competence and autonomy affected the outcomes. Namely, those who expressed more competence (a close relative of self-efficacy) and autonomy had more positive outcomes after playing as opposed to those who did not, indicating that the role of individual differences in background variables might be important for psychological outcomes (Ryan et al., 2006).

In Study III, I measured trait vitality, curiosity and self-efficacy before and after playing. Importantly, I asked about these experiences related to the participants' everyday life as well as related to when they were playing. This is because I had reason to assume that people would have a different experience of these concepts in the context of a game world than in the real world. Curiosity, vitality, and self-efficacy are emerging topics because they have potential to shape the game experience and its motivational outcomes. Next, I will discuss what these concepts are and how they are related to game experience and motivation.

Curiosity refers to the desire to seek out novelty and challenge, and has been regarded as a method for personal growth (Kashdan et al., 2004). Curiosity is also a core motivational mechanism for increasing intrinsic motivation (Ryan & Deci, 2000). In short, curiosity "pushes" a person to carry out new and perhaps challenging tasks, which may lead to advancement in many psychological processes. Games largely consist of both challenges and novelty, which may be reasons many players want to play them (Sherry et al., 2006). Games also contain a safe environment to be curious and explorative – while the player still remains physically free from real danger. When playing, people can take on new roles (Bessière et al., 2007), try new actions they would not perform in real life (Sherry et al., 2006), and explore the game world for hidden items and places (Vahlo et al., 2017). There is also a theoretical claim that video games can cater to at least five types of curiosity: 1. Perceptual curiosity such as observing items and exploring areas, 2. Manipulatory curiosity, which refers to manipulating and understanding objects in the game world, 3. Curiosity about the complex or ambiguous, for example, actions that have multiple consequences, or other players who may act in various unpredictable ways, 4. Conceptual curiosity such as information-seeking or creating a mental model of a topic, and 5. Adjustive-reactive curiosity such as finding out how everyday objects work in the game environment (To et al., 2016). Schaekermann et al. (2017) developed a scale for measuring various components of curiosity in the context of digital games in particular. These different components of curiosity were connected to players' behaviors in an FPS game, further giving evidence that curiosity is a meaningful topic to explore in the context of games. Kumari et al. (2019) noted that curiosity tended to be a particularly essential motivation for players to continue playing in moments of uncertainty, and that the uncertainty that feeds curiosity is a key feature of playing. However, studies directly comparing curiosity before and after playing are scarce. Even though games have been manipulated to foster more curiosity in the player (Togelius et al., 2007), and there have been attempts to test whether these manipulations affect enjoyment (Yannakakis & Hallam, 2007), not much direct evidence is available about whether games create an environment in which curiosity tends to be higher than in real life. Because of this, curiosity before and after playing was measured in Study III to explore how susceptible it is to change as a product of playing. I used The Curiosity and Exploration Inventory-II scale (Kashdan et al., 2009), which measures how willing a person is to seek out novel experiences and to enjoy unpredictable situations. The scale contains items such as: “Everywhere I go, I am out looking for new things or experiences.”

Vitality refers to feelings of energy and of being alive. As violent FPS games are infamous for being fast-paced and emotionally arousing (Anderson & Bushman, 2001; Carnagey et al., 2007; Staude-Müller et al., 2008), they may induce an elevated state of energy or alertness. If thought of from a positive perspective, this intense emotional experience may increase vitality. There are some studies that have looked into self-reported vitality or similar concepts in a gaming context. For example, Reinecke et al. (2011) explored satisfaction of recovery needs after a cognitively straining task. By satisfaction of recovery needs they meant experiences such as relaxation and control that occur after a cognitively challenging task when an individual is recovering. This recovery can happen during, for example, passive rest, active media use, or another activity that is unrelated to the task. In Reinecke et al.’s (2011) study, the participants either played a video game, viewed a video of it, viewed an animated film, or simply rested. Reinecke et al. (2011) found that the satisfaction of recovery needs via these activities had a relationship with energetic arousal. Enjoyment of the activity, such as game enjoyment, mediated this relationship between satisfaction of recovery needs and energetic arousal. Tyack and Wyeth (2021) had participants play a game which was manipulated in such a way as to either support or thwart autonomy. After this, the participants filled out a vitality scale. They then played another game that was aimed at supporting autonomy. After the second game, they again answered the vitality scale. Those who first had their autonomy thwarted experienced improvements in vitality after playing the second game, indicating a restoration of vitality. Those whose autonomy was already supported by the first game showed no change in vitality as a product of playing the second game. Another notable study by Przybylski et al. (2009) showed an increase in players’ reports of post-play energy, but only if they had a so-called “harmonious passion” for playing. Harmonious passion meant that their playing was not problematic; that is, the participants wanted to play instead of having to play. However, those who had “obsessive passion” for playing reported reduced post-play energy. These studies’ results hint that vitality can be influenced by individual differences in being inclined to be positively affected by games – either by enjoyment, situational factors such as depleted autonomy, or by other motivational factors such as an obsessive/harmonious attitude toward playing. Something that is left to uncover is whether a similar phenomenon might present also as a function of game dynamics preferences, as whether one likes the content of the game is likely to affect motivation and the psychological gains received from playing. In Study III, I used a modified version (Bostic et al., 2000) of The Subjective Vitality Scale (Ryan

& Frederick, 1997), which measures feelings of energy and of “being alive.” The scale contains items such as: “Sometimes I am so alive I just want to burst.”

Self-efficacy means one’s belief in one’s capability to successfully perform a task (Bandura, 1997). It is a key motivational factor for playing, as game enjoyment has been noted to be affected by the player’s self-efficacy (Trepte & Reinecke, 2011). This may be because many games essentially consist of challenges and goals, and the player controls the events that are happening in the game to their best ability through their own actions (Klimmt et al., 2007; Vorderer et al., 2003). Self-efficacy as a concept is related to other similar concepts that have been studied in a gaming context. For example, it comes close to perceived difficulty, and players have been noted to have high enjoyment when a game’s difficulty level is low and player performance is at its best (Klimmt et al., 2009). Another concept that is similar to self-efficacy is competence, which has been studied extensively as part of the Self-Determination Theory model (Deci & Ryan, 2013; Ryan & Deci, 2017), which has become a well-established paradigm in games research (Tyack & Mekler, 2020). The Self-Determination Theory posits that there are three key needs that affect motivation and well-being: autonomy, competence, and relatedness (Deci & Ryan, 2013; Ryan & Deci, 2017). Of relevance here is competence, which resembles self-efficacy. It is generally acknowledged that feelings of competence are pivotal for game enjoyment (for example Tamborini et al., 2010). Adolescents have reported that one key motivation for playing games is the sense of achievement playing gives, as well as how that achievement affects feelings of competence and self-confidence (Funk et al., 2006). When it comes to violent games in particular, it has been noted that they may make some players feel powerful and effective (Klimmt, & Hartmann, 2006), concepts that resemble self-efficacy. In Study III, I used The General Self-Efficacy Scale (Schwarzer & Jerusalem, 1995) to measure the participants’ perceptions of working through difficult or novel situations with confidence. The scale contains items such as: “I can solve most problems if I invest the necessary effort.”

In Study III, I was interested in whether experiences of curiosity, vitality, and self-efficacy indeed differ between real life and when playing, as there are theoretical indications that they might. Moreover, I was particularly interested in whether game dynamics preferences could affect these experiences. Next, I will discuss the final area of interest in this thesis: visual attention and how it affects viewing of gameplay videos.

5 The Role of Visual Attention in First-Person Shooter Games

While violent FPS games have become somewhat notorious in psychological research, there is also a more recent line of research that focuses on positive effects of these games. Namely, it has been noted that FPS games may benefit some cognitive functions such as visual attention (Bediou et al., 2018; Ferguson, 2007; Green & Bavelier, 2007). It has been noted that expert video game players tend to be better than novices at a number of visual cognitive skills to begin with (Boot et al., 2008), and that video game training of novices may induce improvement in such skills (Feng et al., 2007). Because of the noted beneficial effects for visual cognition, recent research has even started looking into whether FPS games could be used for cognitive rehabilitation (Griffiths et al., 2017; Toril et al., 2014). However, there is some debate over whether the noted positive effects of action video games are overestimated. For example, some scholars have expressed concerns over possible publication bias (Hilgard et al., 2019), and small effect sizes (Sala et al., 2018). Nevertheless, it is important to note the substantial rise in studies investigating action video games' effects on visual cognitive skills. What this points out is that many scholars view action video games as a complex visual environment that might strain and thus train the visual system.

One particular area where skill differences and training effects have been found is visual attention. Visual attention refers to what a person is paying attention to in the visual field, which is often but not always indicated by what they are looking at (Boot et al., 2009; Carrasco, 2011). Visual attention is guided by two processes: top-down and bottom-up attention (Carrasco, 2011; Desimone & Duncan, 1995; Posner, 1980). Top-down attention is defined as goal-oriented attention in which a person selectively focuses their attention on particular features, locations, or objects in their environment. In contrast, bottom-up attention refers to stimulus-driven attention directed at features or objects that "pop up" by their distinctiveness, such as flashing lights or other visually salient phenomena. These two types of attention are understood to be independent of each other (Pinto et al., 2013). Top-down attention is sometimes referred to as "endogenous," as in controlled by the person themselves, and bottom-up as "exogenous," to highlight that it is not necessarily under voluntary control (Carrasco, 2011). The time course of both of these processes is also different. Bottom-up processes are typically rapid and appear early on, whereas top-down processes are usually slower or refer to sustained attention (Carrasco, 2011). Attentional targets are selected on the basis of a combination of bottom-up (local features) and top-down (global features) processes (Torralba et al., 2006). According to the Contextual Guidance Model (Torralba et al., 2006), local features such as low-level saliency and global features such as scene context are processed in parallel, and they affect each other in a feed-forward fashion. Thus, there is a constant interplay of bottom-up and top-down processes in visual attention.

The control of both top-down and bottom-up visual attention processes is known to be affected by playing action video games such as FPSs (Bediou et al., 2018; Feng et al., 2007; Green & Bavelier, 2006; West et al., 2008). This is likely because action video games such as FPSs tend to be hectic, require sustained attention for spotting enemies and keeping track of teammates, and involve constant turning, navigation, and aiming at targets. In addition, these games often require visual searching in an environment that has low contrast between objects, especially when games emulate war scenes in which buildings are in ruins and the enemies wear camouflage suits. Thus, games such as FPSs are likely to strain visual attention, affecting both bottom-up and top-down processes. For example, Bediou et al. (2018) found in their meta-analysis on multiple cognitive skills that playing was associated with better top-down visual attention. Besides this, active video game players tended to have enhanced bottom-up processes, too. Multiple studies have shown that active video game players have improved target detection; that is, they are more likely to attend to visual targets that others might miss, and also from a wider area of the screen (Feng et al., 2007; Green & Bavelier, 2006; West et al., 2008). For example, Green and Bavelier (2003, 2006) have found evidence that active action video game players tend to be better able to see any presented stimuli, including distractors, from the periphery. Interestingly, under high cognitive load they change their viewing strategy and concentrate more on the center of the screen than participants who are not active video game players, indicating that they are better able to allocate their attention according to the attentional requirements of the game. Chisholm et al. (2010) likewise suggest that active players are better able to let go of irrelevant stimuli and continue their visual search. These results indicate that while active video game players detect targets that others do not, they are also better at controlling their attention.

Because of these noted differences in visual attention skills, I was interested in exploring how such skills might affect the game experience. Despite the multiple findings that visual attention skills are connected to playing, studies on what people actually focus on during video game playing or watching are still scarce. In short, we do not know much empirically about what in the games draws visual attention, even though we know that games may enhance visual attention skills. What this means is that there is a lack of basic research on games as visual stimuli. Some questions that could be explored in more detail include the following. What is the role of specific visual attention skills for playing or viewing a video game? How do different aspects of visual attention affect the game experience? Is it possible to detect changes in visual attention during playing/viewing of video games? If they can be detected, what kind of special features do games involve that might drive attention in a particular way?

In sum, the way visual attention has been previously researched in association with action video games such as FPS games has mainly focused on interventions measuring visual attention skills and then looking into whether these skills improve across time after the player has been exposed to several training sessions with games. Another way that this topic has been handled includes measuring skills, namely, exploring pre-existing differences in skills between players and non-players of these games. However, much less is known about how visual attention actually shows up when viewing a game. Even less is known about the roles of specific visual attention skills in how game material is viewed. In this thesis, I focused on this topic by using eye movements as an index of visual attention during gameplay viewing. I compared the eye movements of viewers with differing visual attention skills to see how specific skills affect the way attention is directed during viewing. Next, I will discuss what eye movements are and how they can be used to measure visual attention.

5.1 Eye Movements as Indexes of Visual Attention

Visual attention in action is often explored through studying eye movements. Human vision consists of high acuity foveal vision, more blurry parafoveal vision, and the least-clear peripheral vision (Henderson, 2003; Rayner, 2009; Tatler et al., 2011). What this means is that human vision is clear only in the center of where one is looking and gets blurrier toward the edges of the visual field. Because only part of the visual field can be perceived clearly, people need to make eye movements in order to direct the high acuity foveal vision to locations that they want to inspect with full clarity (Henderson, 2003; Rayner, 2009; Tatler et al., 2011). Fixations are cessations in eye movements during which the eyes stop to observe a certain point in the visual field (Rayner, 2009). Conversely, saccades are movements of the eyes when they are in motion to look at another point (Rayner, 2009). During saccades, the eyes move very rapidly and acquisition of new information is mostly suppressed (Rayner, 2009). Eye movements can be tracked unintrusively and reliably via a special type of a camera (Poole & Ball, 2006).

Measurements of eye movements are commonly used to study attention during visual tasks because looking at objects tends to be a sign of overt attention toward them (Rayner, 2009). It should be noted, however, that parafoveal or peripheral vision is sometimes enough to determine what an object is, even if it is a bit blurry (Pollatsek et al., 1984). Hence, eye movements need not necessarily be directed overtly to points of interests, even if they generally are. In fact, sometimes people utilize what is known as covert looking; that is, using peripheral vision intentionally even though it is less sharp than foveal vision (Boot et al., 2009). This can happen for multiple reasons, such as when trying to search for a target amidst multiple distractors under time pressure (Boot et al., 2009).

I will next discuss eye movements during scene perception. In this thesis, the word scene refers to naturalistic images, such as a picture of a forest (as opposed to, for example, text material or abstract computer art). While I used videos as stimuli in Study I, I will first explain some general phenomena related to static scene viewing, as the study of visual attention in scene perception is rather complex.

5.2 Eye Movements During Scene Viewing

Both bottom-up and top-down attention drive the selection of fixation targets during scene viewing (Torralba et al., 2006). Bottom-up cues such as visual saliency and low-level features capture attention and predict where fixations will land, even to the degree that computer models can be created that predict with fairly good accuracy which parts of a picture will be looked at (Borji et al., 2019). The most important saliency features known to grab attention are object color, motion, orientation, size (Wolfe, 2000), and the edges of an object (Henderson, 2003). It has been shown that target objects that differ from other objects in these salient low-level features tend to "pop up" and are detected rapidly (Treisman & Gelade, 1980). However, visual saliency tends to be overridden by the meaningfulness of the stimuli (Henderson, 2003; Henderson et al., 2019; Rayner, 2009; Tatler et al., 2011). Most of the time, viewers fixate on meaningful or informative parts of the scene and do not necessarily scan the scene completely (Henderson, 2003; Rayner, 2009).

Besides these general rules, there are other phenomena particular to scene viewing, and many of these have to do with the time course of eye movements. For example, it is known that viewers can gather an overall impression of what a scene contains in the first couple of fixations or even a single fixation, meaning that parafoveal and peripheral vision is mostly used in the early stages of processing (Rayner, 2009, Henderson, 2003). After this initial "gist," eye movements tend to occur in two serial stages: ambient (global) and focal (local) (Trevarthen, 1968).

The ambient stage consists of short fixations and long saccades as people scan the image to make sense of it. Following the scanning, which usually lasts for only a few seconds, the focal stage emerges. During this stage, fixations become longer and saccades shorter; that is, the gaze tends to stay more fixated within a smaller area

(Pannasch et al., 2013; Unema et al., 2005). The effect of fixations becoming longer and saccades getting shorter as time passes during static image viewing has been reported in various studies (e.g., Antes, 1974; Buswell, 1935; Friedman & Liebelt, 1981; Karpov et al., 1968). Importantly, the ambient stage of visual inspection shares similarities with bottom-up processing, in which global orientation is controlled by the saliency of the stimuli (Pannasch, 2014). In contrast, during the focal stage of visual processing, top-down control is exerted as certain parts of the stimulus material are inspected in detail (Pannasch, 2014). One reason for why the ambient-to-focal tendency happens might have to do with the fact that many scenes contain smaller local environments which are nested within the larger scene (Castelhano & Krzyś, 2020). For example, a scene of a room might contain an aquarium, which is its own environment with its own content. Viewers tend to first focus on the larger scene context before moving on to study subregions of the scene (Castelhano & Krzyś, 2020).

So far, I have discussed visual perception in relation to static scene viewing. In sum, I have explained that there are several cues that drive visual attention – both internal in the sense that the viewer controls attention, as well as external, such as when visual features of the scene "pop up" and drive attention whether the viewer intends it or not. There are also processes that can be observed over time – for example, viewers tend to first scan the scene (ambient processing) before proceeding to focus on details (focal processing). In dynamic scene perception, such as when watching movies, some of these rules of thumb apply, but there are also differences between static and dynamic scene perception (Tatler et al., 2011). I will next focus on the particulars of visual attention during dynamic scene viewing, such as gameplay video viewing.

5.3 Eye Movements During Dynamic Scene Viewing

Much less is known about the viewing of dynamic scenes than static scenes (Rayner, 2009; Tatler et al., 2011). This has to do with the complexity of the stimulus. Long dynamic scenes such as movies contain many visual properties and spatial relationships which may include movements, transitions between cuts, and actions (Levin & Baker, 2017). Needless to say, the processing and interpretation of such scenes can be far more complex than inspecting just one picture. However, some general phenomena about dynamic scene viewing are known.

One key feature that differs between static scenes and dynamic scenes is that dynamic scenes often contain events that in a way divide the dynamic scene into segments (Eisenberg & Zacks, 2016). Interestingly, the ambient-to-focal processing tendency noted during static scene viewing also shows during dynamic scene perception, and is present during starts of events, scene onsets and cuts – namely, when something new happens (Eisenberg & Zacks, 2016; Pannasch, 2014; Smith et al., 2006). Because of this, I was interested in whether this phenomenon shows up in eye movement patterns during watching of FPS material, as they contain recurring distinct events.

Another key feature of dynamic scene perception is that viewers tend to fixate much more on the center of the scene than viewers of static scenes (Dorr et al., 2010; Smith & Mital, 2013). This relates to the fact that dynamic scenes move and there is a chance of missing information if one focuses too much on details in the periphery. This is particularly true for fast-paced material, such as FPS games, which present a "blink and you will miss what happened" scenario. The center of the screen is a natural fixation point as it is an optimal location for seeing the "gist" of the scene quickly (Henderson, 2003; Rayner, 2009) by using parafoveal or peripheral vision to determine what objects in the periphery might be (Pollatsek et al., 1984). This is because distances to different locations of the screen are more or less equal.

During dynamic scene viewing, most viewers tend to gaze at the same objects of the scene, indicating attentional synchrony between viewers (Mital et al., 2011; Smith & Henderson, 2008). These objects tend to be either informative or particularly visually salient. The fixation objects that attract attention in movies, edited video clips, and natural scenes tend to be those that move or flicker (Carmi & Itti, 2006; Le Meur et al., 2007; Mital et al., 2011; Smith & Mital, 2013). This is likely because motion is both visually salient as well as often being a source of information. In a war scene, for example, it is informative to notice that a grenade is being tossed somewhere nearby, or that an enemy soldier appears in the periphery. Human motion in particular is something that instinctively draws the gaze (Smith & Mital, 2013). This may be because people often move in dynamic scenes (Smith & Mital, 2013), but also because perceiving other people's behavior is likely informational. Some of the informativeness may come from ethological importance for survival – human beings are social in nature and are attuned to social cues. Moreover, movies usually rely on acting to drive the plot, increasing pressure to focus on actors. Because of this social pull, viewers tend to look at people more often than at objects that are just visually salient (Rubo & Gamer, 2018).

In sum, understanding what drives visual attention in dynamic scene perception is complex and research on the topic is still emerging. For the sake of brevity, I have introduced some key factors that capture attention, the most important ones being movement and human beings. Moreover, I have noted that viewers tend to have attentional synchrony when viewing dynamic scenes and that they tend to focus more on the center of the scene during dynamic than during static scene perception. I also briefly discussed how the ambient-to-focal eye movement pattern is present in dynamic scene perception, and how it is related to new information such as event boundaries.

Most studies about eye movements during dynamic scene viewing have focused on movies and naturalistic scenes. To my knowledge, there are no eye tracking studies that have utilized gameplay videos to study the mechanisms of dynamic scene perception. More information about the specifics of gameplay viewing is needed, as gameplay videos have become increasingly popular (Burroughs & Rama, 2015; Hamari & Sjöblom, 2017). One thing I was particularly interested in was whether individual differences in visual attention skills would show up in eye movements. This interested me because individual differences might affect the game experience. For example, some players or viewers of FPS games might find following the game quite easy, whereas others might struggle to make sense of the game. Next, I will give a short description of previous studies that have looked into eye movements during video game playing and viewing.

5.4 Eye Movements During Video Game Playing and Viewing

The use of eye tracking to study video games academically is still in its infancy, especially for commercial FPS games. However, some recent preliminary studies have focused on eye movements of FPS players in particular (Choi & Kim, 2018; Dahl et al., 2021; Koposov et al., 2020; Smerdov et al., 2020; Velichkovsky et al., 2019). What unifies these preliminary studies is the intention to explore how eye movements vary across players' skill or experience levels, and many of the studies have focused on comparing professional players to novices. Importantly, the results indicate that there is indeed variance in eye movements between individuals of different skill and experience levels, even to the point that machine learning algorithms have successfully managed to predict from players' eye movements whether they are a professional player or an amateur (Smerdov et al., 2020). Interestingly, those who are more skilled tend to have more varied eye movement patterns in general, whereas less-skilled players have more stable eye movement patterns in terms of fixation locations, fixation durations, and saccadic latencies (Koposov et al., 2020; Velichkovsky et al., 2019). Moreover, experts tend to focus on more informational parts of the screen than novices, and to move their gaze in a different order to novices (Choi & Kim, 2018). The results overall indicate that skilled players are able to shift their attentional strategy to fit the needs of the game. Recently, a study on a strategy game has offered similar results to these preliminary FPS game studies. Namely, Jeong et al. (2022) note that expert players of the strategy game Starcraft have a wider gaze distribution, a larger ratio of saccades, and shorter fixation times than players who are less skilled. They also attend to informational parts of the screen that low skill level players rarely look at.

While the results on eye movements of FPS players are intriguing, all of the presented experiments are underpowered, with the typical N of participants ranging from four to ten in each comparison group. This problem also pertains to other studies that have focused on eye movements in gaming in general, not just FPS games. Most published studies on eye movements when playing typical entertainment games consist of case studies or studies with only a handful of participants, although there has been a recent push for more rigorous studies. Almeida et al. (2011) summarize the use of eye tracking and video game material in academic research as consisting mostly of studies that have used eye tracking and eye gaze as an input for video games, sometimes known as gaze interaction. Almeida et al. (2011) also identify some preliminary studies that have focused on eye movements during playing of video games, but these studies were likewise underpowered, with the number of participants in comparison groups ranging from 6 to 12. Since Almeida et al.'s (2011) summary, however, there has been a growing interest in eye movements in video games, with eye tracking conferences such as ETRA hosting workshops dedicated to eye tracking in games and play (Burch et al., 2022). Moreover, game developers and esports teams have started to utilize eye tracking inventions, hinting at its possible utility. In addition, theoretical short papers discussing how eye tracking might be beneficial to game scholars or designers have started appearing recently. For example, Burch and Kurzhals (2020) note several possible ways to utilize eye tracking in games, such as analysis of gaze data post-play to understand what players pay attention to.

Recently, eye tracking has also been used to study both VR games and two-dimensional educational games (e.g., Kiili et al., 2014; Ninaus et al., 2020; Rappa et al., 2019). These types of studies are typically intended for game design purposes, as they may inform designers about which elements of the game users pay attention to, as well as what separates good learners from poor learners, for example. The rising popularity of utilizing eye tracking in a VR context likely has to do with the availability of integrated models of VR glasses that include eye trackers. However, both the complex VR environment and the typically rather simple visual appearance of two-dimensional educational games present a vastly different visual environment to commercially prominent entertainment games such as the FPS game utilized in the studies of this thesis.

Despite the recent interest in utilizing eye tracking in a video game context, no studies to my knowledge have focused on the role of visual attention skills in eye movements during playing or game spectating. While there are many studies on the training effects of action video games on visual attention (e.g., Bediou et al., 2018; Green & Bavelier, 2006; Feng et al., 2007; Ferguson, 2007), studies about how specific visual attention skills present during playing or gameplay viewing are scarce. Thus, even though it is implied that there are visual features in FPS games that could train visual attention, not much is known about how visual attention skills are actually showcased when playing or watching video game material. One way to study this is to look at eye movements during FPS spectating, which is what I did in Study I. In this sense, my idea was to turn the more traditional research trend the other way around and to first look at the ways in which some of these visual attention skills show up when viewing FPS games, instead of whether the games affect these skills. I chose gameplay video viewing as I wanted to focus in particular on visual attention, and thus to avoid possible interference coming from the act of playing, such as the additional cognitive load of controlling the protagonist in the game.

Next, I will go through three skills indicated to be enhanced through playing action video games such as FPSs, and how I think they are relevant for FPS spectating in particular. In Study I, measurements of these skills were explored in association with eye movements when viewing an FPS gameplay video.

5.5 Visual Attention Skill Measures

In order to identify visual attention skills that are relevant for FPS games, I looked into studies and meta-analyses on which kinds of visual attention skills have been particularly indicated to be enhanced through action video game playing (e.g., Bediou et al., 2018; Green & Bavelier, 2003). After this, I chose three skills that I considered particularly relevant to the game I was using as a stimulus. These skills were Multiple Object Tracking, hereby known as MOT (Pylyshyn & Storm, 1988), Visual Search, hereby known as VS (Eckstein, 2011; Wolfe, 2007), and resistance to Attentional Blink, hereby known as AB (Duncan et al., 1994). In Study I, I measured the participants' skills in these tasks before they commenced viewing gameplay videos.

MOT refers to a skill of tracking multiple objects simultaneously while they are in motion, while ignoring distractor objects. In a naturalistic setting, an example of MOT would be watching over multiple children while they play. The idea is that a person must keep track of all the indicated targets (in the example, the children under your supervision), and the task may be complicated by distractor targets (such as children you do not know who are playing in the same place). In the case of an FPS game, the task is to keep track of multiple moving enemy soldiers, as well as teammates who you should not shoot at (distractors).

VS refers to finding a target object among distractor objects as quickly as possible (Eckstein, 2011; Wolfe, 2007). Typically, these types of tasks tend to be rather simple in a research setting – such as finding the letter 'T' among many 'I' letters or finding a blue target amidst many red distractors. However, VS also happens in naturalistic settings, such as when you are searching for your keys and need to ignore irrelevant objects in order to spot the keys. In an FPS game, an example of VS is when you have to find enemies in a cluttered and murky environment. The game used in the studies of this thesis makes the task difficult by depicting a realistic-looking war scene with camouflage suits, rubble, snowfall, dust, and so on, making spotting enemies particularly difficult.

AB is a phenomenon in which participants find it hard to see a target when a distractor object is shown right before the actual target (Duncan et al., 1994). What this means is that when two objects are shown in rapid succession, the latter one slides past unnoticed. In real life, this phenomenon is utilized for example in many card tricks. The AB phenomenon is typical in people (hence it being called a phenomenon), but there is individual variance in how susceptible a person is to it (Martens & Wyble, 2010), with a minority even being able to resist it entirely (Martens et al., 2006). In the case of FPS material, the AB phenomenon may be quite detrimental for following the game, as enemies tend to move very rapidly and pop up in different places. Failing to detect all enemies is likely to affect a player’s success in the game. Also, it will likely become very difficult to follow a gameplay video, as the gameplay consists of constant enemy movement, explosions, and changes in the surroundings. In other words, it is crucial that the player or viewer is able to see everything that is important despite the hectic pace.

6 Aims of the Thesis

The overall aim of this thesis was to explore the role of emotions and visual attention in FPS game playing and viewing. More specifically, the aim was to investigate how game dynamics preferences affect emotion-related responses as well as curiosity, vitality, and self-efficacy associated with the game. In addition, the aim was to assess how visual attention skills affect gameplay spectating as indexed by eye movements. The hypothesis was that both game dynamics preferences and visual attention skills have an effect on the game experience of an FPS game.

7 Overview of the Studies

7.1 Study I

Holm, S. K., Häikiö, T., Olli, K., & Kaakinen, J. K. (2021). Eye movements during dynamic scene viewing are affected by visual attention skills and events of the scene: Evidence from first-person shooter gameplay videos. *Journal of Eye Movement Research, 14*(2), Article 3. https://doi.org/10.16910/jemr.14.2.3

Study I examined visual attention during video game viewing by measuring eye movements. We examined whether there are any general tendencies in eye movement behavior during video game viewing. We also examined whether performance in specific visual attention tasks was associated with eye movements during video game viewing.

The participants (N = 38) were inexperienced players. In order to assess the participants' visual attention skills, the participants completed three computerized visual attention tests: susceptibility to Attentional Blink (AB) (Duncan et al., 1994), Visual Search (VS) (Eckstein, 2011; Wolfe, 2007), and Multiple Object Tracking (MOT) (Pylyshyn & Storm, 1988). Following this, the participants watched an FPS gameplay video while their eye movements were recorded. Four videos were randomized so that each participant watched one of the four videos.

The videos were coded for different types of gameplay events and eye movements during these events were explored. Four types of eye movement measures were extracted from the eye tracking data: number of fixations, fixation durations, saccade amplitudes, and fixation distances from the center of the screen. Generalized linear mixed models were used to analyze the association of visual attention skills with eye movement patterns during different game events. Time from the start of the video was also considered in the analyses to investigate how eye movements developed from the beginning until the end of the video.

The results showed that there were both general tendencies and individual differences in eye movements. As for general tendencies, the participants proceeded from what seemed to be a diffuse scanning mode toward a more focal and central viewing mode, and this effect got stronger the longer they viewed the videos. This was indexed as the number of fixations decreasing, saccade amplitudes shortening, and fixations landing closer to the center of the screen as time progressed. These results may be due to the viewers' need to get accustomed to the hectic stimulus of the FPS video in the beginning by scanning the screen to make sense of what was happening.

We also found that some of the events were associated with distinct eye movement patterns. For example, events that contained something meaningful appearing suddenly in the periphery (e.g. enemies, explosions, or a new environment) led to a more diffuse, scanning type of eye movement pattern. This pattern was indexed by increased numbers of fixations, decreased fixation durations, long saccades, or less central fixation locations. In contrast, visually perplexing events (e.g. the field of view being splattered with blood), events with a visual aid in the middle of the screen (e.g. a gun's crosshair when aiming at a target), or events during which the protagonist moved forward led to a more focal and central type of eye movement pattern. These eye movement patterns were characterized by decreased numbers of fixations, increased fixation durations, short saccades, and fixation locations closer to the center of the screen. The results on the overall effects of the events highlight that (visual) content appears to drive attention in dynamic game scenes, at least during some types of events.

The performance in visual attention tasks was associated with video viewing in many ways. The main points are highlighted here. In comparison to lower scores in the MOT task, better scores were related to a more central viewing style overall, a steeper reduction in number of fixations across time, and less reactivity to events that contained novel information, movement in the background, or ambiguous visual qualities. The results indicate that participants with better MOT skills do not have to scan the screen as much when confronted with visually challenging new information, and they adapt to the visual environment of the video faster in general than participants with poorer MOT skills.

Susceptibility to AB was associated with reductions in numbers of fixations, whereas resistance to AB was reflected in numbers of fixations staying more at the same level across time. Resistance to AB was also associated with reductions in fixation durations across time. These effects showed that being able to process rapidly appearing visual content (i.e., resistance to AB) was associated with more stable scanning of the screen instead of moving toward less scanning. This is likely because participants who were good at resisting the AB phenomenon could detect targets appearing rapidly better than those who were more susceptible to AB. This also showed during some events: compared to viewers who were more susceptible to AB, viewers who were better able to resist AB made more fixations especially during events that contained new stimuli (i.e., a new environment, new targets in the background, or when the protagonist moved forward).

The results regarding VS were not as straightforward as those regarding both MOT and AB. However, when compared to viewers with poorer VS skills, better abilities in VS were associated with a stronger tendency toward a viewing strategy in which fixations first landed away from the center of the screen at the beginning of the video and then tended to move toward more central locations as time went by. Better VS skills were also connected with a lesser decrease in the number of fixations over time, indicating a more sustained state of scanning. The results showed that better abilities in VS might be connected with the ability to adapt faster to the visual environment by changing viewing strategy, but still sustaining attention by scanning the screen when needed. The results regarding the events also reflected these shifts in viewing strategy. For the events in general, poorer VS skills were associated with longer fixation durations than better VS skills, indicating that better VS viewers tended to engage in scanning behavior more than viewers with poorer VS skills during events. This was particularly true for a certain visually ambiguous event in which the screen filled with blood that partially covered the screen. During this event, faster performance in VS was connected with a stable or slightly increased amount of fixations, whereas viewers with poorer VS skills tended to have a major drop in the number of fixations. However, during an event in which the enemy opened fire in the periphery of the screen, the effect of VS reversed. During this event, poorer performance in VS was associated with shorter fixation durations, possibly indicating an overt search for the enemies. The results regarding the events highlight that performance in VS was associated with switching of viewing strategy during situations in which there was visually ambiguous or novel information to find.

In sum, the results show that there are both general and individual tendencies in eye movements during FPS video viewing. In general, viewers tend to proceed from a diffuse scanning mode toward a more focal and central viewing mode as time passes. Moreover, the visual qualities and saliency of particular events tend to guide eye movements. Keeping these general tendencies in mind, individual differences in visual attention skills also affect what is attended to on the screen. Namely, visual attention skills show up as differing eye movements during the video as a whole as well as in fluctuations in eye movement tendencies over time. Moreover, the role of visual attention skills in eye movements is more prominent during visually distinct events of the dynamic scene. The results show that specific visual attention skills may lead to specific eye movement patterns. They highlight that the perceptual demands of FPS games are strong enough to bring about individual differences, both in short events and during the course of the entire video.

7.2 Study II

Holm, S. K., Kaakinen, J. K., Forsström, S., & Surakka, V. (2021). Self-reported playing preferences resonate with emotion-related physiological reactions during playing and watching of first-person shooter videogames. *International Journal of Human-Computer Studies,* 155, Article 102690. https://doi.org/10.1016/j.ijhcs.2021.102690

In Study II, the aim was to explore how game dynamics preferences are connected both with emotion-related physiological responses and self-reports during playing (active participation) and gameplay video viewing (passive watching).

The participants (N = 24) were divided into two groups based on their game dynamics preferences: a high and low preference for violent game dynamics. The participants were active players of video games. All the participants both played and watched a gameplay video of the same game.

The emotion-related responses were measured in terms of physiological changes in electrodermal activity (EDA), skin conductance responses (SCR), heart rate (HR), and electromyographic (EMG) activity of the *corrugator supercilii* and *zygomaticus major* facial muscles. These registrations were recorded during playing and video viewing. The participants also reported their emotion-related experiences by ratings of valence and arousal after both playing and video viewing.

We used generalized linear mixed effects models to explore the change across time in physiological recordings – that is, we were interested in how the different tonic physiological responses developed and evolved across time rather than focusing on phasic responses.

The results showed that there were overall general tendencies related to playing and viewing gameplay videos, but also individual differences between players with differing preferences. All players gave both higher valence and arousal ratings after playing an FPS game than after viewing a gameplay video, regardless of their game dynamics preferences. However, there were notable differences between the different preference groups in terms of their physiological responses.

Those who liked the game content showed stable levels of EDA and HR both during playing and viewing a video, and there was no difference in their overall levels of these measures between the conditions. In contrast, the dislike group had higher EDA and HR levels during playing rather than when watching a gameplay video. Further, the dislike group showed a rising tendency in EDA across time, especially when viewing the video material. The results regarding SCRs were in the same direction. Those who disliked the game's dynamics experienced a slight increase in the number of SCRs across time. Those who liked the content showed a decrease in SCRs, especially while watching a video. The results regarding measures of autonomic arousal (EDA, SCR, HR) highlight that those who disliked the content showed overall higher physiological arousal during playing. Further, the dislike group showed accumulating arousal, especially during video viewing. However, those who liked the content showed rather stable patterns of arousal across time and condition, and even a slight decrease in SCRs.

As for facial EMG, those who liked the game dynamics showed a steep EMG increase in the activity of the *corrugator supercilii*, whereas the dislike group showed less increase in *corrugator supercilii* activity.

The results highlight that there are individual differences in physiological responses to FPS video games, even when players give similar ratings of valence and arousal. The effect seems to be slightly different when the content is presented either in a passive way (video viewing) or through active participation (playing), but only for those participants who dislike the content. The results also indicate that there are methodological considerations that need to be taken into account in future studies of players' emotion-related responses. For example, the results point out that self-reports of players do not necessarily correlate with physiological measures of valence and arousal. Moreover, the results regarding facial EMG do not seem to align very well with facial expressions of negative and positive emotions. This may suggest that facial EMG is not a straightforward measure of valence when participants are playing or watching a video game, as activation of the *corrugator supercilii* may be related to other aspects, such as concentration or effort. Importantly, the results suggest that the use of physiological signals as an index of purely emotion-related responses during playing and viewing of video games may not be as straightforward as was previously thought. However, the results do show that game dynamics preferences are associated with players' physiological responses during both active and passive exposure to the game content. The differences in responses are most evident in measures of autonomic arousal (EDA, SCR, HR).

7.3 Study III

Holm, S. K., & Kaakinen, J. K. (2021). Game dynamics preferences are connected with experiences derived from first-person shooters. *2021 IEEE Conference on Games (CoG)*. https://doi.org/10.1109/CoG52621.2021.9619138

In Study III, the aim was to investigate how game dynamics preferences affect perceptions of vitality, self-efficacy, and curiosity in general and in association with playing an FPS video game.

Forty inexperienced players took part in the experiment. The participants filled out a survey about their game dynamics preferences for violent content. They also filled out surveys regarding their perceived vitality, curiosity, and self-efficacy both before and after playing the game. Importantly, the surveys before playing referred to "life in general," whereas the ones filled out after playing referred to "during playing." We also looked into ratings of valence and arousal before and after playing using SAMs (Bradley & Lang, 1994). Moreover, we asked the participants about their perceived difficulty of the game and of using the gaming pad, as well as their perceived familiarity with the game and the gaming console.

The differences between life in general and after gaming were examined with a repeated measures ANCOVA with the preference for violent game dynamics as a covariate. Game dynamics preferences did not correlate significantly with perceived curiosity, vitality, or self-efficacy during life in general, showing that there were no initial differences in these measures as a function of preferences.

The results showed that individual differences in game dynamics preferences were connected with experiences derived from playing an FPS game. Follow-up comparisons were made by splitting the participants into two groups based on the median score of the sum of game dynamics preferences and then using paired samples t-tests for the conditions (life in general versus playing) for each measure (curiosity, vitality, self-efficacy). The group that disliked violent game dynamics experienced more vitality, curiosity, and self-efficacy during life in general rather than when playing. The dislike group also experienced more positive emotional valence before playing than after playing. The group that was neutral/positive toward violent dynamics also experienced more self-efficacy during real life rather than when playing, although the difference was not as substantial as with the dislike group. However, the neutral/positive group experienced similar amounts of vitality, curiosity, and valence both in life in general and when playing.

Both groups rated their emotional arousal as higher after playing than before it. The game dynamics preferences correlated with the perceived difficulty of using the gaming pad and with the perceived difficulty of the game itself.

The results highlight that players who are neutral or mildly positive toward violent content experience stable levels of vitality, curiosity, and emotional valence both during life in general and when playing. In contrast, players who dislike violent dynamics report clear declines in these measures when playing as compared to real life, and they consider playing difficult. While those who have a neutral preference toward violent dynamics also experience higher self-efficacy in life in general, the decline in it is more modest during playing than for those who dislike violent dynamics. In sum, the results show that game dynamics preferences are reflected in perceptions of gaming-related vitality, curiosity, self-efficacy, and valence.

8 Discussion

In this thesis, I studied the playing and viewing of an FPS game through a series of three experiments to explore potential factors that could affect the game experience. The topics explored in this thesis and considered to represent some of the central dimensions of an FPS game experience were visual attention, emotions, and experiences of vitality, curiosity, and self-efficacy.

FPS games require abundant visual attention (Bavelier & Green, 2019) and how one is able to focus visual attention likely has significant effects on player experience. To start exploring this topic, Study I presented findings on how visual attention skills show up as eye movements during viewing of an FPS game. While Study I did not focus on emotions, it is likely that visual attention skills and thus performance in the game may affect the emotional responses of a player. Emotions in turn are central motivators of all human behavior (Kleinginna & Kleinginna, 1981), and are also likely to be so in respect to gaming. Study II focused on emotions by analyzing emotion-related electrophysiology and experiences. As gaming has spread widely into our everyday life, one can make a speculative assumption that psychological reflections about playing are relevant for both the game experience as well as the well-being of individuals in general. Study III focused on experiences of vitality, curiosity, and self-efficacy, exploring these concepts both during life in general and in association with playing an FPS game.

The underlying theme of the studies is to explore player experience from the point of view that it consists of both attentional as well as emotion-related components, and that there are individual differences between players and spectators that affect the overall game experience.

8.1 Study I

Study I provided basic knowledge on eye movements in gameplay viewing, as it showed that there were both individual differences in eye movements as well as general tendencies shared by most players. Recognizing typical eye movement patterns and how visual attention skills affect these patterns is important, as previous eye movement research has not paid much attention to gameplay spectating. Exploring this topic was essential to understanding an activity that constitutes a large portion of time spent in many people's everyday lives (Burroughs & Rama, 2015; Hamari & Sjöblom, 2017; Taylor, 2020; Woodcock & Johnson, 2019). I will first discuss the results regarding general eye movement tendencies typical of most viewers before moving on to discuss individual differences in eye movements based on visual attention skills.

Study I partially confirmed previous findings showing that viewers of dynamic scenes tend to proceed from a diffuse, ambient scanning mode toward a more focal and central viewing mode during the beginnings of certain meaningful events (Eisenberg & Zacks, 2016; Pannasch, 2014; Smith et al., 2006). Moreover, Study I provided new information showing that there is a general tendency for this ambient-to-focal eye movement pattern across time during the entire video, not just during specific events. This is something that has not been noted before in dynamic scene viewing research, although it is a well-known phenomenon in static scene viewing (Antes, 1974; Buswell, 1935; Friedman & Liebelt, 1981; Karpov et al., 1968). Thus, this ambient-to-focal eye movement pattern tendency shows up in dynamic scenes not only during starts of events, scene onsets, and cuts, as has been previously shown (Eisenberg & Zacks, 2016; Pannasch, 2014; Smith et al., 2006), but also in general over an entire dynamic scene. This is likely because the viewers have developed an overall understanding of the dynamic scene toward its end, and no longer need to initiate scanning as much to make sense of the scene. For example, given that certain types of events tend to repeat in the game (Nacke et al., 2008; Ravaja et al., 2008; Weber et al., 2009; Lang et al., 2013; Lopes et al., 2017), it is likely that there is more scanning during these events when they first occur than when the player has already seen a similar event.

Previously, the ambient-to-focal eye movement pattern has been hypothesized to happen because new events trigger a memory segmentation process (Eisenberg & Zacks, 2016; Pannasch, 2014; Smith et al., 2006). This may well be behind the results of Study I, but other reasons may also affect this scanning tendency during certain types of events. Namely, the events that were associated with this type of an eye movement pattern were not necessarily reliant on episodic memory, but visually distinct enough to trigger the scanning via other aspects. Events that triggered an ambient pattern of eye movements contained important information for the game, surprising events, or highly visually salient content, often at the periphery of the screen. For example, viewers tended to scan the screen when multiple enemy soldiers suddenly appeared. This finding is in line with previous studies showing that visually salient features and movement tend to draw attention (Carmi & Itti, 2006; Le Meur et al., 2007; Mital et al., 2011; Smith & Mital, 2013).

Even though there was an overall tendency for eye movements to become ambient or scanning at event onsets, some particular events contained objects that tended to capture attention particularly well and last a long time on the screen, and thus conversely led to what could be termed as focal instead of ambient eye movements. These events contained visually distinct overlays such as specks of blood in the protagonist's visor or a crosshair for aiming. There is currently evidence that eye movements are guided in scene viewing to a large extent by both visual saliency as well as meaningfulness or semantic informativeness, and these factors tend to have a high correlation (Henderson & Hayes, 2017; Pedziwiatr et al., 2021a). There is currently a debate about whether models that aim to predict fixation locations in scene viewing should be based on visual saliency versus semantic meaningfulness; that is, which is more important in guiding eye movements (Pedziwiatr et al., 2021b; Henderson et al., 2021). The results of Study I showed that both semantic meaningfulness and visual saliency affect eye movement patterns, and underline the difficulty of prioritizing one over another. This highlights the importance of recognizing visually distinct qualities and events that may affect dynamic scene perception, especially in new media forms such as gameplay videos. Thus, the results of Study I indicated that different types of events trigger differing eye movement patterns, and not just the ambient-to-focal tendency that has been previously identified in studies on movies and naturalistic dynamics scenes (Eisenberg & Zacks, 2016; Pannasch, 2014; Smith et al., 2006). This should be taken into account when using gameplay videos as a stimulus in further research.

One example of how visual qualities of events affected eye movements comes from a particular event called "Advancing (self)," in which the protagonist moved in a point-of-view (POV) shot. This type of an event tended to lead to lengthy fixations toward central areas of the screen. One explanation for this could be that the viewers might need to focus on the center of the screen to get a quick gist of the scene (Henderson, 2003; Rayner, 2009) in order to take in what is happening as the character's entire view is changing constantly. Alternatively, viewers might be trying to avoid motion sickness by focusing their gaze on a point. As the results of Study I showed that this type of shot is likely to induce a certain type of eye movement pattern, future studies should utilize different camera angles and shots to see whether they affect eye movements in particular ways. So far, comparing different shots, perspectives, and angles has been largely ignored in the literature.

Importantly for the thesis at hand, Study I showed that individual differences in three visual attention skills (MOT, VS, and AB) affect eye movement patterns when viewing a gameplay video. These effects showed both over the duration of the entire video and during particular events. For example, participants who were better able to resist AB tended to show a more persistent scanning eye movement pattern over the duration of the entire video compared to those who were more susceptible to AB. This is likely because they could keep up with detecting rapidly appearing targets better than those who were more susceptible to AB. The results of Study I are thus somewhat contradictory to results of previous studies on dynamic scenes, especially ones done on movies, that have noted attentional synchrony between viewers (Mital et al., 2011; Smith & Henderson, 2008). What this means is that viewers of movies and other dynamic scenes tend to look at roughly the same areas of the screen. These areas are usually the middle point of the screen as well as moving or otherwise salient objects (Carmi & Itti, 2006; Dorr et al., 2010; Le Meur et al., 2007; Mital et al., 2011; Smith & Henderson, 2008; Smith & Mital, 2013). Instead of finding this attentional synchrony, the results of Study I showed that during spectating of gameplay videos, there were individual differences in eye movement patterns, and these differences were based on visual attention skills. This effect was likely detected because the gameplay video was challenging enough to bring about individual differences, as it induced enough cognitive load on the visual attention (Bavelier & Green, 2019).

The results of Study I regarding individual differences are important for understanding why skills such as resistance to AB are important for video game players and spectators. Namely, they help explain how visual attention skills show up during viewing of an FPS video game. Previous research has focused on the effects of playing, noting that action video game players tend to be better at certain visual attention skills (Bediou et al., 2018; Boot et al., 2008; Feng et al., 2007; Ferguson, 2007; Green & Bavelier, 2007). However, it has so far been unclear how exactly these visual attention skills show up as eye movements during viewing of game material. This makes it difficult to fully understand why there is a connection between action video game play and certain visual attention skills. Study I helps bridge this gap by showing that different visual attention skills are associated with different eye movement patterns. Interestingly, the findings of Study I did not indicate an overall pattern associated with “better” visual attention skills, but rather that variations in different types of visual attention skills may lead to different viewing styles.

Study I focused on general eye movement tendencies instead of what areas of the screen viewers looked at specifically. In future studies, it might be interesting to focus on exactly what objects viewers tend to fixate; that is, whether their gaze data tends to cluster on some areas, such as objects that are important for the game. Areas of interest could be determined, for example, by gathering data from professional players to see where they tend to look at the most during gameplay, as those areas are likely important. There is already a growing interest in comparing professional esports players to novices, as well as predicting players’ skill levels from their eye movements (Choi & Kim, 2018; Velichkovsky et al., 2019; Smerdov et al., 2020), and similar settings could be used to study the role of visual attention skills in fixation locations.

In the future, the role of expertise and game literacy in eye movements during dynamic game scene viewing could be explored further. In general, eye movements are known to change as a function of expertise (Gegenfurtner et al., 2011; Mann et al., 2007; Wu & Wolfe, 2019). In other words, the ability to "read" what is relevant for the game could potentially affect eye movements along with visual attention skills. For example, preliminary findings have shown that professional FPS players focus on different things than non-professionals (Choi & Kim, 2018; Smerdov et al., 2020; Velichkovsky et al., 2019). While it is likely that professional players have better visual attention skills, it is also likely that they have a better understanding of the game in general.

It is also left for further studies to determine how visual attention skills are associated with perceived difficulty, performance in the game, or game enjoyment. For example, Trepte and Reinecke (2011) have found that player performance and gaming-related self-efficacy affect how much a player enjoys gaming, and when players receive a bad ratio of negative versus positive reinforcement during a game they become frustrated (Chumbley & Griffiths, 2006). Having poor visual attention skills relevant to a game could lead to difficulties in following the game, which raises the question of whether visual attention skills affect perceptions of difficulty, and thus game enjoyment and the game experience. Perhaps some players may be drawn to FPS games because their visual attention skills get challenged in a meaningful way. In contrast, other players may get discouraged if they do not have the required skills to make sense of the scene. In order to understand whether this is the case, self-reports of viewers on difficulty are needed in the future.

The main limitation of Study I is that it was rather exploratory in nature, as not much is currently known about either general eye movement patterns or individual differences in these patterns during gameplay video viewing. This is because dynamic scene research has been largely limited to either movies or naturalistic scenes (for example Dorr et al., 2010; Eisenberg & Zacks, 2016; Smith & Henderson, 2008). Differing from this canon, Study I utilized a gameplay video that involved unique characteristics such as high cognitive load and visceral content, contained computer-generated human characters instead of actors, and was shot in a moving first-person point-of-view that is not typically used in dynamic scene perception research. For these reasons, gameplay videos may induce different eye movement patterns than movies or naturalistic dynamic scenes. Given this, gameplay videos still comprise a familiar dynamic scene in modern day life (Burroughs, & Rama, 2015; Woodcock & Johnson, 2019), and should thus be studied further. My hope is that Study I will bring forth other papers that aim to explore eye movements during video game viewing. In the meanwhile, Study I presents novel information about general eye movement phenomena related to gameplay viewing. Namely, the results showed that scanning or ambient eye movements decrease toward the end of the video, and that different events of the video are likely to induce different eye movement patterns within the video. In addition, the results showed that individual differences in visual attention skills affect eye movements in gameplay spectating during both the scene as a whole and within specific events.

To sum up the most important finding of Study I, the results showed that the way a game is viewed varies according to a viewer's strengths and weaknesses in certain visual attention skills as indexed by their eye movements. Put simply, viewers view the game in differing ways, both during the entirety of the video and when reacting to particular events of the game. This is important for understanding the game experience, as it shows that players or viewers pay attention to different things in the game. Whether visual attention is directed to relevant targets in the game is likely important for the overall game experience. FPS games consist largely of spotting and shooting at rapidly moving targets. Thus, visual attention skills are paramount for being able to follow and play an FPS game, and likely affect enjoyment derived from playing or viewing, although further studies on this topic are needed.

8.2 Study II

Study II showed that game dynamics preferences affect emotion-related physiological reactions both when watching and when playing an FPS game. This is relevant new information for studies that have focused on games' user experience (e.g., Christy & Kuncheva, 2014; Drachen et al., 2010; Kivikangas et al., 2011; Mandryk & Klarkowski, 2008; Ravaja et al., 2008) and emotion-related outcomes of violent games (e.g., Anderson & Bushman, 2001; Carnagey et al., 2007; Gentile et al., 2016; Ivarsson et al., 2013; Read et al., 2016; Staude-Müller et al., 2008).

The results of Study II were clearest when it came to autonomic arousal. Namely, physiological arousal was related to game dynamics preferences. Those who liked the dynamics of the game showed a rather stable level of arousal across time, whereas those who disliked the dynamics showed a rising tendency in the level of physiological arousal. Differences in player preferences for game dynamics have not been associated with physiological changes during playing or viewing in previous studies.

There was no main effect between the participant groups in arousal, but instead the difference showed in arousal slopes across time. The current research into physiological reactions to games has mostly utilized either tonic averages over the entire playing session (e.g., Drachen et al., 2010; Ivarsson et al., 2013) or looked into event-related phasic responses (e.g., Ravaja et al., 2008). Instead, Study II examined changes in physiological reactions over the entire playing and viewing sessions. The advantage of this method is that it enables one to look at how the player's physiological state evolves across time. For example, it is possible that players might have become habituated or, as was the case in Study II, have increasing arousal to the stimuli. The playing and viewing sessions were rather short (six minutes), which may explain why there were no differences in overall arousal. Namely, it could be that if the sessions were longer, the dislike group's arousal might have continued increasing, leading to a state in which it would have been detected as a main effect. As playing sessions tend to be rather long in real life, further research into this fluctuation in the game experience would be fruitful for understanding players' motivation to keep playing or stop playing, for example. Nevertheless, the results are interesting as they show that there is a change in physiological responses over time, which likely affects the game experience. This change across time has largely been ignored in the current literature, and the results of Study II show that it is a valid theme that could be explored more.

The key question raised by the results regarding physiological arousal is this: what does increasing arousal for those who dislike the dynamics of the game mean? The most obvious interpretation would be that players who like something in a game remain rather relaxed, whereas those who do not like the content react to it with arousal. In this sense, "liking" a game's content would be associated with a stable arousal state. Similar interpretations have previously been drawn in FPS user research for example by Drachen et al. (2010), who correlated tonic long-term averages in EDA and HR with subjective reports of positive and negative emotions, and found that low HR was associated with positive valence and high EDA with negative valence. However, in Study II I did not find any correlations between players' game dynamics preferences and subjective evaluations of valence or arousal. This would mean that physiological responses are not necessarily linked with experiential outcomes. In previous literature, an increase in initial arousal related to violent games has often been interpreted as a negative stress response or a sign of psychological distress (e.g., Anderson & Bushman, 2001; Carnagey et al., 2007; Gentile, 2016; Hasan et al., 2013; Sherry, 2001; Staude-Müller et al., 2008). However, as neither the subjective reports nor the EMG results on valence indicated negative valence for these participants, it cannot be concluded that the participants perceived the situation as a source of negatively valenced stress. I will next consider other possibilities behind the increasing arousal of those who disliked the game's dynamics.

Firstly, while I controlled for time spent playing digital games overall, I did not control for how much the participants played violent FPS games in particular. This is because I had a default assumption that those active players who like violent dynamics likely play a lot of violent games, whereas those who do not like violent dynamics likely do not play them as much. While I did not control for experience with particular types of games, I did ask the participants how familiar they were with the game used in the study. The groups did not differ in their familiarity with playing the particular game. However, it is possible that previous experience with violent FPS games could have affected the results to some extent, as mere experience can affect arousal as a stimulus becomes more familiar. Tyack and Mekler (2021) recently introduced the concept of "ordinary player experience," which posits that playing can over time become a less intensive experience that resembles routine and is emotionally moderate. Thus, it is likely that those who like violent dynamics and may therefore be used to violent games present a more "ordinary" response to the game, whereas those who are used to other types of games experience something out of the ordinary psychologically, such as increased arousal. What this means is that novel content tends to be more surprising and require more effort, and therefore perhaps be more arousal-inducing than something that has become an everyday pastime. Another way to conceptualize this phenomenon is suspense-induced arousal (Nomikos, 1968); that is, the tendency of arousal to be high if there is a suspense of danger ahead. Namely, players who are used to violent FPS games may have learned which situations in the game tend to be non-threatening, and thus may not have an increasing arousal state as there is less suspense. In contrast, players new to the genre may anticipate more danger to their character, leading to increasing arousal. In earlier research, Ivarsson et al. (2013) showed that experienced players of violent video games showed similar HR averages when playing a violent and a non-violent game, whereas those who were not used to violent games showed higher average HR during playing of the violent game than the non-violent game. A preliminary study of eight participants by Gilleade et al. (2005) also showed that experienced players had less HR responses to a simple Atari-style game than inexperienced players. Gilleade et al. (2005) took this as a sign that the experienced players had habituated to playing games by repeated exposure and learned to control their physiological arousal to the game's challenging events. Thus, more background information about the games and genres the participants typically play would be beneficial, as there could be a carry-over effect in familiarity from other similar games and previous exposure to violent content. Having said that, it is very hard to circumvent this problem if game dynamics preferences are what drive players to select and play certain types of games. In short, it is likely very hard to find matching groups of active players who play a similar amount of violent games despite the other group disliking the content.

Another reason for the noted differences could be that those who like the dynamics have become hardened to violent content. Previous research has hypothesized that violent games cause desensitization that results from initial high physiological arousal that leads to decreased arousal to subsequent violent content (Bushman & Anderson, 2002; Carnagey et al., 2007; Staude-Müller et al., 2008). While I did not study desensitization per se, one could make the argument that the group that liked violent dynamics has likely played a lot of violent games because they like such dynamics, and thus might have become desensitized. Given this, they would no longer react with arousal responses to the stimulus. Similarly, one could assume that those players who dislike violent content have not played many violent games, and the results indicating their increasing arousal state reflect the initial stage of high arousal associated with the desensitization process. However, this cannot be determined without an intervention study in which novice players are exposed to violent games over the course of weeks or months to see whether there is a change in their physiological arousal over time.

Another area that needs further scrutiny is individual variation in the responsivity of the autonomic arousal system. Namely, some people have a more stable arousal state to begin with than others – in other words, they are not affected as much by various stimuli, such as violent content (Derryberry & Rothbart, 1988). In Study II, those who liked the dynamics showed a stable arousal state across time. There is a possibility that this stable arousal state for those who liked the dynamics could be inborn, instead of resulting from, for example, previous exposure to violent content or other factors related to the game experience. Differences in arousal responses are generally thought to form the basis for temperament and personality and have to do with individuals' brains' regulatory systems, which are at least partially genetically determined (Derryberry & Rothbart, 1988; Heller, 1993). What this essentially means is that there is a "chicken or the egg" problem when it comes to determining the causality of physiological effects of violent video games. In essence, it might be that those who have a more stable physiological state to begin with tend to want to play violent or hectic games, instead of playing leading to a stable physiological state. Because of reasons like these, more studies on the characteristics of the players of these types of games are needed (Ferguson et al., 2017). Besides players liking violent dynamics as such, a stable arousal state when playing violent FPS games may be beneficial for successfully playing the game, as FPS games require steady hands for aiming and intense concentration in a hectic environment – that is, a stable state of low physiological arousal. Having a stable arousal state system could thus make the game experience rewarding by offering better chances of succeeding. More intervention studies regarding autonomic arousal and violent video game play are needed to truly understand the relationship between gaming and physiology. Moreover, experiments using arousal-reducing drugs or other methods to stabilize participants' physiological arousal might show whether a stable arousal state leads to better performance.

What also needs further exploration is the time course of arousal responses, as averages over the whole playing session may not be able to detect all relevant information. This was clear from the results of Study II, in which differences in arousal between groups did not show in main effects, but rather in fluctuations of the arousal state. However, future research should consider this even further. For example, Reinecke (2009b) has pointed out that while many video games are associated with psychophysiological arousal, users still experience games as relaxing. Reinecke (2009a) compares this paradoxical phenomenon with exercise, which presents a similar profile of initially increasing tension and state anxiety, but which may lead to a feeling of relaxation afterwards. In general, one should keep in mind that an increase in arousal during an activity does not necessarily mean that an individual suffers long-term negative consequences because of it. It is also possible that game dynamics preferences could moderate arousal after playing, but further research on this topic is needed.

The results of Study II regarding facial EMG showed somewhat perplexing tendencies. Firstly, the preference groups did not differ in their *zygomaticus major activity*, an indicator of positive valence. Secondly, those who liked the game dynamics showed a steep EMG increase in the activity of the *corrugator supercilii*, whereas the dislike group showed a lesser increase in *corrugator supercilii* activity. As activity of the *corrugator supercilii* is typically associated with negative valence (Bradley & Lang, 2007), the EMG results do not seem to align very well with expressions of valence. It is likely that the activity of the *corrugator supercilii* in this case may not reflect negative valence in so much as it may reflect, for example, concentration or investment in the game, as this muscle is often active during frowning related to concentration (e.g. Bosch et al., 2016; Cohen et al., 1992; de Morree & Marcora, 2010; Van Boxtel & Jessurun, 1993). It is also possible for the *corrugator supercilii* to activate if the brow is lifted in an upwards direction, for example as a sign of surprise or confusion. Some participants may also squint their eyes in order to see better, which may activate the *corrugator supercilii*. Perhaps the most likely reason for the increased *corrugator supercilii* activity in the context of Study II was increased effort. It is likely that those who liked the violent dynamics approached the game as a competitive activity that they were used to and wanted to do well in, and hence frowned in concentration. In contrast, those who disliked the dynamics possibly approached the task as a less serious entertaining activity that they committed to mostly just because they were taking part in an experiment, and thus had less *corrugator supercilii* activity related to concentration or effort. Previously, somewhat similar EMG results to those found in Study II have been noted in a picture-viewing paradigm by Weinreich et al. (2015), who found that experienced video game players tended to have less valence-concordant *corrugator supercilii* activation to emotionally stimulating pictures than other participants. Perhaps one explanation for this lack of valence-concordant facial muscle activation in Study II and that found by Weinreich et al. (2015) could be a form of attunement over time to visceral emotional stimuli presented on a screen. Namely, all of the participants in Study II were active players of video games. Violent video games in particular are often filled with visually gruesome and shocking content, which over time may lead players to become used to seeing such material and knowing that it does not necessarily convey a lot of meaning in the grander scheme of the game.

Rather, some players may view such content on a screen as something artificial, or "visual decoration," and do not necessarily empathize much with the characters. This may be a form of moral disengagement that some players adopt (Hartmann & Vorderer, 2010), a conscious knowledge of "this is not real." Instead of the emotional content or the story of a game, it is possible that active players may focus more on task-related or strategic aspects of the game. Factors such as these could thus lead to less valence-concordant facial expressions. This phenomenon may also be reflected in the stable arousal state of those who liked the game's dynamics in Study II. Namely, whether one immerses oneself in the story and empathizes with the characters of the game or considers playing as a more of a competitive cognitive task likely affects both facial muscle activation and arousal. However, this is mere speculation and needs further research.

In general, there are some pitfalls in interpreting EMG data. For example, one should note that facial EMG recordings follow an assumption that facial expressions work in an autonomous manner, whereas they might not in reality always do so. Some researchers contend that facial expressions happen even in solitude in a fairly reflexive manner, as human beings tend to imagine a social audience even if there is none (Crivelli & Fridlund, 2018). However, others contend that EMG measures of valence can be tricky to interpret because the muscles of the face are under voluntary control, and facial expressions can be used to communicate or mask valence to others (Cacioppo et al., 1992). This presents a challenge, as playing or watching a video on your own is mostly a solitary experience during which there is no need to convey emotional valence to others. However, if one is of the opinion that the experimenter is socially involved in the situation, the participants may want to use voluntary control of their facial muscles to convey something to the experimenter, such as forced expressions of joy or horror, depending on what they think is socially most appropriate. Besides social appropriateness, players may want to compensate their emotional reactions by using converse emotional expressions – such as smiling to soothe themselves or to alleviate disappointment in their performance. An example of the difficulty of interpreting facial EMG data during gameplay comes from Ravaja et al. (2006). They found that when players' avatars fell from heights and died, this elicited heightened arousal and smiling activity but less frowning activity in the participants. Interestingly, watching a replay of the death event negated the situation, causing negative affect. Ravaja et al. (2006) postulate that active participation might lead players to perceive situations as positive, but passive watching as negative. While this may be a true finding, the perplexing result also highlights that physiological measures may be hard to interpret and may not align well with hypotheses made by researchers. In short, perhaps utilizing facial expressions as an index of valence in a gaming situation is not as easy as it may be in other situations.

In general, one limitation of the current research is that the results on physiological measures are vulnerable to errors in interpretation, as how they relate to affect is a complex matter that is sometimes over-simplified (Cacioppo & Tassinary, 1990). As the name implies, physiological reactions are physiological – that is, changes that have to do with the physiological state of the participant may be confused with their emotional responses or other psychological states that may not be solely emotion-related or related to the task that they are carrying out. For example, mental effort, physical exercise, respiratory changes, or sensory stimuli such as pain can lead to measurable changes in arousal (Critchley, 2002; Landis, 1930). Moreover, playing first-person shooter games requires fast and accurate actions, which may in themselves induce arousal, especially for those unaccustomed to such games. In fact, separating arousal related to cognitive load versus arousal related to emotion can be complicated (Setz et al., 2009). For example, it has been noted that during playing of FPS games, challenge and difficulty may elevate physiological arousal (Klarkowski et al., 2018; Nacke & Lindley, 2008). Steps have been taken to create models that could distinguish cognitive load from psychological stress from the EDA signal during highly abstract tasks (Setz et al., 2009), but so far this remains only a future possibility for naturalistic situations such as video game play. As for Study II, all participants were active video game players and there were no differences between the groups in their perceptions of game difficulty, using the game pad or with familiarity with the gaming console. Moreover, the game's difficulty level was adjusted for each participant during a tutorial level that automatically calibrated the difficulty settings. Thus, it is not likely that the groups had major differences in difficulty with playing, even if some players may have been more used to content similar to the game used here. However, having said that, in the future I would utilize performance metrics such as number of hit targets and character deaths to see if arousal has anything to do with how good the participants are at playing the game. This would be in keeping with the typical triangulation of task performance, physiological measurements, and self-assessment questionnaires used in GUR (Darzi et al., 2019). Doing this would help further understand how game design choices such as game dynamics (and how they match players' preferences) affect player experience and performance (Drachen et al., 2018; Abeele et al., 2020).

The role of agency was explored in Study II by comparing the playing situation to merely viewing the same game. The results showed that playing a game induced more self-reported arousal than watching a gameplay video of the same game. In addition to this, those who disliked the dynamics showed higher physiological arousal in the playing context. The results thus established that playing is a more arousal-inducing situation than merely watching the game, despite the dynamics and content being the same. However, in the case of physiological arousal, the effect was moderated by game dynamics preferences. One of the concerns related to violent video game playing is that players take active part in violent behaviors, albeit in a fictional environment. This is different from just seeing violence in a passive manner, for example when watching movies. Because of this active agency, arousal could be higher in the playing context. However, it is also just as true that the act of playing is likely more cognitively straining than just passively watching the material, which could increase arousal and make interpretation difficult. In fact, there is a theoretical debate about whether the hecticness, competitiveness, and cognitive demands of playing or the violent content itself affect players' physiological arousal to violent games (Adachi & Willoughby, 2011; Ravaja, 2004). Thus, comparisons between being exposed to mere content in a passive way (watching a violent gameplay video) and active participation (playing) are important for the field to determine whether mere violent content is the culprit in increasing physiological arousal. The results of Study II help further this knowledge by showing that playing is indeed different from merely viewing the content in terms of arousal.

In order to not rely solely on physiological measures, I asked the participants of Study II to give self-reports of their experienced valence and arousal. The results showed disparities between the physiological and experiential measures. Namely, game dynamics preferences did not affect self-reported valence and arousal, even though there was a clear difference in physiological signals. There may be several reasons for this.

Firstly, experiential arousal and valence were measured with the SAM scale, which consisted of a single data point (answers to a single item) for both arousal and valence. In contrast, the physiological recordings contained a vast amount of data points and may thus be less prone to randomness than the single-item SAM scales.

Secondly, the time frame of the responses was different: physiological data collection happened during the process of playing and viewing, whereas participants reported their arousal and valence after playing. One should remember that emotions are prone to change, and they may be reappraised (Ellsworth & Scherer, 2003), which may lead to reflections after an entire playing session being different to during the actual playing session (Bopp et al., 2016; Bopp et al., 2018). However, it is very hard to circumvent this problem, as self-reports are hard to give during playing and viewing without interrupting the experience. In Study II, the self-reports were recorded immediately after the playing session to prevent these problems as much as possible. Nevertheless, it is still plausible that the timing of the measurements is showing in the results.

Finally, it is known that introspective access to perceived experiences during playing can be difficult and players may thus find it hard to describe their game experience (IJsselstein et al., 2007). Thus, one reason for the disparity may be that physiological signals could be more sensitive than self-reporting. Because of this, studies focusing on players' experiences should take on a multi-method multi-measure approach in which, for example, self-reports and psychophysiological and behavioral measures are recorded and then correlated (IJsselstein et al., 2007), a view that is shared generally in emotion research (Mauss & Robinson, 2009). The findings of Study II are a case in point for this recommendation, as the results showed that different measures may yield different results. Even though the obvious benefit of using physiological measures is that they are time-sensitive and do not disturb the game experience, self-reports are valuable (in fact absolutely necessary) for interpretation purposes. This is because solely relying on physiological data leaves the interpretation to the researchers, unless coupled with experiential measures. Given this, self-reports alone are not the solution either. It may not always be simple for the player to explicate their experience, for reasons such as the game experience being partly based on an unconscious process that is hard to verbalize (IJsselstein et al., 2007) or difficulties with objective self-reflection (King et al., 2009). Thus, it is my hope that there will be more critical discussion and guidelines about studying the user experience of games, as neither physiological signals nor self-reports seem to be a silver bullet for exploring the emotions of players, at least by themselves.

Future research needs to focus on what players seek to gain psychologically from the game experience of violent FPS games. This is especially true for arousal. For example, is playing supposed to be a relaxing or an invigorating event, or something else? As Gentile (2016) points out, people watch horror movies to feel scared and play violent games to feel a surge of adrenaline. One might also use a metaphor of a rollercoaster: some people will find a rollercoaster ride thrilling and fun, others scary and miserable. However, if one were to measure only arousal, there might not be a difference between these people. In much of the psychological research on aggression and video games, physiological arousal or negative valence are interpreted as something that is essentially harmful or at least a source of negative stress to a person (e.g., Anderson & Bushman, 2001; Prescott et al., 2018; Sherry, 2001). While this sort of an interpretation certainly feels like common sense, other views have also been expressed. For example, Krcmar et al. (2015) conceptualize the individual differences in players' arousal responses to violent video games as consisting of either appetitive or defensive arousal – that is, whether the arousal is perceived as positive or negative. Moreover, Hartmann and Vorderer (2010) point out that some players tend to engage in moral disengagement when playing violent video games, whereas others do not, which may affect emotion-related responses. Given all of these points, it is interesting that both dynamics preference groups in Study II reported similar, slightly positive valence, despite the other group not liking the game's dynamics. This result, along with the possibility that the physiological arousal state differences between the groups could have been a result of something other than dynamics preferences, prompted the conducting of Study III.

8.3 Study III

In Study III, I sought to find out whether experiences of curiosity, vitality, and self-efficacy change when playing as a function of game dynamics preferences. To control for differences in these measures in life in general, I also asked the participants about their experiences of curiosity, vitality, and self-efficacy in their everyday life. The results showed that those players who were neutral or mildly positive toward violent content experienced similar levels of vitality, curiosity, and emotional valence both during life in general and when playing. They experienced slightly less self-efficacy during playing as compared to real life. In contrast, players who disliked violent dynamics reported a clear decline in levels of vitality, curiosity, and emotional valence when playing as compared to real life, and a strong decline in self-efficacy. The groups did not differ in these measures in the life in general context. Thus, the results demonstrate that game dynamics preferences really are connected to these measures when playing.

When it comes to curiosity, the results showed that curiosity indeed is a measure that can be affected by playing, and further that it is moderated by dynamics preferences and how they match the game played. This information is important as there was scarce experimental evidence that curiosity can be altered by playing. However, curiosity has been considered a key feature in video games (To et al., 2016), and manipulating it in game design has been considered something that might affect game enjoyment (Togelius et al., 2007; Yannakakis & Hallam, 2007). Thus, the results affirm that curiosity truly is key to game experience, but also highlight the role of game dynamics in fostering or even diminishing it.

Likewise, the results regarding vitality showed that playing affects experiences of vitality, and that game dynamics preferences moderate this phenomenon. Namely, those who did not like the game's dynamics experienced less vitality in the playing context as opposed to real life, whereas those who were neutral or positive toward the dynamics experienced similar levels of vitality in both contexts. These results are partly in line with a previous study by Ryan et al. (2006), who focused on, among other matters, changes in vitality. Ryan et al. (2006) found that vitality was sapped by playing, something that was also true in Study III for those who disliked the game's dynamics. However, this was not true for those who held neutral or positive views about the game's dynamics. Other studies that have directly focused on vitality and gaming are scarce, but there are a few studies that have focused on a similar concept, namely experiential energy. Reinecke et al. (2011) noted that satisfaction of recovery needs via activities such as playing a video game was associated with energetic arousal, and that this connection was mediated by enjoyment of the activity. Similarly, in Study III, the amount of vitality in the playing context was moderated by game dynamics preferences. Whether a player likes the game's dynamics is not exactly the same as game enjoyment, but the results are still somewhat similar to Reinecke et al.'s (2011). Another previous finding highlights that whether a person has an internal feeling of "wanting to" play or "having to" play affects perceptions of energy post-play (Przybylski et al., 2009). Namely, those who wanted to play experienced increased levels of energy, whereas those who had an obsessive tendency of "having to play" experienced reduced energy (Przybylski et al., 2009). This relates somewhat to Study III, as the participants were not avid gamers and thus might consider taking part in playing more of a "having to play in the name of science" rather than something that is inherently motivating. This may be particularly true for those participants who disliked the game's dynamics.

The results also showed that perceptions of self-efficacy became weaker in the playing context. Self-efficacy as a concept may be closely related to perceptions of difficulty, as the very definition of self-efficacy is the capability to successfully perform a task (Bandura, 1997). Thus, it is perhaps not surprising that novice players did not experience increased self-efficacy during playing, as they had little experience with playing, and on average considered playing the game somewhat difficult. Ryan et al. (2006) found that participants who expressed more autonomy and competence had more positive psychological outcomes after playing, as opposed to those who did not. In Study III, perceived difficulty correlated with game dynamics preferences, which in turn moderated perceptions of curiosity, vitality, and self-efficacy. However, the amount of self-efficacy still changed as a function of game dynamics preferences, which is an interesting finding in the sense that it can be affected not only by, for example, game difficulty, but by the dynamics content and whether the player likes said dynamics. As self-efficacy and feelings of competence have been considered key concepts that affect game enjoyment (Tamborini et al., 2010; Trepte & Reinecke, 2011), it is interesting that self-efficacy can be manipulated by features that are not necessarily tied to game difficulty, but rather to the dynamics of the game. What this implies is that whether the dynamics are pleasing may have a significant effect on self-efficacy and perceptions of difficulty.

Perhaps one of the most interesting findings of Study III was that those who were neutral or mildly positive toward the content did not experience increases in their curiosity, vitality, or self-efficacy in the playing context as compared to real life. What this implies is that games do not by default provoke curiosity, vitality, or self-efficacy. Thus, the mere structure of the game environment is not enough to foster these experiences. However, there was certainly a perceivable trend in curiosity, vitality, and self-efficacy increasing as a function of game dynamics preferences. This suggests that one has to truly like the game's dynamics in order for these effects to take place. Having said that, the main limitation of Study III was that I had trouble recruiting enough participants that were inexperienced players but still liked violent dynamics. Thus, it is impossible to say whether those who highly prefer violent dynamics would have shown an increase in these measures. In the future, I hope it will be possible to find participants who are not used to playing but have a strong preference for violent dynamics.

The results of Study III contribute to the extensive branch of research on motivations for video game play (e.g., Abeele et al., 2020; Chou & Tsai, 2007; Chumbley & Griffiths, 2006; Colwell, 2007; Connolly et al., 2007; Ferguson & Olson, 2013; Greenberg et al., 2010; Griffiths & Hunt, 1995; Griffiths et al., 2004; Karakus et al., 2008; King & Delfabbro, 2009; Lucas & Sherry, 2004; Sherry et al., 2006; Xu et al., 2012; Yee et al., 2012). Namely, the results demonstrate that curiosity, vitality, and self-efficacy may be worth studying in terms of potential components of playing motivations. The results of Study III showed that these measures differ between real life and playing, demonstrating that playing can alter these measures. These changes, in turn, may contribute to motivation. Moreover, the results indicate that preferences for game content may be a motivational factor in themselves, driving the experience players receive from playing.

8.4 Comparisons Between Studies I, II, and III

As FPS games are known both for their visceral emotional content and for being skill-based competitive games, the studies presented in this thesis explored the role of both emotions and visual attention in gaming. The studies help form a multifaceted view of gaming by exploring how individual differences in game dynamics preferences and visual attention skills affect the game experience. To further form an all-round view of gaming, both gameplay videos and actual playing were used as stimuli. Study I utilized a gameplay video, whereas the participants played the game in Study III. Study II utilized both gameplay videos and playing. In addition, players' background was considered by Studies I and III focusing on novice players, whereas Study II focused on experienced players.

When discussing the results of Study II, I noted that previous experience with FPS games may have affected the results regarding physiological responses, as either desensitization to violence (Bushman & Anderson, 2002; Carnagey et al., 2007; Staude-Müller et al., 2008) or becoming used to the game experience in general (Tyack & Mekler, 2021) could reduce strong arousal reactions to the game. Partly because of this, Study III focused on novice players with differing preferences and looked into their experiential reactions to the game. As they had not had much previous experience with playing video games, it was assumed that their game dynamics preferences would have a more direct effect on the outcomes. In Study III, those who had a neutral or mildly positive preference for violent dynamics experienced a much more stable state in curiosity, vitality, and self-efficacy than those who did not like the dynamics, which showed a similar trend to the physiological arousal measures in Study II. While physiological and experiential measures are not directly comparable, I would like to note that the results of Studies II and III presented a matching analogy: similarly to the physiological arousal state of experienced players in Study II, inexperienced players showed significant changes in their psychological state as a function of dynamics preferences. The combined results of Studies II and III thus indicate that game dynamics as such have an effect on psychological outcomes, and may not be solely related to desensitization or other experience-related phenomena.

The results of Studies II and III also gave evidence that game dynamics preferences are not associated with experiential arousal, at least when measured with the SAM. Namely, in Study III, both of the dynamics preference comparison groups reported similar arousal states, which is in line with the experiential arousal measures of Study II. As for valence, however, participants with differing preferences indicated similar valence in Study II but not in Study III. One explanation for this finding could be differences in expertise and interest toward playing in general. The participants in Study II were avid players, and thus even those participants who did not prefer violent dynamics could have been intellectually interested in the game, leading to similar evaluations of valence with the dislike group. In contrast, the participants in Study III were not active video game players, and thus likely not very enthusiastic about playing in general. Thus, their preferences for the game's dynamics could have played a larger role in their evaluations of valence.

A key implication of both Studies II and III is that there may be rather simple explaining factors that affect the game experience, either when it comes to physiological responses or to larger self-reflections about curiosity, vitality, and self-efficacy. Earlier studies on gaming motivations have often adopted grand motivational theories, such as the Self-Determination Theory (Deci & Ryan, 2013; Ryan & Deci, 2017), when discussing what drives people to play video games or how games affect players (Tyack & Mekler, 2020). While this is laudable, I argue that there are also simple factors, such as game dynamics preferences (Tondello et al., 2017; Tondello & Nacke, 2019; Vahlo et al., 2017), that can have a profound impact on emotions and motivation. In short, simply asking players what they would prefer to do in a game and seeing whether the game matches that ideal can explain a great deal of the psychological outcomes of playing, and perhaps help in understanding why people choose to play in the first place. The results of both Study II and III thus help justify the use of game dynamics preferences as a valid theme in studying player experience, along with more comprehensive concepts. The results of Study III also highlights the practicality of using game dynamics preferences – even novice players know what kind of content they would prefer before playing, and experience psychological changes during playing that are in line with their preferences.

What the findings of Studies II and III also highlight is that game dynamics need to be taken into account as moderating factors, for example when studying the effects of violent content in games or when conducting playtests. Namely, it is to be expected that players who do not like the content of certain types of games will react negatively toward them, as indexed by dynamics preferences moderating physiological arousal and experiences of curiosity, vitality, and self-efficacy. While FPS games do tend to be popular, it is also likely that many people find them off-putting because of their visceral and morally questionable dynamics. If participants are recruited randomly and made to play violent content, it is more than likely that many of the participants will be opposed to the dynamics, which may show up in arousal responses, which in turn may lead to interpretation errors. Because of this, players' content preferences need to be controlled for or added to the analyses in future studies.

Finally, the results of Study III show that playing not only leads to the short-term physiological responses that were identified in Study II, but also to changes in wider experiential reflections related to playing, such as vitality, curiosity, and self-efficacy. This is in line with other results showing that video game playing may affect broader psychological functioning and well-being (Reinecke, 2009a; Reinecke et al., 2011), although the time period studied here referred only to during or instantly after playing. In the future, it would be fruitful to utilize intervention studies to see whether these changes last longer.

While Studies II and III handled to some extent similar topics, namely game dynamics and emotion or motivation-related concepts, Study I focused more on the cognitive aspects of the game experience. However, these themes are intertwined: how visual attention skills affect the following of a game may have a profound effect on the emotion-related responses players have. The game experience is an all-encompassing concept that needs to be studied comprehensively. Because the scope of this thesis is limited, it is left for future studies to explore how visual attention skills are connected to emotions and motivation in the FPS gameplay experience. One unifying topic that might bridge the cognitive and emotion-related responses is perceived difficulty. Namely, it is likely that visual attention skills affect perceptions of difficulty, which in turn likely affect emotions and motivation.

8.5 Implications and Future Directions for Games User Research

The current work has significance for GUR and game development. For example, the results regarding game dynamics preferences indicate that it could be fruitful to tailor and personalize games based on players' and viewers' dynamics preferences. The role of dynamics preferences has previously been studied in the context of gamification. Gamification means using game elements in a non-gaming setting to achieve goals such as learning (Deterding et al., 2011). There is some evidence that personalizing a gamified environment may lead to more motivated users (Rodrigues et al., 2020). Motivation, in turn, is particularly important because players need to stick with the gamified intervention or learning platform in order for it to be effective. Because of this, gamification as a research field has recently discussed player segmentation and personalization more and more (Passalacqua et al., 2021). Recently, scales focused on game dynamics or game element preferences have been developed with personalization in mind (Tondello et al., 2016; Tondello et al., 2019). Importantly, personalization based on these preferences has been shown to potentially increase performance in a gamified environment (Tondello & Nacke, 2020). This along with my results suggest that game dynamics preferences could indeed be an effective tool in GUR. For example, games could be designed with a specific player dynamics preference type in mind, utilizing a limited set of dynamics. Alternatively, a game could include a more varied set of dynamics and then provide options and choices that lead to the preferred dynamics.

Besides highlighting the potential utility of game dynamics preferences, the results of the studies have other implications for GUR. For example, the results of Study II pointed out potential pitfalls and strengths of utilizing physiological measures as indexes of emotions in GUR. Namely, the reactions' origins can be multidimensional and thus hard to interpret, but on the other hand, physiological measures may be able to detect changes that would not be noted in self-reports. This showed up in the results of Study II: game dynamics preferences were reflected in physiological signals, but not in reports of arousal and valence. This sensitivity may be particularly beneficial in playtesting. For example, if a player only says that something is "ok" to more or less everything, looking at their physiological data may be more helpful than self-reports to understand their user experience. Besides giving information that might otherwise be missed, a known benefit of using physiological measures in GUR is not disrupting players while they are playing. As IJsselstein et al. (2007) explain, one main difficulty of assessing player experience in the middle of playing is that it may "break the spell," which is particularly true for self-reports such as think-alouds.

In addition to pointing out pitfalls and strengths of physiological measures, Study II used novel methods in a game context for the data analysis of the physiological data. Namely, the study focused on how physiological responses evolve during a play session. This may be of interest to GUR experts who wish to know more about physiological responses across time.

The results of Study II are also relevant for physiological computing, which refers to the interaction between computerized systems and human physiological responses (Fairclough, 2009). In a gaming context, this is usually known as affective or adaptive gaming (Bontchev, 2016; Gilleade et al., 2005). Physiological computing may be used, for example, to maximize pleasure associated with using systems such as video games by having the game system monitor and respond to the players' affective psychophysiology (Bontchev, 2016; Fairclough, 2009). For instance, if the players' HR speeds up too much, the game may adapt its content to lower it. In fact, tailoring game content and difficulty to individual players in the process of playing is one area where game development is heading (Bakkes et al., 2012; Bontchev, 2016; Gilleade et al., 2005). Among other things, there has been an effort to utilize players' facial expressions during playing to mold the way a game progresses during playing (Blom et al., 2014). The results of Study II indicated that there may be difficulties ahead for using facial EMG responses as measures of valence for physiological computing. Other possible pitfalls of using physiological measures were discussed previously and also pertain to shaping how a game progresses.

Concerning physiological responses and emotions, further research could be done on what kind of and what intensity of emotions are expected from a good player experience. Many studies measure player experience in terms of positive valence (Mekler et al., 2014), but perhaps this should be discussed critically more in GUR. For example, it has been noted that some players may wish to feel and process initially negative emotions through playing (Bopp et al., 2018). Also, one might want to look further into the preferred change or fluctuation in emotional responses over the course of playing a game. In short, should a good player experience elicit constant strong and positive emotional reactions during the course of an entire game? Or does it consist of something else, such as having a variety of different sorts of responses? Will players get bored and quit playing a game if it no longer induces peak experiences? Recently, Tyack and Mekler (2021) have discussed these topics and suggested that playing often becomes an ordinary, everyday experience once players become experienced enough. In the future, it would be interesting to know whether this potential decrease in emotionally invigorating experiences over time affects frequencies of playing sessions and session lengths, for example. In my opinion, the discussion put forward by Tyack and Mekler (2021) may also suggest that motivations for playing could shift as players become more used to a game or their lifelong experience with gaming becomes extensive enough. If this is true, it may affect what kind of experiences are sought from playing.

As for the results regarding eye movements, Study I showed that the viewers' visual attention skills have an effect on how the screen is scanned. This, in turn, suggests that the visual qualities of FPS games are cognitively straining and may create accessibility issues for some players or viewers. Moreover, game designers may not realize what the end product looks like to the user – some players may look at things that were not intended to be paid attention to, or they might not find the relevant targets, and so on. In general, the interplay between visual attention, perceived difficulty, and performance has implications for game design, esports training, and accessibility. For game design, finding an optimally challenging visual environment for each player could be a key factor that affects game enjoyment. As for accessibility, it could be that some viewers might benefit from visual aids that highlight areas of particular importance. This could be important in for example esports streams that often present an overcrowded screen. In general, more research needs to look into the topic to make actionable suggestions on how to tailor games' visual qualities to meet the visual attention capabilities of players and viewers, while still offering a challenge to those who want it.

Another area that needs further research is the way visual attention skills affect the game experience of games used for cognitive rehabilitation. Action video games have been indicated as a possible means of cognitive training (e.g., Griffiths et al., 2017; Toril et al., 2014; Strobach et al., 2012), and may thus be used in cognitive rehabilitation programs in the future. Some feasibility studies on utilizing action video games in cognitive rehabilitation indicate that participants in interventions may need a great deal of support in sticking to the intervention (Välimäki et al., 2018). This may have to do with accessibility issues or personal preferences for game content; that is, the game not being motivating enough for various reasons. While action video games used for rehabilitation should pose enough cognitive load to enhance visual attention, participants in interventions may find them too hard to follow in the first place or might not like the games' dynamics, which may affect their persistence with the intervention. Thus, the results of all of the studies in this thesis have implications for the design of cognitive rehabilitation games for visual attention. Namely, Study I indicated that differences in visual attention skills clearly affect how participants scan the screen, and Studies II and III showed that game dynamics preferences affect emotion-related and motivational responses. In short, it seems that games utilized in interventions need to be at least somewhat tailored to the needs of the users, although further studies on this topic are needed.

In general, the academic GUR field has so far utilized eye tracking fairly little compared to other methods. For future research, my suggestion would be not to jump immediately into having participants play a game, but to take a step back and focus first on a slightly less complex stimulus, such as a pre-recorded video of gameplay. The difficulty of using eye movement methods when investigating playing lies in the fact that video games tend to be very dynamic, cluttered, and full of ever-changing activity, resulting in eye movement patterns that may be hard to interpret. This is especially true given that dynamic scene perception research is still very much in a developing stage. What is more, the nature of video games is that each player undertakes their own actions while playing, creating a stimulus environment that is unique to each player. This, in turn, makes comparisons between participants difficult. Moreover, novice players in particular may glance at other things than the screen, such as the gaming pad they are using. For reasons such as these, eye movement recordings may still be considered a somewhat challenging method for studying video game playing in a user research context, especially if aiming for rigorous study standards. Nevertheless, given that digital games are mostly a visual medium, eye tracking could be a particularly informative method, especially in the future.

8.6 Conclusion

Three people sit in a restaurant, each with a glass of red wine in front of them. One of them is a wine connoisseur who loves drinking wine, one is a person who has never had wine before but would like to try it, and the third one is an absolutist because of moral reasons. They are taking part in an experiment on the experience of drinking wine. Each person is asked to drink the wine. Given their backgrounds, it is likely they will have differing experiences. The connoisseur will likely enjoy the wine and be able to appreciate its many notes. The person who is tasting wine for the first time but is not opposed to it will likely taste strong bitterness, which may be either unpleasant or pleasant. The person who has moral qualms about drinking the wine in the first place may find the experience distasteful despite agreeing to the experiment.

While this example is a very simplified analogy to the topic at hand, it is my view that video game studies on FPS games present a similar phenomenon. Namely, besides previous experience with games, the personal preferences and other qualities of the players should be taken into account to truly understand the game experience. If a person is asked to play a game in which they must violently maim and kill other characters, they will likely experience negative reactions if they dislike such in-game actions in the first place. Conversely, if the player already holds positive views about the content before playing, it is likely that they will enjoy the experience. Moreover, other features of the player such as their visual attention skills are a prerequisite for being able to follow the game in the first place. Also, whether one is able to see relevant objects in the game is likely to affect the overall game experience. To use the wine analogy, some people have more taste buds on their tongue and may thus be better able to taste the many notes of the wine. Similarly, some people have visual attention skills that make following the game easier.

The results of this thesis help in understanding individual variation in the playing experience: players and viewers have differing skills and preferences. These skills and preferences in turn are connected to how players or viewers pay attention to the game, and what kind of physiological and experiential reactions they have. The association between players' game dynamics preferences and emotion-related game experience has not been previously explored in the manner presented in this thesis.

Therefore, it has not been known whether the content preferences of players are just abstract self-reflections or whether they show up during playing and viewing of video games as emotion-related responses. Neither has it been known whether these preferences affect larger-scale motivational components such as curiosity, vitality, and self-efficacy. To my knowledge, this thesis also presents the first study on how visual attention skills show up as eye movements during video game spectating. The results have implications for GUR and game design, and various fields of psychology, such as aggression-related research and dynamic scene perception.

The game experience of FPS games was explored with a wide perspective, including both playing and viewing, and using game dynamics preferences and visual attention skills as a starting point. The methodological choices can be seen as laudable in the sense that they consist of diverse measures, handle findings that all center around the topic of the FPS game experience, present novel methodology in terms of data analysis, and delve into under-researched topics. However, the studies presented here are merely a starting point and somewhat exploratory in nature. Thus, my hope is that they might inspire future endeavors in the academic literature.

The mechanics of games vary, game content varies, and the players and spectators themselves vary. In determining what the users' game experience is like, all of these factors and more need to be acknowledged. In this thesis, I have shown that the game dynamics preferences and visual attention skills of users of video games have a profound impact on the game experience. Moreover, I have argued that studies focusing on the game experience should include a diverse methodology that touches on several aspects of the game experience and the psychology of the player or viewer.

Abbreviations

AB	Attentional Blink
EMG	Electromyography
EDA	Electrodermal Activity
FPS	First-Person Shooter
GAIN	The Gameplay Activity Inventory
GUR	Games User Research
HR	Heart Rate
MOT	Multiple Object Tracking
SAM	The Self-Assessment Manikin
SCL	Skin Conductance Level
SCR	Skin Conductance Response
VS	Visual Search

List of References

Abeele, V. V., Spiel, K., Nacke, L., Johnson, D., & Gerling, K. (2020). Development and validation of the player experience inventory: A scale to measure player experiences at the level of functional and psychosocial consequences. *International Journal of Human-Computer Studies, 135*, 102370. https://doi.org/10.1016/j.ijhcs.2019.102370

Adachi, P. J. C., & Willoughby, T. (2011). The effect of video game competition and violence on aggressive behavior: Which characteristic has the greatest influence? *Psychology of Violence, 1*(4), 259. https://doi.org/10.1037/a0024908

Ahmed, I., Mahapatra, A., Poole, M. S., Srivastava, J., & Brown, C. (2014). Identifying a typology of players based on longitudinal game data. In M. Ahmad, C. Shen, J. Srivastava & N. Contractor (Eds.), *Predicting Real World Behaviors from Virtual World Data. Springer Proceedings in Complexity* (pp. 103-115). Springer, Cham. https://doi.org/10.1007/978-3-319-07142-8_7

Almeida, S., Veloso, A., Roque, L., & Mealha, Ó. (2011). The eyes and games: A survey of visual attention and eye tracking input in video games. *Proceedings of SBGames 2011*, 1-10.

Altmeyer, M., Tondello, G. F., Krüger, A., & Nacke, L. E. (2020). Hexarcade: Predicting hexad user types by using gameful applications. *CHI Play '20: Proceedings of the Annual Symposium on Computer-Human Interaction in Play*, 219-230. https://doi.org/10.1145/3410404.3414232

Anderson, C. A., & Bushman, B. J. (2001). Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: A meta-analytic review of the scientific literature. *Psychological Science, 12*(5), 353-359. https://doi.org/10.1111/1467-9280.00366

Antes, J. R. (1974). The time course of picture viewing. *Journal of Experimental Psychology, 103*(1), 62. https://doi.org/10.1037/h0036799

Appelhans, B. M., & Luecken, L. J. (2006). Heart rate variability as an index of regulated emotional responding. *Review of General Psychology, 10*(3), 229-240. https://doi.org/10.1037/1089-2680.10.3.229

Bakkes, S., Tan, C. T., & Pisan, Y. (2012). Personalised gaming: A motivation and overview of literature. *IE '12: Proceedings of The 8th Australasian Conference on Interactive Entertainment: Playing the System*, 1-10. https://doi.org/10.1145/2336727.2336731

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W H Freeman/Times Books/Henry Holt & Co.

Bartle, R. (1996). Hearts, clubs, diamonds, spades: Players who suit MUDs. *Journal of MUD Research, 1*(1), 19.

Bartsch, A., Vorderer, P., Mangold, R., & Viehoff, R. (2008). Appraisal of emotions in media use: Toward a process model of meta-emotion and emotion regulation. *Media Psychology, 11*(1), 7-27. https://doi.org/10.1080/15213260701813447

Bateman, C., Lowenhaupt, R., & Nacke, L. E. (2011). Player typology in theory and practice. *DiGRA '11 - Proceedings of the 2011 DiGRA International Conference: Think Design Play, 6*, 1-24.

Bavelier, D., & Green, C. S. (2019). Enhancing attentional control: Lessons from action video games. *Neuron, 104*(1), 147-163. https://doi.org/10.1016/j.neuron.2019.09.031

Karpov, B. A., Luria, A. R., & Yarbus, A. L. (1968). Disturbances of the structure of active perception in lesions of the posterior and anterior regions of the brain. *Neuropsychologia, 6*(2), 157-166. https://doi.org/10.1016/0028-3932(68)90057-2

Kashdan, T. B., Gallagher, M. W., Silvia, P. J., Winterstein, B. P., Breen, W. E., Terhar, D., & Steger, M. F. (2009). The curiosity and exploration inventory-II: Development, factor structure, and psychometrics. *Journal of Research in Personality, 43*(6), 987-998. https://doi.org/10.1016/j.jrp.2009.04.011

Kashdan, T. B., Rose, P., & Fincham, F. D. (2004). Curiosity and exploration: Facilitating positive subjective experiences and personal growth opportunities. *Journal of Personality Assessment, 82*(3), 291-305. https://doi.org/10.1207/s15327752jpa8203_05

Kiili, K., Ketamo, H., & Kickmeier-Rust, M. D. (2014). Evaluating the usefulness of eye tracking in game-based learning. *International Journal of Serious Games, 1*(2). https://doi.org/10.17083/ijsg.v1i2.15

King, D. L., & Delfabbro, P. (2009). Motivational differences in problem video game play. *Journal of Cybertherapy and Rehabilitation, 2*(2), 139-149.

King, D., Delfabbro, P., & Griffiths, M. (2009). The psychological study of video game players: Methodological challenges and practical advice. *International Journal of Mental Health and Addiction, 7*(4), 555-562. https://doi.org/10.1007/s11469-009-9198-0

Kinnunen, J., Tuomela, M., & Mäyrä, F. (2022). Pelaajabarometri 2022: Kohti uutta normaalia. *TRIM Research Reports, 31*.

Kivikangas, J. M., Chanel, G., Cowley, B., Ekman, I., Salminen, M., Järvelä, S., & Ravaja, N. (2011). A review of the use of psychophysiological methods in game research. *Journal of Gaming & Virtual Worlds, 3*(3), 181-199. https://doi.org/10.1386/jgvw.3.3.181_1

Klarkowski, M., Johnson, D., Wyeth, P., Phillips, C., & Smith, S. (2018). Don't sweat the small stuff: The effect of challenge-skill manipulation on electrodermal activity. *CHI PLAY '18: Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play*, 231-242. https://doi.org/10.1145/3242671.3242714

Kleinginna, P. R., & Kleinginna, A. M. (1981). A categorized list of emotion definitions, with suggestions for a consensual definition. *Motivation and Emotion, 5*(4), 345-379. https://doi.org/10.1007/BF00992553

Klimmt, C., Hartmann, T., & Frey, A. (2007). Effectance and control as determinants of video game enjoyment. CyberPsychology & Behavior, 10(6), 845-848. https://doi.org/10.1089/cpb.2007.9942

Klimmt, C., & Hartmann, T. (2006). Effectance, self-efficacy, and the motivation to play video games. In P. Vorderer & J. Bryant (Eds.), *Playing video games: Motives, responses, and consequences* (pp. 133–145). Lawrence Erlbaum Associates Publishers.

Klimmt, C., Blake, C., Hefner, D., Vorderer, P., Roth, C. (2009). Player performance, satisfaction, and video game enjoyment. In S. Natkin & J. Dupire (Eds.), *Entertainment computing – ICEC 2009. Lecture notes in computer science* (Vol. 5709, pp. 1-12). Springer. https://doi.org/10.1007/978-3-642-04052-8_1

Koposov, D., Semenova, M., Somov, A., Lange, A., Stepanov, A., & Burnaev, E. (2020). Analysis of the reaction time of esports players through the gaze tracking and personality trait. *2020 IEEE 29th International Symposium on Industrial Electronics (ISIE),* 1560-1565. https://doi.org/10.1109/ISIE45063.2020.9152422

Krcmar, M., Farrar, K. M., Jalette, G., & McGloin, R. (2015). Appetitive and defensive arousal in violent video games: Explaining individual differences in attraction to and effects of video games. *Media Psychology, 18*(4), 527-550. https://doi.org/10.1080/15213269.2014.888007

Kubey, R., & Larson, R. (1990). The use and experience of the new video media among children and young adolescents. *Communication Research, 17*(1), 107-130. https://doi.org/10.1177/009365090017001006

Kumari, S., Deterding, S., & Freeman, J. (2019). The role of uncertainty in moment-to-moment player motivation: A grounded theory. *CHI PLAY '19: Proceedings of the Annual Symposium on Computer-Human Interaction in Play*, 351-363. https://doi.org/10.1145/3311350.3347148

Burch, M., Pfleging, B., Bernhaupt, R., & Lankes, M. (2022). 3rd Eye Tracking in Games and Play Workshop (PLEY 2022). *ETRA '22: 2022 Symposium on Eye Tracking Research and Applications*.

Burroughs, B., & Rama, P. (2015). The eSports Trojan horse: Twitch and streaming futures. *Journal of Virtual Worlds Research, 8*(2). https://doi.org/10.4101/jvwr.v8i2.7176

Bushman, B. J., & Anderson, C. A. (2002). Violent video games and hostile expectations: A test of the general aggression model. *Personality and Social Psychology Bulletin, 28*(12), 1679-1686. https://doi.org/10.1177/014616702237649

Buswell, G. T. (1935). *How people look at pictures: A study of the psychology and perception in art*. Univ. Chicago Press.

Cacioppo, J. T., Bush, L. K., & Tassinary, L. G. (1992). Microexpressive facial actions as a function of affective stimuli: Replication and extension. *Personality and Social Psychology Bulletin, 18*(5), 515-526. https://doi.org/10.1177/0146167292185001

Cacioppo, J. T., & Tassinary, L. G. (1990). Inferring psychological significance from physiological signals. *American Psychologist, 45*(1), 16. https://doi.org/10.1037/0003-066X.45.1.16

Canossa, A., Drachen, A., & Sørensen, J. R. M. (2011). Arrrgghh!!! Blending quantitative and qualitative methods to detect player frustration. *FDG '11: Proceedings of the 6th International Conference on Foundations of Digital Games,* 61-68. https://doi.org/10.1145/2159365.2159374

Carmi, R., & Itti, L. (2006). Visual causes versus correlates of attentional selection in dynamic scenes. *Vision Research, 46*(26), 4333-4345. https://doi.org/10.1016/j.visres.2006.08.019

Carnagey, N. L., Anderson, C. A., & Bushman, B. J. (2007). The effect of video game violence on physiological desensitization to real-life violence. *Journal of Experimental Social Psychology, 43*(3), 489-496. https://doi.org/10.1016/j.jesp.2006.05.003

Carrasco, M. (2011). Visual attention: The past 25 years. *Vision Research, 51*(13), 1484-1525 https://doi.org/10.1016/j.visres.2011.04.012

Castelhano, M. S., & Krzyś, K. (2020). Rethinking Space: A Review of Perception, Attention, and Memory in Scene Processing. *Annual Review of Vision Science, 6*(1), 563-586. https://doi.org/10.1146/annurev-vision-121219-081745

Chisholm, J. D., Hickey, C., Theeuwes, J., & Kingstone, A. (2010). Reduced attentional capture in action video game players. *Attention, Perception, & Psychophysics, 72*(3), 667-671. https://doi.org/10.3758/APP.72.3.667

Choi, G., & Kim, M. (2018). Eye gaze information and game level design according to FPS gameplay beats. *Journal of Information and Communication Convergence Engineering, 16*(3), 189-196. https://doi.org/10.6109/jicce.2018.16.3.189

Chou, C., & Tsai, M. J. (2007). Gender differences in Taiwan high school students' computer game playing. *Computers in Human Behavior, 23*(1), 812-824. https://doi.org/10.1016/j.chb.2004.11.011

Christy, T., & Kuncheva, L. I. (2014). Technological advancements in affective gaming: A historical survey. *GSTF Journal on Computing (JoC), 3*(4), 1-10.

Chumbley, J., & Griffiths, M. (2006). Affect and the computer game player: The effect of gender, personality, and game reinforcement structure on affective responses to computer game-play. *CyberPsychology & Behavior, 9*(3), 308-316. https://doi.org/10.1089/cpb.2006.9.308

Cohen, B. H., Davidson, R. J., Senulis, J. A., Saron, C. D., & Weisman, D. R. (1992). Muscle tension patterns during auditory attention. *Biological Psychology, 33*(2-3), 133-156. https://doi.org/10.1016/0301-0511(92)90028-S

Colwell, J. (2007). Needs met through computer game play among adolescents. *Personality and Individual Differences, 43*(8), 2072-2082. https://doi.org/10.1016/j.paid.2007.06.021

Connolly, T. M., Boyle, E. A., Stansfield, M. H., & Hainey, T. (2007). A survey of students' computer game playing habits. *International Journal for Advanced Technology for Learning, 4*, 218-223. https://doi.org/10.2316/Journal.208.2007.4.208-0923

Critchley, H. D. (2002). Electrodermal responses: What happens in the brain. *The Neuroscientist, 8*(2), 132-142. https://doi.org/10.1177/107385840200800209

Crivelli, C., & Fridlund, A. J. (2018). Facial displays are tools for social influence. *Trends in Cognitive Sciences, 22*(5), 388-399. https://doi.org/10.1016/j.tics.2018.02.006

Dahl, M., Tryding, M., Heckler, A., & Nyström, M. (2021). Quiet eye and computerized precision tasks in first-person shooter perspective esport games. *Frontiers in Psychology*, 5142. https://doi.org/10.3389/fpsyg.2021.676591

Dale, G., Joessel, A., Bavelier, D., & Green, C. S. (2020). A new look at the cognitive neuroscience of video game play. *Annals of the New York Academy of Sciences, 1464*(1), 192-203. https://doi.org/10.1111/nyas.14295

Darzi, A., Wondra, T., McCrea, S., & Novak, D. (2019). Classification of multiple psychological dimensions in computer game players using physiology, performance, and personality characteristics. *Frontiers in Neuroscience, 13*, 1278. https://doi.org/10.3389/fnins.2019.01278

Dawson, M.E., Schell, A.M., Filion, D.L., 2007. The Electrodermal System. In J. T. Cacioppo, L. G. Tassinary & G. G. Berntson (Eds.), *Handbook of psychophysiology* (pp. 159–181). Cambridge University Press. https://doi.org/10.1017/CBO9780511546396.007

Deci, E. L., & Ryan, R. M. (2013). *Intrinsic motivation and self-determination in human behavior*. Springer Science & Business Media.

De Morree, H. M., & Marcora, S. M. (2010). The face of effort: Frowning muscle activity reflects effort during a physical task. *Biological Psychology, 85*(3), 377-382. https://doi.org/10.1016/j.biopsycho.2010.08.009

Derryberry, D., & Rothbart, M. K. (1988). Arousal, affect, and attention as components of temperament. *Journal of Personality and Social Psychology, 55*(6), 958. https://doi.org/10.1037/0022-3514.55.6.958

Desimone, R., & Duncan, J. (1995). Neural mechanisms of selective visual attention. *Annual Review of Neuroscience, 18*(1), 193-222. https://doi.org/10.1146/annurev.ne.18.030195.001205

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining "gamification". *MindTrek '11: Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*, 9-15. https://doi.org/10.1145/2181037.2181040

Dorr, M., Martinetz, T., Gegenfurtner, K. R., & Barth, E. (2010). Variability of eye movements when viewing dynamic natural scenes. *Journal of Vision, 10*(10), 28-28. https://doi.org/10.1167/10.10.28

Drachen, A. (2015). Behavioral telemetry in games user research. In R. Bernhaupt (Ed.), *Game user experience evaluation* (pp. 135-165). Springer, Cham. https://doi.org/10.1007/978-3-319-15985-0_7

Drachen, A., Canossa, A., & Yannakakis, G. N. (2009). Player modeling using self-organization in Tomb Raider: Underworld. *2009 IEEE Symposium on Computational Intelligence and Games*, 1-8. https://doi.org/10.1109/CIG.2009.5286500

Drachen, A., Nacke, L. E., Yannakakis, G., & Pedersen, A. L. (2010). Correlation between heart rate, electrodermal activity and player experience in first-person shooter games. *Sandbox '10: Proceedings of the 5th ACM SIGGRAPH Symposium on Video Games*, 49-54. https://doi.org/10.1145/1836135.1836143

Drachen, A., Mirza-Babaei, P., & Nacke, L. E. (2018). *Games user research*. Oxford University Press. https://doi.org/10.1093/oso/9780198794844.001.0001

Duncan, J., Ward, R., & Shapiro, K. (1994). Direct measurement of attentional dwell time in human vision. *Nature, 369*(6478), 313-315. https://doi.org/10.1038/369313a0

Eckstein, M. P. (2011). Visual search: A retrospective. *Journal of Vision, 11*(5), 14-14. https://doi.org/10.1167/11.5.14

Eisenberg, M. L., & Zacks, J. M. (2016). Ambient and focal visual processing of naturalistic activity. *Journal of Vision, 16*(2), 5-5. https://doi.org/10.1167/16.2.5

Ekman, P. (1999). Basic emotions. In T. Dalgleish & M. J. Power (Eds.), *Handbook of cognition and emotion* (pp. 45-60). John Wiley & Sons, Ltd. https://doi.org/10.1002/0470013494.ch3

Ellsworth, P. C., & Scherer, K. R. (2003). Appraisal processes in emotion. In R. J. Davidson & K. R. Scherer (Eds.), *Handbook of affective sciences* (pp. 572-596). Oxford University Press.

Fairclough, S. H. (2009). Fundamentals of physiological computing. *Interacting with Computers, 21*(1-2), 133-145. https://doi.org/10.1016/j.intcom.2008.10.011

Ferguson, C. J. (2007). The good, the bad and the ugly: A meta-analytic review of positive and negative effects of violent video games. *Psychiatric Quarterly, 78*(4), 309-316. https://doi.org/10.1007/s11126-007-9056-9

Ferguson, C. J. (2015). Do angry birds make for angry children? A meta-analysis of video game influences on children's and adolescents' aggression, mental health, prosocial behavior, and academic performance. *Perspectives on Psychological Science, 10*(5), 646-666. https://doi.org/10.1177/1745691615592234

Ferguson, C. J. (2018). *Video game influences on aggression, cognition, and attention*. Springer. https://doi.org/10.1007/978-3-319-95495-0

Ferguson, C.J., Bowman, N.D. and Kowert, R. (2017). Is the link between games and aggression more about the player, less about the game? In P. Sturmey (Ed.), *The Wiley handbook of violence and aggression*. John Wiley & Sons Ltd. https://doi.org/10.1002/9781119057574.whbva036

Ferguson, C. J., & Olson, C. K. (2013). Friends, fun, frustration and fantasy: Child motivations for video game play. *Motivation and Emotion, 37*(1), 154-164. https://doi.org/10.1007/s11031-012-9284-7

Friedman, A., & Liebelt, L. S. (1981). On the time course of viewing pictures with a view towards remembering. In D. F. Fisher, R. A. Monty & J. W. Senders (Eds.), *Eye movements: Cognition and visual perception* (pp. 137-155). Routledge. https://doi.org/10.4324/9781315437415-12

Gegenfurtner, A., Lehtinen, E., & Säljö, R. (2011). Expertise differences in the comprehension of visualizations: A meta-analysis of eye-tracking research in professional domains. *Educational Psychology Review, 23*(4), 523-552. https://doi.org/10.1007/s10648-011-9174-7

Gentile, D. A. (2016). The evolution of scientific skepticism in the media violence "debate". *Analyses of Social Issues and Public Policy, 16*(1), 429-434. https://doi.org/10.1111/asap.12110

Gentile, D. A., Swing, E. L., Anderson, C. A., Rinker, D., & Thomas, K. M. (2016). Differential neural recruitment during violent video game play in violent-and nonviolent-game players. *Psychology of Popular Media Culture, 5*(1), 39. https://doi.org/10.1037/ppm0000009

Gilleade, K., Dix, A., & Allanson, J. (2005). Affective videogames and modes of affective gaming: Assist me, challenge me, emote me. *DiGRA '05 - Proceedings of the 2005 DiGRA International Conference: Changing Views: Worlds in Play, 3*, 1-7.

Green, C. S., & Bavelier, D. (2003). Action video game modifies visual selective attention. *Nature, 423*(6939), 534-537. https://doi.org/10.1038/nature01647

Green, C. S., & Bavelier, D. (2006). Effect of action video games on the spatial distribution of visuospatial attention. *Journal of Experimental Psychology, 32*, 1465-1478. https://doi.org/10.1037/0096-1523.32.6.1465

Green, C. S., & Bavelier, D. (2007). Action-video-game experience alters the spatial resolution of vision. *Psychological Science, 18*(1), 88-94. https://doi.org/10.1111/j.1467-9280.2007.01853.x

Greenberg, B. S., Sherry, J., Lachlan, K., Lucas, K., & Holmstrom, A. (2010). Orientations to video games among gender and age groups. *Simulation & Gaming, 41*(2), 238-259. https://doi.org/10.1177/1046878108319930

Griffiths, M. D., Davies, M. N., & Chappell, D. (2004). Online computer gaming: A comparison of adolescent and adult gamers. *Journal of Adolescence, 27*(1), 87-96. https://doi.org/10.1016/j.adolescence.2003.10.007

Griffiths, M. D., & Hunt, N. (1995). Computer game playing in adolescence: Prevalence and demographic indicators. *Journal of Community & Applied Social Psychology, 5*(3), 189-193. https://doi.org/10.1002/casp.2450050307

Griffiths, M. D., Kuss, D. J., & de Gortari, A. B. O. (2017). Videogames as therapy: An updated selective review of the medical and psychological literature. *International Journal of Privacy and*

Health Information Management (IJPHIM), 5(2), 71-96. https://doi.org/10.4018/IJPHIM.2017070105

Hartmann, T., & Vorderer, P. (2010). It's okay to shoot a character: Moral disengagement in violent video games. *Journal of Communication, 60*(1), 94-119. https://doi.org/10.1111/j.1460-2466.2009.01459.x

Hasan, Y., Bègue, L., & Bushman, B. J. (2013). Violent video games stress people out and make them more aggressive. *Aggressive Behavior, 39*(1), 64-70. https://doi.org/10.1002/ab.21454

Heller, W. (1993). Neuropsychological mechanisms of individual differences in emotion, personality, and arousal. *Neuropsychology, 7*(4), 476. https://doi.org/10.1037/0894-4105.7.4.476

Henderson, J. M. (2003). Human gaze control during real-world scene perception. *Trends in Cognitive Sciences, 7*(11), 498-504. https://doi.org/10.1016/j.tics.2003.09.006

Henderson, J. M., & Hayes, T. R. (2017). Meaning-based guidance of attention in scenes as revealed by meaning maps. *Nature Human Behaviour, 1*(10), 743-747. https://doi.org/10.1038/s41562-017-0208-0

Henderson, J. M., Hayes, T. R., Peacock, C. E., & Rehrig, G. (2019). Meaning and attentional guidance in scenes: A review of the meaning map approach. *Vision, 3*(2), 19. https://doi.org/10.3390/vision3020019

Henderson, J. M., Hayes, T. R., Peacock, C. E., & Rehrig, G. (2021). Meaning maps capture the density of local semantic features in scenes: A reply to Pedziwiatr, Kümmerer, Wallis, Bethge & Teufel (2021). *Cognition, 214*, 104742. https://doi.org/10.1016/j.cognition.2021.104742

Hilgard, J., Sala, G., Boot, W. R., & Simons, D. J. (2019). Overestimation of action-game training effects: Publication bias and salami slicing. *Collabra: Psychology, 5*(1). https://doi.org/10.1525/collabra.231

IJsselsteijn, W., De Kort, Y., Poels, K., Jurgelionis, A., & Bellotti, F. (2007). Characterising and measuring user experiences in digital games. *Proceedings of the International Conference on Advances in Computer Entertainment Technology*, *2*, 1-4.

Ivarsson, M., Anderson, M., Åkerstedt, T., & Lindblad, F. (2013). The effect of violent and nonviolent video games on heart rate variability, sleep, and emotions in adolescents with different violent gaming habits. *Psychosomatic Medicine, 75*(4), 390-396. https://doi.org/10.1097/PSY.0b013e3182906a4c

Feng, J., Spence, I., & Pratt, J. (2007). Playing an action video game reduces gender differences in spatial cognition. *Psychological Science, 18*, 850-855. https://doi.org/10.1111/j.1467-9280.2007.01990.x

Funk, J. B., Chan, M., Brouwer, J., & Curtiss, K. (2006). A biopsychosocial analysis of the video game-playing experience of children and adults in the United States. *SIMILE: Studies in Media & Information Literacy Education, 6*(3), 79. https://doi.org/10.3138/sim.6.3.001

Hamari, J., & Sjöblom, M. (2017). What is eSports and why do people watch it? *Internet Research, 27*(2), 211-232. https://doi.org/10.1108/IntR-04-2016-0085

Hamari, J., & Tuunanen, J. (2014). Player types: A meta-synthesis. *Transactions of the Digital Games Research Association, 1*(2), 29-53. https://doi.org/10.26503/todigra.v1i2.13

Jansz, J., & Tanis, M. (2007). Appeal of playing online first person shooter games. *CyberPsychology & Behavior, 10*(1), 133-136. https://doi.org/10.1089/cpb.2006.9981

Jeong, I., Nakagawa, K., Osu, R., & Kanosue, K. (2022). Difference in gaze control ability between low and high skill players of a real-time strategy game in esports. *PloS ONE, 17*(3), e0265526. https://doi.org/10.1371/journal.pone.0265526

Johannes, N., Dienlin, T., Bakhshi, H., & Przybylski, A. K. (2022). No effect of different types of media on well-being. *Scientific Reports, 12*(1), 1-13. https://doi.org/10.1038/s41598-021-03218-7

Karakus, T., Inal, Y., & Cagiltay, K. (2008). A descriptive study of Turkish high school students' game-playing characteristics and their considerations concerning the effects of games. *Computers in Human Behavior, 24*(6), 2520-2529. https://doi.org/10.1016/j.chb.2008.03.011

Karpov, B. A., Luria, A. R., & Yarbus, A. L. (1968). Disturbances of the structure of active perception in lesions of the posterior and anterior regions of the brain. *Neuropsychologia, 6*(2), 157-166. https://doi.org/10.1016/0028-3932(68)90057-2

Kashdan, T. B., Gallagher, M. W., Silvia, P. J., Winterstein, B. P., Breen, W. E., Terhar, D., & Steger, M. F. (2009). The curiosity and exploration inventory-II: Development, factor structure, and psychometrics. *Journal of Research in Personality, 43*(6), 987-998. https://doi.org/10.1016/j.jrp.2009.04.011

Kashdan, T. B., Rose, P., & Fincham, F. D. (2004). Curiosity and exploration: Facilitating positive subjective experiences and personal growth opportunities. *Journal of Personality Assessment, 82*(3), 291-305. https://doi.org/10.1207/s15327752jpa8203_05

Kiili, K., Ketamo, H., & Kickmeier-Rust, M. D. (2014). Evaluating the usefulness of eye tracking in game-based learning. *International Journal of Serious Games, 1*(2). https://doi.org/10.17083/ijsg.v1i2.15

King, D. L., & Delfabbro, P. (2009). Motivational differences in problem video game play. *Journal of Cybertherapy and Rehabilitation, 2*(2), 139-149.

King, D., Delfabbro, P., & Griffiths, M. (2009). The psychological study of video game players: Methodological challenges and practical advice. *International Journal of Mental Health and Addiction, 7*(4), 555-562. https://doi.org/10.1007/s11469-009-9198-0

Kinnunen, J., Tuomela, M., & Mäyrä, F. (2022). Pelaajabarometri 2022: Kohti uutta normaalia. *TRIM Research Reports, 31*.

Kivikangas, J. M., Chanel, G., Cowley, B., Ekman, I., Salminen, M., Järvelä, S., & Ravaja, N. (2011). A review of the use of psychophysiological methods in game research. *Journal of Gaming & Virtual Worlds, 3*(3), 181-199. https://doi.org/10.1386/jgvw.3.3.181_1

Klarkowski, M., Johnson, D., Wyeth, P., Phillips, C., & Smith, S. (2018). Don't sweat the small stuff: The effect of challenge-skill manipulation on electrodermal activity. *CHI PLAY '18: Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play*, 231-242. https://doi.org/10.1145/3242671.3242714

Kleinginna, P. R., & Kleinginna, A. M. (1981). A categorized list of emotion definitions, with suggestions for a consensual definition. *Motivation and Emotion, 5*(4), 345-379. https://doi.org/10.1007/BF00992553

Klimmt, C., Hartmann, T., & Frey, A. (2007). Effectance and control as determinants of video game enjoyment. CyberPsychology & Behavior, 10(6), 845-848. https://doi.org/10.1089/cpb.2007.9942

Klimmt, C., & Hartmann, T. (2006). Effectance, self-efficacy, and the motivation to play video games. In P. Vorderer & J. Bryant (Eds.), *Playing video games: Motives, responses, and consequences* (pp. 133–145). Lawrence Erlbaum Associates Publishers.

Klimmt, C., Blake, C., Hefner, D., Vorderer, P., Roth, C. (2009). Player performance, satisfaction, and video game enjoyment. In S. Natkin & J. Dupire (Eds.), *Entertainment computing – ICEC 2009. Lecture notes in computer science* (Vol. 5709, pp. 1-12). Springer. https://doi.org/10.1007/978-3-642-04052-8_1

Koposov, D., Semenova, M., Somov, A., Lange, A., Stepanov, A., & Burnaev, E. (2020). Analysis of the reaction time of esports players through the gaze tracking and personality trait. *2020 IEEE 29th International Symposium on Industrial Electronics (ISIE),* 1560-1565. https://doi.org/10.1109/ISIE45063.2020.9152422

Krcmar, M., Farrar, K. M., Jalette, G., & McGloin, R. (2015). Appetitive and defensive arousal in violent video games: Explaining individual differences in attraction to and effects of video games. *Media Psychology, 18*(4), 527-550. https://doi.org/10.1080/15213269.2014.888007

Kubey, R., & Larson, R. (1990). The use and experience of the new video media among children and young adolescents. *Communication Research, 17*(1), 107-130. https://doi.org/10.1177/009365090017001006

Kumari, S., Deterding, S., & Freeman, J. (2019, October). The role of uncertainty in moment-to-moment player motivation: A grounded theory. *CHI PLAY '19: Proceedings of the Annual Symposium on Computer-Human Interaction in Play*, 351-363. https://doi.org/10.1145/3311350.3347148

Kätsyri, J., Hari, R., Ravaja, N., & Nummenmaa, L. (2013). Just watching the game ain't enough: Striatal fMRI reward responses to successes and failures in a video game during active and vicarious playing. *Frontiers in Human Neuroscience, 7*, 278. https://doi.org/10.3389/fnhum.2013.00278

Landis, C. (1930). Psychology and the psychogalvanic reflex. *Psychological Review, 37*(5), 381. https://doi.org/10.1037/h0072320

Lang, A., Bradley, S. D., Schneider, E. F., Kim, S. C., & Mayell, S. (2013). Killing Is Positive! Intra-Game Responses Meet the Necessary (But Not Sufficient) Theoretical Conditions for Influencing Aggressive Behavior. *Journal of Media Psychology, 24*(4). https://doi.org/10.1027/1864-1105/a000075

Lazarus, R. S., Speisman, J. C., Mordkoff, A. M., & Davison, L. A. (1962). A laboratory study of psychological stress produced by a motion picture film. *Psychological Monographs: General and Applied, 76*(34), 1. https://doi.org/10.1037/h0093861

Lazzaro, N. (2004). *Why we play games: Four keys to more emotion without story* [Paper presentation]. Game Developers Conference, San Jose, California, US. https://www.gdcvault.com/play/1022908/Why-We-Play-Games-The

Le Meur, O., Le Callet, P., & Barba, D. (2007). Predicting visual fixations on video based on low-level visual features. *Vision Research, 47*(19), 2483-2498. https://doi.org/10.1016/j.visres.2007.06.015

Levin, D. T., & Baker, L. J. (2017). Bridging views in cinema: A review of the art and science of view integration. *Wiley Interdisciplinary Reviews: Cognitive Science, 8*(5), e1436. https://doi.org/10.1002/wcs.1436

Linz, D., Donnerstein, E., & Adams, S. M. (1989). Physiological desensitization and judgments about female victims of violence. *Human Communication Research, 15*(4), 509-522. https://doi.org/10.1111/j.1468-2958.1989.tb00197.x

Longman, H., O'Connor, E., & Obst, P. (2009). The effect of social support derived from World of Warcraft on negative psychological symptoms. *CyberPsychology & Behavior, 12*(5), 563-566. https://doi.org/10.1089/cpb.2009.0001

Lopes, P., Yannakakis, G. N., & Liapis, A. (2017). Rank-Trace: Relative and unbounded affect annotation. *2017 Seventh International Conference on Affective Computing and Intelligent Interaction (ACII)*, 158-163. https://doi.org/10.1109/ACII.2017.8273594

Lucas, K., & Sherry, J. L. (2004). Sex differences in video game play: A communication-based explanation. *Communication Research, 31*(5), 499-523. https://doi.org/10.1177/0093650204267930

Mandryk, R., & Klarkowski, M. (2008). Physiological measures for game evaluation. In K. Isbister & N. Schaffer (Eds.), *Game usability* (2nd ed., pp. 161-187). CRC Press. https://doi.org/10.1201/9781003109389-16

Mann, D. T., Williams, A. M., Ward, P., & Janelle, C. M. (2007). Perceptual-cognitive expertise in sport: A meta-analysis. *Journal of Sport and Exercise Psychology, 29*(4), 457-478. https://doi.org/10.1123/jsep.29.4.457

Martens, S., & Wyble, B. (2010). The attentional blink: Past, present, and future of a blind spot in perceptual awareness. *Neuroscience & Biobehavioral Reviews, 34*(6), 947-957. https://doi.org/10.1016/j.neubiorev.2009.12.005

Martens, S., Munneke, J., Smid, H., & Johnson, A. (2006). Quick minds don't blink: Electrophysiological correlates of individual differences in attentional selection. *Journal of Cognitive Neuroscience, 18*(9), 1423-1438. https://doi.org/10.1162/jocn.2006.18.9.1423

Mathur, M. B., & VanderWeele, T. J. (2019). Finding common ground in meta-analysis "wars" on violent video games. *Perspectives on Psychological Science, 14*(4), 705-708. https://doi.org/10.1177/1745691619850104

Mauss, I. B., & Robinson, M. D. (2009). Measures of emotion: A review. *Cognition and Emotion, 23*(2), 209-237. https://doi.org/10.1080/02699930802204677

Mekler, E. D., Bopp, J. A., Tuch, A. N., & Opwis, K. (2014). A systematic review of quantitative studies on the enjoyment of digital entertainment games. *CHI '14: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 927-936. https://doi.org/10.1145/2556288.2557078

Mital, P. K., Smith, T. J., Hill, R. L., & Henderson, J. M. (2011). Clustering of gaze during dynamic scene viewing is predicted by motion. *Cognitive Computation, 3*(1), 5-24. https://doi.org/10.1007/s12559-010-9074-z

Murphy, J. K., Alpert, B. S., Willey, E. S., & Somes, G. W. (1988). Cardiovascular reactivity to psychological stress in healthy children. *Psychophysiology, 25*(2), 144-152. https://doi.org/10.1111/j.1469-8986.1988.tb00977.x

Nacke, L. E., Bateman, C., & Mandryk, R. L. (2014). BrainHex: A neurobiological gamer typology survey. *Entertainment Computing, 5*(1), 55-62. https://doi.org/10.1016/j.entcom.2013.06.002

Nacke, L., & Lindley, C. A. (2008). Flow and immersion in first-person shooters: measuring the player's gameplay experience. *Future Play '08: Proceedings of the 2008 Conference on Future Play: Research, Play, Share*, 81-88. https://doi.org/10.1145/1496984.1496998

Nacke, L., Lindley, C., Stellmach, S. (2008). Log who's playing: Psychophysiological game analysis made easy through event logging. In P. Markopoulos, B. Ruyter, W. IJsselsteijn, D. Rowland (Eds.), *Fun and games 2008: Fun and games. Lecture notes in computer science* (Vol. 5294, pp. 150–157). https://doi.org/10.1007/978-3-540-88322-7_15

Ninaus, M., Kiili, K., Wood, G., Moeller, K., & Kober, S. E. (2020). To add or not to add game elements? Exploring the effects of different cognitive task designs using eye tracking. *IEEE Transactions on Learning Technologies, 13*(4), 847-860. https://doi.org/10.1109/TLT.2020.3031644

Nomikos, M. S., Opton Jr, E., & Averill, J. R. (1968). Surprise versus suspense in the production of stress reaction. *Journal of Personality and Social Psychology, 8*(2), 204. https://doi.org/10.1037/h0025274

Oliver, M. B. (1993). Exploring the paradox of the enjoyment of sad films. *Human Communication Research, 19*(3), 315-342. https://doi.org/10.1111/j.1468-2958.1993.tb00304.x

Olson, C. K. (2010). Children's motivations for video game play in the context of normal development. *Review of General Psychology, 14*(2), 180-187. https://doi.org/10.1037/a0018984

Pannasch, S., Helmert, J. R., Hansen, B. C., Larson, A. M., & Loschky, L. C. (2013). Characteristics of ambient and focal processing during the visual exploration of aerial and terrestrial scenes. *Journal of Vision, 13*(9), 1207-1207. https://doi.org/10.1167/13.9.1207

Pannasch, S. (2014). Characteristics of ambient and focal processing during the visual exploration of dynamic stimuli. *Journal of Vision, 14*(10), 1208-1208. https://doi.org/10.1167/14.10.1208

Passalacqua, M., Fredette, M., Nacke, L. E., Pellerin, R., & Leger, P. M. (2021). Should gamification be personalized? A self-deterministic approach. *AIS Transactions on Human-Computer Interaction, 13*(3), 265-286. https://doi.org/10.17705/1thci.00150

Pedziwiatr, M. A., Kümmerer, M., Wallis, T. S., Bethge, M., & Teufel, C. (2021a). Meaning maps and saliency models based on deep convolutional neural networks are insensitive to image meaning when predicting human fixations. *Cognition, 206*, 104465. https://doi.org/10.1016/j.cognition.2020.104465

Pedziwiatr, M. A., Kümmerer, M., Wallis, T. S., Bethge, M., & Teufel, C. (2021b). There is no evidence that meaning maps capture semantic information relevant to gaze guidance: Reply to Henderson, Hayes, Peacock, and Rehrig (2021). *Cognition, 214*, 104741. https://doi.org/10.1016/j.cognition.2021.104741

Pinto, Y., van der Leij, A. R., Sligte, I. G., Lamme, V. A., & Scholte, H. S. (2013). Bottom-up and top-down attention are independent. *Journal of Vision, 13*(3), 16-16. https://doi.org/10.1167/13.3.16

Plutchik, R. (1980). A general psychoevolutionary theory of emotion. In R. Plutchik & H. Kellerman (Eds.), *Theories of emotion* (pp. 3-33). Academic press. https://doi.org/10.1016/B978-0-12-558701-3.50007-7

Pollatsek, A., Rayner, K., & Collins, W. E. (1984). Integrating pictorial information across eye movements. *Journal of Experimental Psychology: General, 113*(3), 426. https://doi.org/10.1037/0096-3445.113.3.426

Poole, A., & Ball, L. J. (2006). Eye tracking in HCI and usability research. In C. Ghaoui (Ed.), *Encyclopedia of human computer interaction* (pp. 211-219). IGI global. https://doi.org/10.4018/978-1-59140-562-7.ch034

Posada-Quintero, H. F., & Chon, K. H. (2020). Innovations in electrodermal activity data collection and signal processing: A systematic review. *Sensors, 20*(2), 479. https://doi.org/10.3390/s20020479

Posner, M. I. (1980). Orienting of attention. *Quarterly Journal of Experimental Psychology, 32*(1), 3-25. https://doi.org/10.1080/00335558008248231

Prescott, A. T., Sargent, J. D., & Hull, J. G. (2018). Meta-analysis of the relationship between violent video game play and physical aggression over time. *Proceedings of the National Academy of Sciences, 115*(40), 9882-9888. https://doi.org/10.1073/pnas.1611617114

Przybylski, A. K., Rigby, C. S., & Ryan, R. M. (2010). A motivational model of video game engagement. *Review of General Psychology, 14*(2), 154-166. https://doi.org/10.1037/a0019440

Przybylski, A. K., Weinstein, N., Ryan, R. M., & Rigby, C. S. (2009). Having to versus wanting to play: Background and consequences of harmonious versus obsessive engagement in video games. *CyberPsychology & Behavior, 12*(5), 485-492. https://doi.org/10.1089/cpb.2009.0083

Pylyshyn, Z. W., & Storm, R. W. (1988). Tracking multiple independent targets: Evidence for a parallel tracking mechanism. *Spatial Vision, 3*(3), 179-197. https://doi.org/10.1163/156856888X00122

Rappa, N. A., Ledger, S., Teo, T., Wai Wong, K., Power, B., & Hilliard, B. (2019). The use of eye tracking technology to explore learning and performance within virtual reality and mixed reality settings: a scoping review. *Interactive Learning Environments*, *30*(7) 1-13. https://doi.org/10.1080/10494820.2019.1702560

Ravaja, N. (2004). Contributions of psychophysiology to media research: Review and recommendations. *Media Psychology,* *6*(2), 193-235 https://doi.org/10.1207/s1532785xmep0602_4

Ravaja, N., Saari, T., Salminen, M., Laarni, J., & Kallinen, K. (2006). Phasic emotional reactions to video game events: A psychophysiological investigation. *Media Psychology, 8*(4), 343-367. https://doi.org/10.1207/s1532785xmep0804_2

Ravaja, N., Turpeinen, M., Saari, T., Puttonen, S., & Keltikangas-Järvinen, L. (2008). The psychophysiology of James Bond: Phasic emotional responses to violent video game events. *Emotion, 8*(1), 114. https://doi.org/10.1037/1528-3542.8.1.114

Rayner, K. (2009). The 35th Sir Frederick Bartlett Lecture: Eye movements and attention in reading, scene perception, and visual search. *Quarterly Journal of Experimental Psychology, 62*(8), 1457-1506. https://doi.org/10.1080/17470210902816461

Read, G. L., Ballard, M., Emery, L. J., & Bazzini, D. G. (2016). Examining desensitization using facial electromyography: Violent videogames, gender, and affective responding. *Computers in Human Behavior, 62*, 201-211. https://doi.org/10.1016/j.chb.2016.03.074

Reinecke, L. (2009a). Games and recovery: The use of video and computer games to recuperate from stress and strain. *Journal of Media Psychology, 21*(3), 126-142. https://doi.org/10.1027/1864-1105.21.3.126

Reinecke, L. (2009b). Games at work: The recreational use of computer games during working hours. *CyberPsychology & Behavior, 12*(4), 461-465. https://doi.org/10.1089/cpb.2009.0010

Reinecke, L., Klatt, J., & Krämer, N. C. (2011). Entertaining media use and the satisfaction of recovery needs: Recovery outcomes associated with the use of interactive and noninteractive entertaining media. *Media Psychology, 14*(2), 192-215. https://doi.org/10.1080/15213269.2011.573466

Rodrigues, L., Toda, A. M., Palomino, P. T., Oliveira, W., & Isotani, S. (2020). Personalized gamification: A literature review of outcomes, experiments, and approaches. *TEEM'20: Eighth*

International Conference on Technological Ecosystems for Enhancing Multiculturality, 699-706. https://doi.org/10.1145/3434780.3436665

Rubo, M., & Gamer, M. (2018). Social content and emotional valence modulate gaze fixations in dynamic scenes. *Scientific Reports, 8*(1), 1-11. https://doi.org/10.1038/s41598-018-22127-w

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39*(6), 1161. https://doi.org/10.1037/h0077714

Ryan, R. M., & Deci, E. L. (2000). The darker and brighter sides of human existence: Basic psychological needs as a unifying concept. *Psychological Inquiry, 11*(4), 319-338. https://doi.org/10.1207/S15327965PLI1104_03

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness.* Guilford Publications. https://doi.org/10.1521/978.14625/28806

Ryan, R. M., & Frederick, C. (1997). On energy, personality, and health: Subjective vitality as a dynamic reflection of well-being. *Journal of Personality, 65*(3), 529-565. https://doi.org/10.1111/j.1467-6494.1997.tb00326.x

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion, 30*(4), 344-360. https://doi.org/10.1007/s11031-006-9051-8

Sala, G., Tatlidil, K. S., & Gobet, F. (2018). Video game training does not enhance cognitive ability: A comprehensive meta-analytic investigation. *Psychological Bulletin, 144*(2), 111. https://doi.org/10.1037/bul0000139

Schaekermann, M., Ribeiro, G., Wallner, G., Kriglstein, S., Johnson, D., Drachen, A., Sifa, R., & Nacke, L. E. (2017). Curiously motivated: Profiling curiosity with self-reports and behaviour metrics in the game "Destiny". *CHI PLAY '17: Proceedings of the Annual Symposium on Computer-Human Interaction in Play*, 143-156. https://doi.org/10.1145/3116595.3116603

Schlosberg, H. (1952). The description of facial expressions in terms of two dimensions. *Journal of Experimental Psychology, 44*(4), 229. https://doi.org/10.1037/h0055778

Schwarzer, R., & Jerusalem, M. (1995). Self-efficacy measurement: Generalized self-efficacy scale (GSES). In J. Weinman, S. Wright & M. Johnston (Eds.), *Measures in health psychology: A user's portfolio* (pp. 35-37). NFER-Nelson. https://doi.org/10.1037/t00393-000

Setz, C., Arnrich, B., Schumm, J., La Marca, R., Tröster, G., & Ehlert, U. (2009). Discriminating stress from cognitive load using a wearable EDA device. *IEEE Transactions on Information Technology in Biomedicine, 14*(2), 410-417. https://doi.org/10.1109/TITB.2009.2036164

Sherry, J. L. (2001). The effects of violent video games on aggression: A meta-analysis. *Human Communication Research, 27*(3), 409-431. https://doi.org/10.1111/j.1468-2958.2001.tb00787.x

Sherry, J. L., Lucas, K., Greenberg, B. S., & Lachlan, K. (2006). Video game uses and gratifications as predictors of use and game preference. In P. Vorderer & J. Bryant (Eds.), *Playing video games: Motives, responses, and consequences* (pp. 213–224). Lawrence Erlbaum Associates Publishers.

Smerdov, A., Zhou, B., Lukowicz, P., & Somov, A. (2020). *Collection and validation of psychophysiological data from professional and amateur players: A multimodal eSports dataset.* arXiv preprint arXiv:2011.00958. https://doi.org/10.48550/arXiv.2011.00958

Smith, T., & Henderson, J. (2008). Attentional synchrony in static and dynamic scenes. *Journal of Vision, 8*(6), 773-773. https://doi.org/10.1167/8.6.773

Smith, T. J., & Mital, P. K. (2013). Attentional synchrony and the influence of viewing task on gaze behavior in static and dynamic scenes. *Journal of Vision, 13*(8), 16-16. https://doi.org/10.1167/13.8.16

Smith, T. J., Whitwell, M., & Lee, J. (2006). Eye movements and pupil dilation during event perception. *ETRA '06: Proceedings of the 2006 Symposium on Eye Tracking Research & Applications*, 48-48. https://doi.org/10.1145/1117309.1117333

Staude-Müller, F., Bliesener, T., & Luthman, S. (2008). Hostile and hardened? An experimental study on (de-)sensitization to violence and suffering through playing video games. *Swiss Journal of Psychology, 67*(1), 41-50. https://doi.org/10.1024/1421-0185.67.1.41

Strobach, T., Frensch, P. A., & Schubert, T. (2012). Video game practice optimizes executive control skills in dual-task and task switching situations. *Acta Psychologica, 140*(1), 13-24. https://doi.org/10.1016/j.actpsy.2012.02.001

Su, Y., Backlund, P., & Engström, H. (2021). Comprehensive review and classification of game analytics. *Service Oriented Computing and Applications, 15*(2), 141-156. https://doi.org/10.1007/s11761-020-00303-z

Tamborini, R., Bowman, N. D., Eden, A., Grizzard, M., & Organ, A. (2010). Defining media enjoyment as the satisfaction of intrinsic needs. *Journal of Communication, 60*(4), 758-777. https://doi.org/10.1111/j.1460-2466.2010.01513.x

Tatler, B. W., Hayhoe, M. M., Land, M. F., & Ballard, D. H. (2011). Eye guidance in natural vision: Reinterpreting salience. *Journal of Vision, 11*(5), 5-5. https://doi.org/10.1167/11.5.5

Taylor, T. L. (2020). The rise of massive multiplayer online games, esports, and game live streaming. *American Journal of Play, 12*(2), 107-116.

Terlecki, M., Brown, J., Harner-Steciw, L., Irvin-Hannum, J., Marchetto-Ryan, N., Ruhl, L., & Wiggins, J. (2011). Sex differences and similarities in video game experience, preferences, and self-efficacy: Implications for the gaming industry. *Current Psychology, 30*(1), 22-33. https://doi.org/10.1007/s12144-010-9095-5

Thomas, M. H., Horton, R. W., Lippincott, E. C., & Drabman, R. S. (1977). Desensitization to portrayals of real-life aggression as a function of television violence. *Journal of Personality and Social Psychology, 35*(6), 450. https://doi.org/10.1037/0022-3514.35.6.450

To, A., Ali, S., Kaufman, G. F., & Hammer, J. (2016). Integrating curiosity and uncertainty in game design. *DiGRA/FDG '16 - Proceedings of the 1st international joint conference of DiGRA and FDG, 1*(13).

Togelius, J., De Nardi, R., & Lucas, S. M. (2007). Towards automatic personalised content creation for racing games. *2007 IEEE Symposium on Computational Intelligence and Games*, 252-259. https://doi.org/10.1109/CIG.2007.368106

Tondello, G. F., & Nacke, L. E. (2019). Player characteristics and video game preferences. *CHI PLAY '19: Proceedings of the Annual Symposium on Computer-Human Interaction in Play*, 365-378. https://doi.org/10.1145/3311350.3347185

Tondello, G. F., & Nacke, L. E. (2020). Validation of user preferences and effects of personalized gamification on task performance. *Frontiers in Computer Science, 2,* 29. https://doi.org/10.3389/fcomp.2020.00029

Tondello, G. F., Mora, A., Marczewski, A., & Nacke, L. E. (2019). Empirical validation of the gamification user types hexad scale in English and Spanish. *International Journal of Human-Computer Studies, 127,* 95-111. https://doi.org/10.1016/j.ijhcs.2018.10.002

Tondello, G. F., Wehbe, R. R., Diamond, L., Busch, M., Marczewski, A., & Nacke, L. E. (2016). The gamification user types hexad scale. *CHI PLAY '16: Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play*, 229-243. https://doi.org/10.1145/2967934.2968082

Tondello, G. F., Wehbe, R. R., Orji, R., Ribeiro, G., & Nacke, L. E. (2017). A framework and taxonomy of videogame playing preferences. *CHI PLAY '17: Proceedings of the Annual Symposium on Computer-Human Interaction in Play*, 329-340. https://doi.org/10.1145/3116595.3116629

Toril, P., Reales, J. M., & Ballesteros, S. (2014). Video game training enhances cognition of older adults: A meta-analytic study. *Psychology and Aging, 29*(3), 706. https://doi.org/10.1037/a0037507

Torralba, A., Oliva, A., Castelhano, M. S., & Henderson, J. M. (2006). Contextual guidance of eye movements and attention in real-world scenes: The role of global features in object search. *Psychological Review, 113*(4), 766. https://doi.org/10.1037/0033-295X.113.4.766

Treisman, A. M., & Gelade, G. (1980). A feature-integration theory of attention. *Cognitive Psychology, 12*, 97-136. https://doi.org/10.1016/0010-0285(80)90005-5

Trepte, S., & Reinecke, L. (2011). The pleasures of success: Game-related efficacy experiences as a mediator between player performance and game enjoyment. *Cyberpsychology, Behavior, and Social Networking, 14*(9), 555-557. https://doi.org/10.1089/cyber.2010.0358

Trevarthen, C. B. (1968). Two mechanisms of vision in primates. *Psychologische Forschung, 31*, 299-337. https://doi.org/10.1007/BF00422717

Tseng, F. C. (2011). Segmenting online gamers by motivation. *Expert Systems with Applications, 38*(6), 7693-7697. https://doi.org/10.1016/j.eswa.2010.12.142

Tyack, A., & Mekler, E. D. (2020). Self-determination theory in HCI games research: current uses and open questions. *CHI '20: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1-22. https://doi.org/10.1145/3313831.3376723

Tyack, A., & Mekler, E. D. (2021). Off-peak: An examination of ordinary player experience. *CHI '21: Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, 1-12. https://doi.org/10.1145/3411764.3445230

Tyack, A., & Wyeth, P. (2021). "The small decisions are what makes it interesting": Autonomy, control, and restoration in player experience. *Proceedings of the ACM on Human-Computer Interaction, 5*(CHI PLAY), 1-26. https://doi.org/10.1145/3474709

Unema, P. J., Pannasch, S., Joos, M., & Velichkovsky, B. M. (2005). Time course of information processing during scene perception: The relationship between saccade amplitude and fixation duration. *Visual Cognition, 12*(3), 473-494. https://doi.org/10.1080/13506280444000409

Vahlo, J., Kaakinen, J. K., Holm, S. K., & Koponen, A. (2017). Digital game dynamics preferences and player types. *Journal of Computer-Mediated Communication, 22*(2), 88-103. https://doi.org/10.1111/jcc4.12181

Vahlo, J., Smed, J., & Koponen, A. (2018). Validating gameplay activity inventory (GAIN) for modeling player profiles. *User Modeling and User-Adapted Interaction, 28*(4), 425-453. https://doi.org/10.1007/s11257-018-9212-y

Van Boxtel, A., & Jessurun, M. (1993). Amplitude and bilateral coherency of facial and jaw-elevator EMG activity as an index of effort during a two-choice serial reaction task. *Psychophysiology, 30*(6), 589-604. https://doi.org/10.1111/j.1469-8986.1993.tb02085.x

Velichkovsky, B. B., Khromov, N., Korotin, A., Burnaev, E., & Somov, A. (2019). Visual fixations duration as an indicator of skill level in esports. In D. Lamas, F. Loizides, L. Nacke, H, Petrie, M. Winckler & P. Zaphiris (Eds.), *IFIP Conference on Human-Computer Interaction. Human-Computer Interaction – INTERACT 2019. Lecture Notes in Computer Science* (Vol. 11746, pp. 397-405). Springer, Cham. https://doi.org/10.1007/978-3-030-29381-9_25

Vorderer, P., Hartmann, T., & Klimmt, C. (2003). Explaining the enjoyment of playing video games: the role of competition. *ICEC '03: Proceedings of the second international conference on Entertainment computing,* 1-9.

Väliaho, P. (2014). Video games and the cerebral subject: On playing Call of Duty: Modern Warfare 3. *Body & Society, 20*(3-4), 113-139. https://doi.org/10.1177/1357034X14546057

Välimäki, M., Mishina, K., Kaakinen, J. K., Holm, S. K., Vahlo, J., Kirjonen, M., Pekurinen, V., Tenovuo, O., Korkeila, J., Hämäläinen, H., Sarajuuri, J., Rantanen, P., Orenius, T., & Koponen, A. (2018). Digital gaming for improving the functioning of people with traumatic brain injury: Randomized clinical feasibility study. *Journal of Medical Internet Research, 20*(3), e7618. https://doi.org/10.2196/jmir.7618

Wan, C. S., & Chiou, W. B. (2006). Psychological motives and online games addiction: A test of flow theory and humanistic needs theory for Taiwanese adolescents. *CyberPsychology & Behavior, 9*(3), 317-324. https://doi.org/10.1089/cpb.2006.9.317

Weber, R., Behr, K. M., Tamborini, R., Ritterfeld, U., & Mathiak, K. (2009). What do we really know about first-person-shooter games? An event-related, high-resolution content analysis. *Journal of Computer-Mediated Communication, 14*(4), 1016-1037. https://doi.org/10.1111/j.1083-6101.2009.01479.x

West, G. L., Stevens, S. A., Pun, C., & Pratt, J. (2008). Visuospatial experience modulates attentional capture: Evidence from action video game players. *Journal of Vision, 8*(16), 13-13. https://doi.org/10.1167/8.16.13

Weinreich, A., Strobach, T., & Schubert, T. (2015). Expertise in video game playing is associated with reduced valence-concordant emotional expressivity. *Psychophysiology, 52*(1), 59-66. https://doi.org/10.1111/psyp.12298

Whang, L. S. M., & Chang, G. (2004). Lifestyles of virtual world residents: Living in the on-line game "Lineage". *CyberPsychology & Behavior, 7*(5), 592-600. https://doi.org/10.1089/cpb.2004.7.592

Wolfe, J. (2000). Visual attention. In K. K. De Valois (Ed.), *Seeing* (2nd edition., pp. 335-386). Academic Press. https://doi.org/10.1016/B978-012443760-9/50010-6

Wolfe, J. M. (2007). Guided Search 4.0: Current progress with a model of visual search. In W. D. Gray (Ed.), *Integrated models of cognitive systems* (p. 99-119). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195189193.003.0008

Woodcock, J., & Johnson, M. R. (2019). The affective labor and performance of live streaming on Twitch. tv. *Television & New Media, 20*(8), 813-823. https://doi.org/10.1177/1527476419851077

Wu, C. C., & Wolfe, J. M. (2019). Eye movements in medical image perception: A selective review of past, present and future. *Vision, 3*(2), 32. https://doi.org/10.3390/vision3020032

Xu, Z., Turel, O., & Yuan, Y. (2012). Online game addiction among adolescents: Motivation and prevention factors. *European Journal of Information Systems, 21*(3), 321-340. https://doi.org/10.1057/ejis.2011.56

Yannakakis, G. N., & Hallam, J. (2007). Modeling and augmenting game entertainment through challenge and curiosity. *International Journal on Artificial Intelligence Tools, 16*(06), 981-999. https://doi.org/10.1142/S0218213007003667

Yee, N. (2006). Motivations for play in online games. *CyberPsychology & Behavior, 9*(6), 772-775. https://doi.org/10.1089/cpb.2006.9.772

Yee, N., Ducheneaut, N., & Nelson, L. (2012). Online gaming motivations scale: Development and validation. *CHI '12: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 2803-2806. https://doi.org/10.1145/2207676.2208681

Appendix: Descriptions of Game Missions

General note. In all of the Studies, the stimulus material was taken from the game "Call of Duty: Modern Warfare 2" (PlayStation 3 version, Activision, 2009). In Studies I and III, four missions were used as stimuli: "Wolverines," "Exodus," "Gulag," and "Whiskey Hotel." In Study II, the missions "Wolverines" and "Team Player" were used. I used six minutes of gameplay for the videos utilized in Studies I and II. For the sake of brevity, I will describe the content of those videos, and not the entire content of the missions. For the curious reader, I would like to note that there are demonstrative gameplay videos of the missions available on online services such as YouTube for further inspection (at the time of the publication of this thesis). As a general note regarding all the missions, the videos used in the experiment did not include any sniping, as this created a visually very distinctive scene (zooming).

Wolverines. In the mission "Wolverines," the player is at first a passenger in a military truck that is following another friendly vehicle while driving through a suburb in the US. Suddenly, the vehicle in front of the truck the player is in is fired at by an enemy BTR (i.e., an armed and armored personnel carrier). The player must then escape their own truck and engage in a firefight with the enemy using their personal gun. The player then proceeds to run behind houses for cover after which they use smoke grenades to escape the enemy. At this point, there is a full-blown battle on multiple fronts, including air support. The player and their troops move to an alley and proceed to engage in close-quarters combat with enemy troops. Then, the player moves on to a clearing: a main road with shops and parking lots. They must move across it and take cover. After this, the player is ordered to move into a building and to look for a supply drop on its rooftop that contains a sentry gun (a turret that automatically fires at enemies). The player must then start the sentry gun and assist by shooting at enemies from the rooftop.

Team Player. In the mission "Team Player," the player is immediately engaged in battle with the enemy in a town in Afghanistan. The battleground is split by a river, and the player must shoot at enemies residing on the other bank using their gun as both a regular weapon and a grenadier. A nearby partly fallen bridge is infiltrated by the enemy and the player must kill them. Once the enemies on the bridge have been eliminated, friendly troops fix the bridge using a portable bridge-layer. At this point the player is still under heavy fire, and is ordered to move to a vehicle on the fixed bridge in order to move to the other side of the river to get closer to the enemy. The player enters a Humvee (a light military truck) and takes control of the Humvee's gun on its roof. The player observes an airstrike that hits the enemy on the other side of the riverbank, after which the Humvee starts moving in a convoy of other Humvees. The vehicles move around in the streets of the town and the player looks for enemies while manning the Humvee's gun. There is a sense of dread for a minute or so, after which the enemy opens fire. This leads to an intense battle during which the player shoots at the enemies using the Humvee's gun while the vehicle is moving, but the Humvee is eventually hit by a rocket-propelled grenade. The player gets blown out of the Humvee and must seek shelter as they are hurt. The player enters a nearby building and engages in close combat inside it while moving from room to room. Once the building has been cleared of enemies, the player starts shooting at enemies positioned in a school opposite the building.

Exodus. The mission "Exodus" is set in an American suburban area. The player starts out by walking behind a Stryker (an armored fighting vehicle resembling a tank) on a road. The troops are under attack and are ordered to get off the street and to use civilian houses for cover. They must then attack enemies inside the civilian houses and on the street. They move along from house to house, clearing them of enemies. The player is then tasked with using a laser pointer to show the Stryker which targets it should hit. The player progresses up the street using the houses and their porches for cover, all the while battling against enemies and painting targets for the Stryker to hit. Suddenly, helicopters carrying soldiers appear. Troops descend from the helicopters using ropes and join the battle. The player goes on to fire at enemies in clearings such as parking lots and larger roads, continuing also to point targets for the Stryker using the laser designator. The targets are often inside or on top of buildings, but sometimes also in the clearings. The player must next destroy an enemy sentry gun in the middle of a street. The battle continues on the street and inside houses along the street. The scenery is dominated by a large toll station at the end of the road. The enemy has swarmed the offices inside the toll station and effectively cut off the road. The player eliminates the enemy at the toll station and clears the way for troops to move to a new area.

Gulag. In the mission "Gulag," the player is tasked with infiltrating a Russian gulag (a Soviet-era labor camp/prison). The mission takes place in winter. The friendly troops have exited their helicopter transport and are positioned directly outside a fenced prison complex. The player moves across an open area to the gates of the fence and engages in firefights with the enemy. The player and their troops move forward to the courtyard and continue fighting the enemy soldiers who are positioned above them and around them on the ramparts of the gulag. A friendly helicopter joins the troops and fires at the enemies, after which the enemies start fleeing further into the gulag, toward an inner courtyard. The player fires at the retreating enemies and follows them to another courtyard. A gate to the gulag is then found and the player enters the prison through the gate, which leads to a tunnel. At the end of the tunnel is another gate guarded by enemy soldiers. The enclosed space leads to close combat. After clearing the gate, the player enters a panopticon prison. They then proceed to a control room containing several monitors in the middle of the prison using a small bridge. The scenery is dominated by barred walls and metal. The player exits the control room and makes their way toward the actual cells surrounding the walls of the prison. Close combat firefight ensues as the player makes their way across the circular hallway, encountering enemies inside the cells and in the hallway. The player shoots at targets through prison bars. They must sometimes wait for friendly troops to open doors in order to advance, while being under fire. The player is eventually ordered to move to an armory room located in the center of the prison one floor below them. The player runs through a set of stairs and enters the armory. After looking over the weapons displayed there the player is informed that the engineer of the team has failed to open an electric door and that they will be under attack shortly. As the enemies make way to the armory, the player must equip a riot shield. The player then uses the riot shield to survive the attack, sustaining shots to it.

Whiskey Hotel. In “Whiskey Hotel,” the player is trying to retake the American White House (coined “Whiskey Hotel”) which has been invaded by enemy forces. The mission happens during a stormy night and the player starts out in a tunnel under the White House. The tunnel has been split partially open and rainfall is flooding in. The player makes their way across the tunnel until the troops are at the end of it and resurface on the lawn of the White House. They are immediately under heavy fire and try to take cover while simultaneously firing at the enemy in the White House. The player is ordered to move to the left flank of the lawn and to make their way toward the White House. The player does this while intermittently shooting at the enemies and ducking for cover in pits dug into the ground. Meanwhile, the enemy uses searchlights to spot the player’s troops. The player eventually makes their way to the West Wing and enters. There is a momentary pause in the first room. The player then starts moving from room to room and battles enemies lurking in corners. Eventually the player makes their way to a press briefing room with blinking monitors. Close combat again ensues. The press room is next to a terraced garden, which the player momentarily enters to shoot at enemies there. After the enemies have been eliminated, the player continues advancing inside the house, moving to its kitchen before climbing up to the second floor through a hole in the roof. An intense firefight takes place in a lobby before the player makes their way to a staircase as they have been told to move to the rooftop of the building.

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