Game Design for a Sustainable Society

Improving the Behavioral Impact of Persuasive Games

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Game Design for a Sustainable Society

Improving the Behavioral Impact of Persuasive Games

Dissertation

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Chair of the Board for Doctorates,
to be defended publicly on
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by

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Contents

Foreword

This dissertation concerns games and how they can stimulate behavioral change. The reactions to this topic vary. Sometimes, people immediately understand what I mean when discussing serious games and their applications. However, in most cases, I get questioning looks, or games appear to be associated with persistent addiction and aggressive youngsters. Interestingly, despite these differences, I often notice that almost everyone I talk to about this can describe a vivid personal game experience.

I first experienced the powerful nature of games at an international children's camp when I was 11 years old. For one month, children from all over the world came together: from Japan to Senegal and Canada to Jordan. In addition to light-hearted, entertaining games, we played social simulation games about each other's culture and values, often prompting valuable, in-depth discussions that otherwise would have been forced and uncomfortable. I learned a lot about others' worldviews, which made me extra aware of my own. The shared gaming experiences brought us closer together, and many dear friendships were made.

About twenty years later, a newspaper article about the future of storytelling and the role of games caught my attention. Inspired by my own experience of the camp, my curiosity grew about the potential of games to be more than just entertaining. Without a concrete goal but with a strong belief in the positive impact games can make on complex societal issues, I enrolled in a new Game Studies program, eventually leading to the doctoral research described in this dissertation. It was highly engaging to immerse myself in a relatively new scientific research field that continues to grow.

Whether you will read this dissertation in its entirety or flip through it, I hope it can convince you to consider games as a versatile medium, for which we will hopefully see more and more relevant and successful applications.

Summary

Research motivation

Collective action is required to tackle urgent global challenges in energy and climate, biodiversity and food, and peace and security. The United Nations, therefore, adopted 17 global Sustainable Development Goals, to be met by 2030. Implementing these goals has proven to be no mean feat, but they are essential to establishing a sustainable society of ecological, social, and economic stability far into the future.

Psychological processes can provide insights into the dynamics of the complex problems that come with the current challenges. One key psychological component of many of these problems is the need for behavioral change on multiple levels. To stimulate such change, the public sector, societal actors, and the private sector can initiate behavioral interventions, ideally changing behavior simultaneously and consistently on population, community, and individual levels. Intervention frameworks like the Behaviour Change Wheel (BCW)[1] can be helpful for a systematic approach to developing such behavioral interventions.

In addition to the BCW, using persuasive games[2] as an intervention tool looks promising. Persuasive games seem able to influence players' *Capability* (including knowledge and skills) and *Motivation* (all brain processes that energize and direct behavior), two components of the BCW that theoretically directly influence behavior. Moreover, these

1 **Michie, S., van Stralen, M. M., & West, R. (2011)**. The behavioural change wheel: a new method for characterizing and designing behavioural change interventions. *Implementation Science*, *6*. doi: 10.1186/1748-5908-6-42

2 De la Hera and Raessens define persuasive games as gaming practices that combine the distribution of information with attempts to engage players in particular attitudes and behaviors.
de la Hera, T., & Raessens, J. (2021). Looking beyond persuasion through rule-based representations in digital games: designing games to shape, reinforce or change attitudes. In: T. de La Hera, J. Jansz, J. Raessens & B. Schouten (Eds.), *Persuasive Gaming in Context* (pp. 57–72). Amsterdam University Press. doi: 10.1515/9789048543939-005)

games can create personal experiences, making societal issues that may feel overwhelming and far away understandable and relevant, even for skeptics. Crucial to this is that the game's message is interweaved within the game's content without the risk of explicit approaches to persuasion that can backfire or be of limited use.

Still, despite the widespread application and promising impact of persuasive games, evaluation studies' results often seem inconclusive. Game scholars, therefore, conclude that there is still a long way to go before the viability of games as a persuasive medium can be firmly determined. This dissertation attempts to make a positive contribution to this task.

Any research that aims to increase the impact of persuasive games, particularly how they can convey *Meaning* (ensuring that the game will serve its goal and support knowledge transfer)[3], seems like a welcome contribution to the validation research field of persuasive games. Within the context of persuasive games that promote a sustainable society, a focus on reducing players' attitude-behavior gap seems particularly relevant to strengthen this *Meaning*. The gap exists when individuals' attitudes do not correlate with their actions. People can be conflicted by several factors that lead to inaction, although they often agree that action is required. For example, many people agree that humans cause climate change and that it needs to be addressed. However, they still do not make the necessary personal sacrifices to adjust their lifestyle. To reduce the attitude-behavior gap, it seems essential to strengthen people's behavioral intentions. According to the influential Theory of Planned Behavior (TPB)[4], behavioral intentions are the most direct determinants of human behavior. They are directly influenced by one's attitudes, subjective norm, and perceived control. In addition to these three behavioral predictors, it also seems relevant to examine the factor of responsibility to improve the behavioral impact of games for a sustainable society, as the attitude-behavior gap may be partly caused by people's lack of responsibility to put their intentions into action.

The following main research question guided this dissertation:

How can persuasive games that promote a sustainable society be designed so that playing the game has a positive effect on players' post-game behavior?

Research approach

Three case studies were conducted to answer this research question, each linked to a separate subquestion. A different persuasive game was adapted or designed for each study, promoting desirable behavior for a sustainable society.

3 **Harteveld, C. (2011)**. *Triadic game design: balancing reality, meaning, and play*. Springer.

4 **Ajzen, I. (1991)**. The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes*, *50* (2), 179–211. doi:10.1016/0749-5978(91)90020-T

Case study 1 aimed to answer the first subquestion:

To what extent can a persuasive game make players aware of their incapabilities?

The study focused on active listening as a prerequisite for a sustainable society. It was set up as a mixed-methods quasi-experiment and examined to what extent the digital listening game *Free the Listening Mutant!* could make players aware of potential issues with their listening capabilities since it seems crucial to be aware of incapabilities before behavioral intentions can be successfully strengthened. Additionally, the study explored to what extent such a game would have any attitudinal and behavioral effects. Pre- and post-game surveys measured players' awareness of listening incapabilities and their listening attitude before and after the game. Furthermore, after the game, semi-structured interviews were held with players to reflect on the game and to assess to what extent they believed there had been any change in their listening behavior.

Case study 2 aimed to answer the second subquestion:

To what extent can a persuasive game increase players' knowledge, attitude, subjective norm, perceived control, and responsibility concerning specific behavior, and how does this relate to the potential behavioral change of players after the game?

The study focused on secure (digital) information handling, which contributes to minimizing the ongoing cyber threats that undermine the creation of a sustainable society. The research was set up as a mixed-methods experiment and examined to what extent the cybersecurity training game *The Human Firewall* could increase players' knowledge, attitude, subjective norm, perceived control, and responsibility concerning secure information handling and how that would relate to players' potential behavioral change after the game. Additionally, the study included a preliminary exploration of how players' responsibility could be increased by playing a game. Pre- and post-game surveys measured players' knowledge, attitude, subjective norm, perceived control, responsibility, and behavior before and after the game. Next, a follow-up survey measured the concrete behaviors of players on the job one week after the game session. Semi-structured interviews were also conducted to support and explain the survey data results.

Case study 3 aimed to answer the third and last subquestion:

What is the effect of explicitly including a game design element for responsibility in a persuasive game on increasing players' post-game behavior?

The study revolved around vegan eating behavior, as reductions in consumption or replacement of meat and dairy products can contribute to countering the negative effects of factory farming on the environment. The research was set up as a mixed-methods quasi-experiment and examined the effect of including promises as a promising game design element for responsibility on players' vegan eating behavior after the board game *Promise Me*. Pre- and post-game surveys measured players' responsibility toward a vegan diet. Next, a follow-up survey measured the behavioral effect of the implemented promises one week after the game.

Research results

Contrary to expectations, the first case study showed that making people aware of their incapabilities with a persuasive game can be challenging. Players' perception of their listening behavior appeared persistent and did not seem to be easily altered with the one-time play of the digital listening game *Free the Listening Mutant!*. This might have been caused by the fact that the persuasive message of the game was interwoven within the game's content. Not all players could equally easily discover this message, despite the in-game debrief at the end of the game. Especially when players' attitude toward specific behavior, like listening, is considerably positive, admitting not to be very good at it does not seem easy. Still, the game made players aware of some of their listening incapabilities by directly addressing players' behavior in the game and creating interactions whereby they could experience the consequences. Other listening behavior not explicitly addressed in the game appeared too subtle for players to notice and thus reflect on.

As expected, the second case study showed that the cybersecurity training game *The Human Firewall* was able to increase players' knowledge, attitude, subjective norm, perceived control, and responsibility concerning secure information handling. These increases occurred mainly in those areas where there was room for improvement. Additionally, players improved their secure information handling after the game with small but key behavioral changes, and correlations were found between the increased behavioral predictors and increased secure behavior. The included preliminary exploration of how players' responsibility could be increased by playing a game showed that modified text elements conveying a more personal approach, the urgency of the behav-

ioral change, and players' responsibility for this proved too subtle to reinforce players' responsibility.

Finally, as expected, the third case study showed that including a game design element for responsibility, such as promises, increased the *Promise Me* players' post-game vegan eating behavior to a certain extent and motivated players to process information about the game's topic attentively after the game. The players' positive behavioral change was mainly concerned with small and concrete behaviors closely linked to the game content. The player's increased motivation after the game to read more about the game's topic may increase the likelihood of related sustainable behavior. The study also showed that Promise Cards, as a prominent and recurring part of the gameplay, can be a viable way to implement promises of sustainable behavior in a persuasive game. It is essential in this respect to enable players to make a promise that motivates them to keep it. Providing a wide range of promises from which players could choose seemed to enable this requirement. Additionally, it appeared essential to anticipate the players' intrinsic motivation, leaving it open for them to make a promise, stick to it, and choose to whom the promise is made.

Discussion

Despite their research limitations, all three studies showed that playing a persuasive game that promotes a sustainable society can positively contribute to players' post-game behavior, even after a one-time play. This behavior involved relatively small and concrete actions closely related to the game content that could be performed without too much effort. Players' post-game behaviors were probably driven by self-persuasion, which can enormously affect long-term changes in attitudes and behavior. However, the extent to which players will perpetuate these behaviors in their daily lives can not be predicted. Still, the games do seem to have 'planted a seed' in a significant proportion of the players.

Future studies could elaborate on the findings of this dissertation by conducting additional case studies with similar games. The same research questions could be maintained, but the games could involve other topics, use a larger sample size of representative participants if possible, use control groups, and utilize a more random distribution of participants across experimental conditions. Behavioral measurements after the game could be done not only after one or two weeks but also later to discover more about the long-term effects of games that promote a sustainable society. Additionally, examining the behavioral impact of these games would be interesting when they function as a starting point for larger and longer interventions where other intervention tools are used alongside games.

Conclusions

A persuasive game that promotes a sustainable society can have a positive effect on players' post-game behavior if the following is taken into account when designing the game:

1. For players to improve their behavior, they must first be aware of possible incapabilities. A persuasive game can make players somewhat aware of their incapabilities when the behavioral situations are directly addressed and recognizable to players. A prerequisite for this awareness is that the players understand the game's message. If the game fails to do that, a debrief can stimulate players' awareness of their incapabilities. Still, players' perceptions of their behavior can be persistent and do not seem to be easily altered with the one-time play of a persuasive game.
2. Actively targeting players' knowledge, attitude, subjective norm, perceived control, and responsibility concerning specific behavior can increase these behavioral predictors. This increase mostly appears when there is room for improvement, often concerning behaviors that a person does not experience daily. Next to strengthening players' behavioral intentions, the same game can lead to small, concrete, positive changes in players' behaviors in their daily practice. An increase in perceived control can correlate strongly with a positive increase in post-game behavior.
3. Explicitly including a game design element for responsibility, such as promises, can lead to players' positive behavioral change, mainly concerning small and concrete behaviors closely linked to the game content. It is important that the game element can effectively link the game world with the real world by still being relevant to the player even after the game is over. Additionally, the same game can motivate players to process information about the game's topic attentively after the game, possibly increasing the likelihood of related sustainable behavior.

Persuasive games can be helpful to contribute to the behavioral change needed as part of the collective action to tackle the urgent global challenges. However, there is still a long way to go before the viability of games as a persuasive medium can be firmly determined. The outcome of this dissertation forms a modest but positive contribution to this task. It provides practical recommendations for designing persuasive games used as intervention tools to promote a sustainable society. Applying these recommendations could increase the likelihood that players will make small but concrete positive behavioral changes in their daily lives after playing such games. Future research is needed to validate the case study results further. Still, this dissertation could inspire policymakers and game designers who are motivated to successfully deploy persuasive games in realizing a sustainable society.

Samenvatting

Motivatie voor onderzoek

Collectieve actie is nodig om urgente wereldwijde uitdagingen op het gebied van energie en klimaat, biodiversiteit en voedsel, alsmede vrede en veiligheid aan te pakken. De Verenigde Naties hebben daarom 17 doelstellingen voor duurzame ontwikkeling opgesteld die in 2030 bereikt zouden moeten zijn. Het implementeren van deze doelstellingen blijkt geen sinecure, maar is essentieel om een duurzame samenleving met ecologische, sociale en economische stabiliteit op te bouwen tot ver in de toekomst.

Psychologisch onderzoek kan inzicht bieden in de dynamiek van de complexe problemen die gepaard gaan met de mondiale uitdagingen. Een belangrijke psychologische component van veel van deze problemen is de noodzaak van gedragsverandering, op meerdere niveaus. Om dergelijke verandering te stimuleren, kunnen de publieke sector, maatschappelijke actoren en de private sector gedragsinterventies opzetten, waarbij gedrag idealiter gelijktijdig en consistent wordt veranderd op bevolkings-, gemeenschaps- en individueel niveau. Interventieraamwerken zoals het Behaviour Change Wheel (BCW)[1] kunnen bijzonder nuttig zijn voor een systematische aanpak van het ontwikkelen van dergelijke gedragsinterventies.

1 **Michie, S., van Stralen, M. M., & West, R. (2011)**. The behavioural change wheel: a new method for characterizing and designing behavioural change interventions. *Implementation Science*, *6*. doi: 10.1186/1748-5908-6-42

2 De la Hera en Raessens definiëren persuasive games als game toepassingen die de verspreiding van informatie combineren met pogingen om spelers te betrekken bij bepaalde attitudes en gedragingen. **de la Hera, T., & Raessens, J. (2021)**. Looking beyond persuasion through rule-based representations in digital games: designing games to shape, reinforce or change attitudes. In: T. de La Hera, J. Jansz, J. Raessens & B. Schouten (Eds.), *Persuasive Gaming in Context* (pp. 57–72). Amsterdam University Press. doi: 10.1515/9789048543939-005)

Naast het BCW lijkt het gebruik van persuasive games[2] als interventiemiddel veelbelovend. Persuasive games lijken in staat om zowel de *Capability* (inclusief kennis en vaardigheden) als de *Motivation* (alle hersenprocessen die gedrag stimuleren en sturen) van spelers te beïnvloeden. Dit zijn twee componenten van het BCW die volgens het raamwerk gedrag direct beïnvloeden. Daarnaast lijken persuasive games persoonlijke ervaringen te kunnen creëren, waardoor maatschappelijke problemen die overweldigend en ver weg kunnen lijken, begrijpelijk en relevant worden, zelfs voor sceptici. Cruciaal hierbij is dat de boodschap van de game verweven is met de inhoud ervan zonder expliciete benaderingen om de speler te overtuigen, want die kunnen averechts werken of beperkt effect hebben.

Ondanks de wijdverspreide toepassing en de veelbelovende impact van persuasive games, lijken de resultaten van evaluatiestudies tot nu toe vaak niet overtuigend. Gamewetenschappers concluderen dan ook dat er nog een lange weg te gaan is voordat de toegevoegde waarde van persuasive games met zekerheid kan worden vastgesteld. Dit proefschrift probeert een positieve bijdrage aan deze opgave te leveren.

Elk wetenschappelijk onderzoek dat tot doel heeft om de impact van persuasive games te vergroten, in het bijzonder hoe ze *Meaning* (ervoor zorgen dat de game zijn doel dient en kennisoverdracht ondersteunt)[3] kunnen overbrengen, lijkt een welkome bijdrage te bieden aan het validatieonderzoek van persuasive games. Bij persuasive games die een duurzame samenleving promoten, lijkt met name een focus op het verkleinen van de kloof tussen attitude en gedrag van spelers bijzonder relevant om *Meaning* te vergroten. Deze zogenaamde *attitude-behavior gap* bestaat wanneer de attitudes van mensen niet correleren met hun gedrag. Mensen kunnen in de war raken door allerlei factoren die vervolgens leiden tot 'niets doen', ondanks dat ze het er vaak wel over eens zijn dat actie juist nodig is. Bijvoorbeeld bij klimaatverandering: veel mensen zijn het ermee eens dat het door mensen wordt veroorzaakt en dat er iets aan moet worden gedaan, maar toch brengen ze niet de nodige persoonlijke offers om hun levensstijl aan te passen. Om de attitude-behavior gap te verkleinen, lijkt het essentieel om de gedragsintenties van mensen te versterken. Volgens de invloedrijke Theory of Planned Behavior (TPB)[4] zijn gedragsintenties de meest directe voorspellers van menselijk gedrag en worden ze rechtstreeks beïnvloed door iemands attitudes, subjectieve norm en perceived control. Naast deze drie gedragsvoorspellers lijkt het ook relevant om te onderzoeken hoe de verantwoordelijkheid voor duurzaam gedrag kan worden versterkt, omdat de attitude-behavior gap gedeeltelijk kan worden veroorzaakt door het gebrek aan verantwoordelijkheid van mensen om hun intenties om te zetten in daden.

3 **Harteveld, C. (2011)**. *Triadic game design: balancing reality, meaning, and play*. Springer.

4 **Ajzen, I. (1991)**. The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes*, *50* (2), 179–211. doi:10.1016/0749-5978(91)90020-T

Bovenstaande observaties hebben geleid tot de volgende onderzoeksvraag:

Hoe kunnen persuasive games die een duurzame samenleving promoten zo worden ontworpen dat het spelen van zo'n game een positief effect heeft op het gedrag van spelers na de game?

Onderzoeksaanpak

Er werden drie case studies uitgevoerd om de onderzoeksvraag te beantwoorden, elk met een eigen deelvraag. Voor elke studie werd een aparte persuasive game aangepast of ontworpen, elk met het doel om gedrag ter bevordering van een duurzame samenleving te stimuleren.

Case study 1 probeerde de eerste deelvraag te beantwoorden:

In hoeverre kan een persuasive game spelers bewust maken van hun onbekwaamheden?

Het onderzoek richtte zich op actief luisteren als voorwaarde voor een duurzame samenleving. Het werd opgezet als een mixed-methods quasi-experiment en onderzocht in hoeverre de digitale luistergame *Free the Listening Mutant!* spelers bewust kon maken van mogelijke onbekwaamheden in hun luistervaardigheid, omdat het cruciaal is om je eerst bewust te zijn van onbekwaamheden voordat je überhaupt gedragsintenties kan versterken. Daarnaast onderzocht de studie in hoeverre een dergelijke game attitude- en gedragseffecten zou hebben. Vragenlijsten voor en na de game maten het bewustzijn van de spelers van hun luisteronbekwaamheden en hun luisterattitude voor en na de game. Daarnaast werden er na de game semi-gestructureerde interviews gehouden met spelers om te reflecteren op hun game-ervaring en te ontdekken in hoeverre er verandering was opgetreden in hun luistergedrag.

Case study 2 probeerde de tweede deelvraag te beantwoorden:

In welke mate kan een persuasive game de kennis, attitude, subjectieve norm, perceived control en verantwoordelijkheid van spelers met betrekking tot specifiek gedrag vergroten, en hoe hangt dit samen met de potentiële gedragsverandering van spelers na de game?

Het onderzoek richtte zich op veilig werken met (digitale) informatie, om de voortdurende cyberdreigingen die het creëren van een duurzame samenleving ondermijnen te minimaliseren. De case study was opgezet

als een mixed-methods experiment en onderzocht in hoeverre de cybersecurity training game *The Human Firewall* de kennis, attitude, subjectieve norm, perceived control en verantwoordelijkheid van spelers met betrekking tot veilig werken met informatie kon vergroten en hoe dat zou samenhangen met de potentiële gedragsverandering van spelers na afloop van de game. Daarnaast omvatte het onderzoek een eerste verkenning van de manier waarop de verantwoordelijkheid van spelers zou kunnen worden vergroot door het spelen van een game. Vragenlijsten voor en na de game maten de kennis, attitude, subjectieve norm, perceived control, verantwoordelijkheid en het gedrag van spelers voor en na de game. Vervolgens werden in een follow-up vragenlijst concrete gedragingen van de spelers op hun werk gemeten, een week na de gamesessie. Er werden ook semi-gestructureerde interviews afgenomen om de resultaten van de vragenlijsten te kunnen ondersteunen en te verklaren.

Case study 3 probeerde de derde en laatste deelvraag te beantwoorden:

Wat is het effect van het expliciet opnemen van een game design element voor verantwoordelijkheid in een persuasive game op het gedrag van spelers na de game?

Het onderzoek draaide om veganistisch eetgedrag, aangezien het verminderen van de consumptie of het vervangen van vlees en zuivelproducten kan bijdragen aan het tegengaan van de negatieve effecten van de bio-industrie op het milieu. De case study was opgezet als een mixed-methods quasi-experiment en onderzocht het effect van het opnemen van beloften als een veelbelovend game design element voor verantwoordelijkheid op het veganistische eetgedrag van spelers na het spelen van het bordspel *Promise Me*. Vragenlijsten voor en na het spel maten spelers' verantwoordelijkheid ten aanzien van een veganistisch dieet. Vervolgens werd een week na de game met een follow-up vragenlijst het gedragseffect van de gebruikte beloften gemeten.

Onderzoeksresultaten

Tegen de verwachting in liet de eerste case study zien dat het een uitdaging kan zijn om met een persuasive game mensen bewust te maken van hun onbekwaamheden. De manier waarop de spelers naar hun eigen luistergedrag keken bleek hardnekkig en leek niet gemakkelijk te veranderen na het eenmalig spelen van de digitale luistergame *Free the Listening Mutant!*. Dit kan veroorzaakt zijn door het feit dat de boodschap van de game verweven was met de inhoud ervan. Niet alle spelers konden deze boodschap even makkelijk ontdekken, ondanks de in-game debrief aan het einde van de game. Vooral wanneer de

attitude van spelers ten aanzien van specifiek gedrag, zoals luisteren, aanzienlijk positief is, lijkt het niet eenvoudig voor hen om toe te geven dat ze er niet erg goed in zijn. Toch maakte de game spelers bewust van een aantal van hun luistervaardigheden door het gedrag van spelers direct aan te kaarten in de game en interacties te creëren waarbij ze de gevolgen ervan konden ervaren. Ander luistergedrag dat niet expliciet in de game aan bod kwam bleek te subtiel voor spelers om op te merken en dus om over na te gaan denken.

Zoals verwacht bleek uit de tweede case study dat de cybersecurity training game *The Human Firewall* in staat was om de kennis, attitude, subjectieve norm, perceived control en verantwoordelijkheid van spelers met betrekking tot veilig werken met informatie te vergroten. Deze toename deed zich vooral voor bij de gedragsvoorspellers die nog voor verbetering vatbaar waren. Daarnaast nam het veilig werken met informatie na de game toe met kleine maar belangrijke gedragsveranderingen en werden er correlaties gevonden tussen de toegenomen gedragsvoorspellers en het toegenomen veilig werken. Uit de voorlopige verkenning van hoe de verantwoordelijkheid van spelers kan worden vergroot door het spelen van een game, bleek dat aangepaste tekstelementen met een meer persoonlijke benadering en het benadrukken van de urgentie van de gedragsverandering en de verantwoordelijkheid van spelers hiervoor te subtiel waren om de verantwoordelijkheid van de spelers te versterken.

Tot slot, zoals verwacht, toonde de derde case study aan dat het gebruik van een game design element voor verantwoordelijkheid, in dit geval het doen van een belofte, het veganistisch eetgedrag van de *Promise Me*-spelers na de game tot op zekere hoogte deed toenemen en spelers motiveerde om informatie over het onderwerp van de game na de game aandachtig te verwerken. De positieve gedragsverandering van de spelers betrof vooral kleine en concrete gedragingen die nauw verbonden waren met de inhoud van de game. De toegenomen motivatie van de spelers na de game om meer te lezen over het onderwerp kan ervoor zorgen dat ook ander gerelateerd duurzaam gedrag later vertoond zal worden. Het onderzoek toonde ook aan dat Promise Cards, als prominent en terugkerend onderdeel van de game, een haalbare manier kunnen zijn om beloftes over duurzaam gedrag te implementeren in een persuasive game. Het is daarbij essentieel om spelers in staat te stellen een belofte te doen die hen motiveert om zich eraan te houden. Het aanbieden van een breed scala aan beloftes waaruit spelers konden kiezen leek deze vereiste mogelijk te maken. Daarnaast leek het essentieel om in te spelen op de intrinsieke motivatie van spelers, dus dat ze zelf konden kiezen om de belofte überhaupt te doen, zich eraan te houden of niet, en konden kiezen aan wie de belofte werd gedaan.

Discussie

Ondanks hun beperkingen lieten alle drie de case studies zien dat het spelen van een persuasive game over duurzame thema's positief kan bijdragen aan het gedrag van spelers na afloop van de game, zelfs na eenmalig de game te spelen. Dit gedrag betrof relatief kleine en concrete acties die sterk gerelateerd waren aan de inhoud van de game en die zonder al te veel moeite konden worden uitgevoerd. Het gedrag van spelers na de games werd waarschijnlijk gedreven door zelfovertuiging, wat een enorme invloed kan hebben op veranderingen in attitude en gedrag op de lange termijn. De mate waarin spelers dit gedrag in hun dagelijks leven zullen voortzetten kan echter niet worden voorspeld. Toch lijken de games bij een aanzienlijk deel van de spelers 'een zaadje te hebben geplant'.

Toekomstig onderzoek kan de bevindingen van dit proefschrift verder uitwerken door aanvullende case studies uit te voeren met soortgelijke games. Dezelfde onderzoeksvragen zouden kunnen worden gehandhaafd, maar de games zouden over andere onderwerpen moeten gaan. Ook zou mogelijk een grotere steekproefgrootte van representatieve deelnemers gebruikt moeten worden, plus controlegroepen, en zou er een meer willekeurige verdeling van deelnemers over de experimentele condities moeten zijn. Gedragsmetingen na de game zouden niet alleen na één of twee weken gedaan kunnen worden, maar ook nog later om meer te weten te komen over de langetermijneffecten van games die een duurzame samenleving promoten. Daarnaast zou het interessant zijn om de gedragseffecten van deze games te onderzoeken wanneer ze fungeren als startpunt voor grotere en langere interventies waarbij naast games ook andere interventiemiddelen worden gebruikt.

Conclusies

Een persuasive game die een duurzame samenleving promoot kan een positief effect hebben op het gedrag van spelers na de game als bij het ontwerp ervan rekening wordt gehouden met het volgende:

1. Om spelers hun gedrag te laten verbeteren moeten ze zich eerst bewust zijn van hun eventuele onbekwaamheid. Een persuasive game kan spelers enigszins bewust maken van hun onbekwaamheid als de gedragssituaties direct worden aangekaart in de game en herkenbaar zijn voor spelers. Een voorwaarde voor deze bewustwording is dat de spelers de boodschap van de game begrijpen. Als de game daar niet in slaagt kan een debrief spelers alsnog bewust maken van hun onbekwaamheid. Toch kan de manier waarop spelers naar hun eigen gedrag kijken hardnekkig zijn en lijkt dit niet eenvoudig te veranderen door het eenmalig spelen van een persuasive game.

2. Het actief inzetten op de kennis, attitude, subjectieve norm, perceived control en verantwoordelijkheid van spelers met betrekking tot specifiek gedrag kan deze gedragsvoorspellers verhogen. Deze toename treedt meestal op wanneer er ruimte is voor verbetering, vaak met betrekking tot gedrag dat iemand niet dagelijks ervaart. Naast het versterken van de gedragsintenties van spelers kan dezelfde game leiden tot kleine, concrete, positieve gedragsveranderingen in het dagelijks leven van de spelers. Een toename in perceived control kan sterk correleren met een positieve gedragsverandering na de game.

3. Het expliciet opnemen van een game design element voor verantwoordelijkheid, zoals beloftes, kan leiden tot positieve gedragsverandering bij spelers, vooral wat betreft klein en concreet gedrag dat nauw verbonden is met de inhoud van de game. Het is belangrijk dat dit element de gamewereld effectief kan verbinden met de echte wereld door ook na afloop van het spel nog relevant te zijn voor de speler. Bovendien kan dezelfde game spelers motiveren om na de game informatie over het onderwerp van de game aandachtig te verwerken, waardoor de kans op gerelateerd duurzaam gedrag mogelijk toeneemt.

   Het inzetten van persuasive games kan nuttig zijn voor de collectieve gedragsverandering die nodig is om de dringende wereldwijde uitdagingen aan te pakken. Er is echter nog een lange weg te gaan voordat de levensvatbaarheid van persuasive games met zekerheid kan worden vastgesteld. Het resultaat van dit proefschrift vormt een bescheiden maar positieve bijdrage aan deze taak. Het biedt heldere aanbevelingen voor het ontwerpen van persuasive games die gebruikt worden als interventiemiddel om een duurzame samenleving te bevorderen. Het toepassen van deze aanbevelingen zou de kans kunnen vergroten dat spelers kleine maar concrete, positieve gedragsveranderingen toepassen in hun dagelijks leven na het spelen van dergelijke games. Toekomstig onderzoek is nodig om de resultaten van de uitgevoerde case studies verder te valideren. Toch kan dit proefschrift beleidsmakers en gameontwerpers inspireren om persuasive games succesvol in te zetten bij het realiseren van een duurzame samenleving.

1. Introduction

"Play is the answer to how anything new comes about."

Jean Piaget
Cognitive psychologist

Recent global environmental changes suggest that Earth may have entered a new human-dominated geological epoch, the Anthropocene (Lewis & Maslin, 2015). Human activities increasingly impact the environment at all scales and are displacing natural processes in many ways (Crutzen, 2006; Cook et al., 2016). As a result, three main crises have emerged: energy and climate, biodiversity and food, and peace and security (Saris, 2022).

1.1 Collective action to tackle global crises

More than fifty years ago, the environmental scientist Donella Meadows and her MIT research team already presented the limits of Earth's capacity to support human economic expansion (Meadows et al., 1972). Still, in their *Limits to Growth*, the researchers concluded that it is possible to alter the negative trends of growth and to establish a society of ecological, social, and economic stability that is sustainable far into the future. However, urgency is required to realize such a sustainable society. The chances of success are greater the sooner the right actions are taken to turn the tide.

Fifty years later, it seems we are running out of time (Saris, 2022). In 2015, the United Nations adopted 17 global Sustainable Development Goals, to be met by 2030 (UN, 2015). However, implementing these goals has proven to be no mean feat (Kuenkel, 2019). To prevent the possibility of counterproductive outcomes and unrealized collaborations, attention to interlinkages seems vital: between

countries, across societal actors, and across sectors (Stafford-Smith et al., 2017; Hornsey & Fielding, 2020).

This required collective action includes interlinkages on a scientific level (Kuenkel, 2019). More than ever, new connecting scientific orientations are needed to understand and deal with today's global challenges (Westbroek et al., 2020). Complex societal problems that have emerged because of the impact of the Anthropocene involve socioecological, sociopolitical, socioeconomic, and sociocultural dimensions (Saris, 2022). Next to the contribution of natural scientists and engineers to tackle these complex problems, a sustainable society therefore also needs the involvement of social scientists (Westbroek et al., 2020).

1.2 Interventions to stimulate societal behavioral change

Complex societal problems resulting from the current crises regarding energy and climate, biodiversity and food, and peace and security are 'wicked' problems. These problems are difficult to define and can not be solved once and for all but tend to reappear (Rittel et al., 1973). When the 'wicked dynamics' of a complex problem are not recognized, there is a risk of applying inappropriate methods and tools to solve them (Conklin, 2005). Psychological processes can provide welcome insights into these dynamics (Clayton et al., 2015). Although they might be mainly 'micro' oriented, these processes are influenced by 'macro' political, economic, technological, and cultural factors (Hornsey & Fielding, 2020).

One key psychological component of many urgent, complex societal problems is the need for behavioral change on multiple levels (government, companies, and individuals) (Steffen et al., 2018; Van Vuuren et al., 2018; Gierszewska & Seretny, 2019). Examples are reducing air travel (Seegebarth et al., 2024) or the consumption of fast fashion (Niinimäki et al., 2020). After a long period of neglect, the issue of societal behavioral change is now a high priority on the policy agenda (Newell et al., 2021).

To promote behavioral change, the public sector, societal actors, and the private sector can initiate behavioral interventions, which can be defined as *"a coordinated set of activities designed to change specified behaviour patterns"* (Michie et al., 2011). The public sector, for instance, has different policies at its disposal that enable the deployment of behavioral interventions: regulatory (rights and prohibitions), financial (taxes, levies, subsidies), and communicative (information and public campaigns) (McCormick, 1998). An example of such an intervention on an individual level is to reduce smoking behavior. In this regard, it could be controlled by, for instance, (1) a ban on smoking in public places, (2) an increase in VAT on tobacco, and (3) a public campaign on the health harms of smoking (Sandford, 2003; Cohen et al., 2007). Ideally, deployed interventions change behavior simultaneously and consistently on population, community, and individual levels (Kuenkel, 2019).

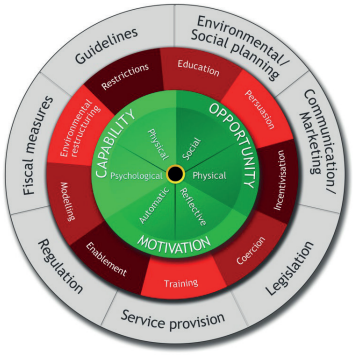
Interventions are more likely to change behavior when they are systematically developed based on theory, particularly focusing on behavioral predictors (Van der Werff, 2023). After an analysis showing what behavior needs to change, the

main barriers to the desired behavior and the main factors that can stimulate this behavior must be identified (Buunk & Van Vugt, 2013). Intervention frameworks can be helpful for such a systematic approach to intervention development. One popular synthesis of multiple intervention frameworks is the Behaviour Change Wheel (Michie et al., 2011), which provides an efficient method for choosing an intervention that is likely to be appropriate for a certain behavioral target in a given context and a given population.

1.3 The Behaviour Change Wheel A synthesis of intervention frameworks

Michie et al. (2011) conducted a systematic literature review on 19 intervention frameworks and evaluated them regarding *comprehensiveness*, *coherence*, and *links to a behaviour model*. No framework appeared to meet all three criteria. The researchers, therefore, synthesized all frameworks into one with two levels: the Behaviour Change Wheel (BCW) (Michie et al., 2011).

The 'wheel' provides a systematic method that starts with making a behavioral diagnosis of what needs to change (level 1) and then links that diagnosis to intervention functions and policy categories to bring about the desired change (level 2). As Figure 1.1 shows, nine intervention functions and seven policy categories are linked to a behavioral model at the hub of the wheel: the *Capability*, *Opportunity*, *Motivation*, and *Behaviour* (COM-B) model. Figure 1.2 shows the relations between the four components of the COM-B model. All nine intervention functions aim to address deficits in capability (including knowledge and skills), motivation (all brain processes that energize and direct behavior), and/or opportunity (all factors outside the individual that enable the behavior or not) to perform a certain type of behavior. The seven policy categories in the BCW could enable the interventions to occur (Michie et al., 2011).



The Behaviour Change Wheel incl. COM-B model (Michie et al., 2011)

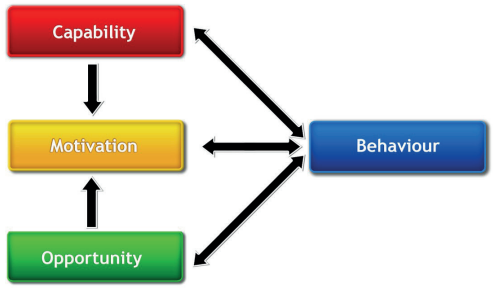


Figure 1.2
Relations between components of the COM-B model (Michie et al., 2011)

The BCW has led to a wide application in recent years due to its simplicity, comprehensiveness, and practical nature (Michie et al., 2016). The researchers acknowledge many other ways of classifying interventions and intervention functions apart from the BCW. Still, the BCW is notable because it is the first time a new framework has been created from existing frameworks explicitly to overcome prior limitations.

1.4 The deployment of persuasive games to promote a sustainable society

Upon successful completion of the BCW, an intervention that is likely appropriate for a given behavioral goal in a given context and population can be created. Additionally, a suitable intervention tool must be chosen to increase the likelihood of the intervention's success (Michie et al., 2014). Especially when it comes to promoting a sustainable society, the use of games is promising for stimulating behavioral change on an individual level.

1.4.1 Games as a versatile intervention tool

Behavioral interventions promoting a sustainable society often provide information to increase knowledge (Kollmuss & Agyeman, 2002; Van der Werff, 2023). In the BCW, this falls inside the policy category of *Communication/Marketing* (see Figure 1.1). In this setting, people are assumed to lack the necessary knowledge of a particular topic, which would keep them from executing the desired behavior. Examples of Dutch public information campaigns include topics such as polarization (SIRE, 2023) or biodiversity (Milieu Centraal, 2024). Such campaigns can indeed inform and mobilize people if used carefully in the right circumstances (Weiss & Tschirhart, 1994).

Research by Prochaska & Velicer (1997) showed that a preference should be given to interactive rather than non-interactive interventions. More specifically, their research concerning health behavioral change implied that providing interactive, individualized interventions via computers will likely produce greater outcomes than relying on non-interactive communications, such as newsletters or traditional media. Building on this, it can be concluded that games, with their interactive character, are promising for increasing the success of behavioral interventions that promote a sustainable society (Stanitsas et al., 2019; Ouariachi et al.,2019).

The abstraction of a complex reality can be presented in a game as a dynamic model (Duke, 1974). In Duke's words: *"... this permits the player to approach a complex problem from whatever perspective seems relevant, in a context which is coherent and logical, and to experiment in a basically safe environment"*. Games provide interactive learning environments in which players experience choice (Klabbers, 2018) and engage with the attitudes, values, and beliefs underlying players' motivations for taking action (Newell et al., 2021). This indicates that games can do more than just transfer knowledge (Kahne et al., 2009). Based on the COM-B model, games seem capable of positively influencing both players' *Capability* and their *Motivation* (see Figure 1.2). This makes games extra attractive as an

intervention tool for behavioral interventions that promote a sustainable society because research shows that behavioral interventions aimed solely at increasing knowledge generally have limited effect (Kollmuss & Agyeman, 2002; Osbaldiston & Schott, 2012; Bada et al., 2019).

1.4.2 Persuasive games allowing laypeople to engage with complex societal issues

Gaming practices that combine the distribution of information with attempts to engage players in particular attitudes and behaviors are referred to as *persuasive games* (De la Hera et al., 2021). These games provide platforms for persuading players to adopt a particular perspective on events in the real world (Kors et al., 2015).

An increased interest exists in persuasive games that allow players to engage with complex societal issues related to a sustainable society (Antle et al., 2014; Hallinger et al., 2020). For example, games about social inclusivity (Ruggiero, 2015; Wertley & Soliz, 2021; Kors et al., 2021), cybersecurity (Yasin et al., 2019), or ecological sustainability (Reeves et al., 2015; Raessens, 2018; Stanitsas et al., 2019). Additionally, this field of games can include games that involve anticipatory governance, in which players imagine and experiment with new governance systems for more sustainable futures (Vervoort et al., 2022).

The games can potentially create experiences that players can relate to and identify with (Klimmt et al., 2009; Kors et al., 2015) and reflect upon (Raessens, 2018). Through these personal experiences, societal issues that may feel overwhelming and far away for someone can be made understandable and relevant. As Chang (2024) emphasizes in the context of climate change: *"Games offer us inspiration, rejuvenation, even comfort, and not only just avoidance."* This way, persuasive games may even have the potential to reach skeptics, who are not easily 'converted' through facts and explication alone (Hornsey et al., 2016).

1.4.3 The impact of persuasive games

Despite their widespread application and promising impact, limited empirical evidence seems to be available to prove the effectiveness of persuasive games (including those promoting a sustainable society) (Antle et al., 2014; Soekarjo & Oostendorp, 2015; Stanitsas et al., 2019). Small attitude changes are found, but these changes are primarily identified only directly after playing the game (Jacobs & Jansz, 2021). Nevertheless, the results of evaluation studies so far often seem inconclusive (De la Hera & Raessens, 2021). Altogether, Jacobs & Jansz (2021) conclude that there is still a long way to go before the viability of games as a persuasive medium can be firmly determined. This dissertation attempts to make a positive contribution to this task.

1.5 Toward enhancing the impact of persuasive games

When an effect study only examines whether a game 'works' as a whole, it hardly helps gather the scientific knowledge needed to enhance the persuasive potential of games. Those research results are not generalizable to other games, making it

impossible to explore the underlying persuasive impact of games (Jacobs & Jansz, 2021). Validation research of persuasive games could advance with a focus on the effects of specific game features, such as game design elements (De la Hera et al., 2021).

1.5.1 Persuasive game design elements

Studying persuasive game design elements could lead to research results that can be incorporated into future game designs (Jacobs & Jansz, 2021). Elaborating on the work of Persuasive Technology (PT) researchers Fogg (2003) and Oinas-Kukkonen & Harjuuma (2009), Orji et al. (2014) therefore identified ten PT design elements that are often implemented in persuasive game design. These elements include, for example, Competition, Reward, Simulation, Customization, and Cooperation. Next, in an attempt to resolve the weakness of a one-size-fits-all design approach, Orji and her research team conducted a large-scale study with 1,108 gamers to examine the perceived persuasiveness of the identified game design elements and the receptiveness of seven gamer personalities (Bateman et al., 2011) to these elements. The study provides valuable knowledge concerning effectively tailoring persuasive game design elements. However, the validation of the exact relation between applying game elements and their effects on the players remains understudied.

1.5.2 Need for Meaning

Based on Hartevelds' *Triadic Game Design* (2011), persuasive game design elements can be linked to three different game components: *Play* (includes the experience of fantasy and fun, as well as the game rules), *Reality* (the representation of the actual system), and *Meaning* (ensuring that the game will serve its goal and support knowledge transfer). All components are equally important, so when designing a game, the right balance between the three components must be sought, according to Harteveld. Remarkably, the most commonly used persuasive game design elements identified by Orji et al. (2014) seem to primarily contribute to the game components of *Play* and *Reality* and less to the creation of *Meaning*, which is essential in persuasive games. Moreover, in addition to their receptiveness to gamer personalities, persuasive game design elements seem considerably context-dependent (Erdbrink et al., 2019). This aligns with Petty & Wegener (1998), who emphasized how varying variables can increase persuasion in some situations and decrease it in others.

Conveying *Meaning* with persuasive games can be accomplished at many levels (De la Hera, 2017). Apart from rule-based representations to influence players' attitudes (Bogost, 2008), there are many other ways and strategies to persuade players through games (De la Hera & Raessens, 2021). Some strategies can work to achieve specific goals, while others do not. Besides, the effects of persuasive games depend on many factors besides the game's design, like the game setting and players' mood during the game (De la Hera & Raessens, 2021), and players' need for agency and tendency to appropriate game rules (Sicart, 2011). Designers of persuasive games must realize that they can not completely control these factors.

As De la Hera et al. (2021) indicate, persuasive communication is a process of learning and internalization (Fogg, 2003; Ryan & Deci, 2000) rather than simply transferring a message. Creating effective persuasive games is, therefore, a very complex matter. Also, Jacobs & Jansz (2021) emphasize that persuasive games are such rich, multi-dimensional experiences that theoretical arguments for how they work on an individual level are relatively scarce. Any research that aims to increase the impact of persuasive games, particularly how they can convey *Meaning*, seems like a welcome contribution to the validation research field of persuasive games. It can help game designers create games where players can draw informed conclusions on relevant issues (Jacobs & Jansz, 2021). After all, it is important that players develop their own insights and not simply follow what the game requires of them. A recent comment related to this comes from the noted persuasive game scholar and designer Ian Bogost (2021): *"How can games become the tools of complex knowledge that many of us have promised, while also participating in, and altering, the media circumstances that resist and even destroy complex knowledge?"*

1.5.3 Persuasive Game Design 2.0

Game-based interventions often include explicit approaches to persuasion that can make players constantly aware and wary of the game's attempt to persuade them. According to Kaufman et al. (2021), such explicit, coercive approaches can backfire or be of limited use. The researchers argue that game-based interventions are enhanced when the persuasive message of the game is interweaved within the game's content. This approach could be labeled *Persuasive Game Design 2.0*, compared to the common, more explicit approach of persuasive game design. The 2.0 approach leaves more opportunities for self-persuasion, which has an enormous power to affect long-term changes in attitudes and behavior (Aronson, 1999). With self-persuasion, no direct attempt is made to convince anyone, and people are convinced that the motivation for change has come from within (Aronson, 1999).

Particularly when persuasive games are deployed to promote a sustainable society, *Persuasive Game Design 2.0* seems valuable. Not only to increase the likelihood of the needed long-term behavioral change but also because complex societal problems can be politically sensitive and thus require such a subtle, nuanced approach. Principles for ethical conduct to influence behavior, reducing the risks for potential (unintended) harm to people and society, must also be considered. Such principles include Responsibility, Integrity, and Expertise (NIP, 2022).

1.6 Game design to narrow the persistent attitude-behavior gap

Despite useful frameworks like the BCW and the promising impact of persuasive games, realizing effective behavioral interventions remains complex (Prochaska & Velicer, 1997; Fishbein & Ajzen, 2015; Abraham & Michie, 2008), especially within the context of a sustainable society (Heimlich & Ardoin, 2008; De Vries, 2019; Newell et al., 2021). People can be conflicted by (a) mixed external messages, (b) incompatible internal motivations (hedonism or altruism), and (c) holding multiple roles simul-

taneously, where their expectations and influence may vary (Newell et al., 2021). These situations can result in being overwhelmed, disengaged, and in denial (Weintrobe, 2013; Lertzman, 2015), leading to inaction where action is desired to enable a sustainable society.

1.6.1 The inconsistency between what people say and do

For example, in the case of climate change (the most significant global challenge facing humanity, Luo & Zhao, 2021), many people agree that it is caused by humans and needs to be addressed (Steg, 2018; Hornsey & Fielding, 2020; SCP, 2024). In a recent climate survey, 39% of European respondents even indicated the best way to limit climate change is through radical changes in individual behavior (European Investment Bank, 2021). Still, many people do not make the necessary personal sacrifices to adjust their lifestyle (Hornsey & Fielding, 2020; SCP, 2024). An earlier meta-analysis of belief in climate change by Hornsey et al. (2016) confirms this gap between what people say and do. Belief in climate change appeared to have a solid relationship with the extent to which people intend to behave in climate-friendly ways but a small-to-moderate relationship with the extent to which people act.

This phenomenon, where individuals' attitudes do not correlate to their actions, is often referred to (as in this dissertation) as the *attitude-behavior gap* (Claudy et al., 2013; Park & Lin, 2018). Other common terms for the same phenomenon are *intention-behavior gap* (Godin et al., 2005; Frank & Brock, 2018), *attitude-intention-behavior gap* (ElHaffar et al., 2020), or *value-action gap* (Essiz et al., 2022). The gap applies to many behaviors essential for a sustainable society, such as green consumption (ElHaffar et al., 2020), adoption of solar energy panels (Claudy et al., 2013), and household energy consumption (Huang & Warnier, 2019). Given the high priority of behavioral change on the policy agenda, it seems critical to deploy interventions (including the use of persuasive games) that take the attitude-behavior gap into account and help to solve it (Steg, 2018; ElHaffar et al., 2020).

1.6.2 Reinforcing players' behavioral intentions using the Theory of Planned Behavior

Conner & Norman (2022) state that strong behavioral intentions can reduce the attitude-behavior gap. According to the influential Theory of Planned Behavior (TPB) by Ajzen (1991), behavioral intention is the most direct determinant of human behavior. The TPB describes three factors that could directly strengthen behavioral intentions: (1) one's perception of the importance of the behavior (attitude), (2) one's perception of the group norm concerning the behavior (subjective norm), and (3) one's perception of the amount of control concerning the behavior (perceived control). Fishbein & Ajzen (2015) argue that different intervention tools can and have been used successfully in the context of the TPB, specifically when the interventions target behavior-specific beliefs. Changes in peoples' behavior-specific beliefs are found to produce corresponding changes in their attitudes, subjective norms, and perceived behavioral control, and these changes, in turn, influence people's intentions and actions (Fishbein et al., 2001). In addition to

this substantive argument for applying the TPB, the theory is considered useful because of its clarity and simplicity.

One shortcoming of the TPB is that the theory assumes that people act rationally (Kollmuss & Agyeman, 2002). However, that does not seem to be a concern in the context of persuasive games promoting a sustainable society. Players should process the game's message deliberately and consciously with these games. As described by the well-known Elaboration Likelihood Model (ELM) (Petty & Cacioppo, 1986), attitude change is considered to be the most resistant and enduring when people systematically (thus rationally) process information (Petty & Cacioppo, 1986). Persuasive games seem ideally suited to enable this preferred way of processing information in this context.

Jacobs & Jansz (2021) confirm the applicability of the TPB to game-based interventions. The researchers describe how most validation research on persuasive games focuses on the extent to which those games change or reinforce players' attitudes concerning a specific topic. The reasoning behind this is that attitude change rather than behavioral change is easier to measure. Notable is that players' subjective norm and perceived control concerning that same topic often seem to be overlooked in validation research. Particularly in the context of persuasive games for a sustainable society and the additional issue of the attitude-behavior gap, these factors seem as important as the players' attitude to influence positively.

Theoretically, these three factors could reinforce players' behavioral intention and thereby increase the likelihood of players engaging in a desired behavior after the game. As Fishbein & Ajzen (2015) indicated, interventions should target behavior-specific beliefs to achieve this. However, how this can successfully be applied in the context of persuasive game design is still relatively unknown. Jacobs & Jansz (2021) indeed emphasize that current research on the effects of persuasive games lacks support for psychological mechanisms (like the TPB) because many attempts to apply such mechanisms to games have so far failed to adapt them to the unique experience of playing a game. Rather than examining how persuasive games for a sustainable society can enhance players' attitudes, subjective norms, and perceived control (to stimulate players' behavior ultimately), it would be relevant to start by exploring the extent to which it is possible at all.

1.6.3 Additional focus on players' personal responsibility to act

In addition to the three factors of the TPB that could strengthen players' behavioral intentions, game design that aims to narrow the attitude-behavior gap should focus on players' responsibility to act. The gap may be partly caused by people's lack of responsibility to put their intentions into action (Hines et al., 1987; Blake, 1999; De Vries, 2020). With the current global crises, this lack may be caused by *diffusion of responsibility*: the more bystanders surround someone facing the same problems, the less responsible that person feels to take action (Latané & Nida, 1981). People may think that others are responsible for acting (like the government or corporations), that others already have taken action, or that they will never

be considered responsible themselves. In global crises, the 'bystanders' can be interpreted as all world citizens (De Vries, 2020).

In the case of climate change, it seems to be widely assumed that emphasizing responsibility is effective at increasing pro-climate behavior, while the collective framing of the causes of climate change diffuses responsibility (Obradovich & Guenther, 2016). Bolsen et al. (2014) examined when people take action for the common good, even in cases where individual benefits are small or non-existent. Interestingly, the research showed that communication about energy conservation emphasizing personal responsibility and collective benefits can stimulate collective action. So, a positive effect can be obtained by both convincing people to be responsible and emphasizing that positive collective benefits will occur as a result. Accordingly, Rickard et al. (2014) found that climate change communication can benefit from emphasizing individual responsibility to attract more attention from different audiences and promote deeper thinking about the issue.

Still, recognizing one's role in the climate crises can cause guilt, sadness, and cognitive dissonance (Doherty & Clayton, 2011), which can lead to inaction. Therefore, Obradovich & Guenther (2016) conclude that focusing on people's responsibility to act can encourage behavioral change in one situation but may have an ineffective or even reverse effect in another. This context-dependency of responsibility must be considered when persuasive games are deployed as an intervention tool to promote a sustainable society. Nevertheless, it seems relevant and promising to explore the factor of responsibility to improve the behavioral impact of games that promote a sustainable society.

1.7 Research questions & research design

The brief literature review above showed that behavioral change on multiple levels is one crucial part of the needed collective action to overcome the current global crises. Behavioral interventions can contribute to efforts to realize a sustainable society in the future. To accomplish behavioral change on an individual level, persuasive games that promote a sustainable society are promising intervention tools because they seem capable of positively influencing players' *Capability* and *Motivation* (both influencing *Behaviour*, see Figure 1.2). Moreover, these games can create personal experiences, making societal issues that may feel overwhelming and far away understandable and relevant, even for skeptics. However, there is still a long way to go before the viability of games as a persuasive medium can be determined. This dissertation aims to make a positive contribution to this.

Validation research of persuasive games could advance with a focus on the effects of specific game features. To improve the behavioral impact of persuasive games, it seems especially relevant that these features contribute to conveying *Meaning* through the game. To achieve this, persuasive games promoting a sustainable society should focus on reducing the persistent attitude-behavior gap. Next to knowledge (*Capability*), strengthening players' attitudes, subjective norm, perceived control, and responsibility (*Motivation*) concerning desired

behavior seems promising to narrow that gap. This dissertation, therefore, focuses on game research that further explores this issue.

The following main research question guided the research as described in this dissertation:

How can persuasive games that promote a sustainable society be designed so that playing the game has a positive effect on players' post-game behavior?

Three case studies were conducted using various persuasive games to arrive at an answer to this question. Each case study aimed to answer a separate sub-research question of the main research question. The first case study was a prelude to the following two studies that explored design strategies and the implementation of a concrete game design element. The combined generalized results of these three case studies answer the main research question and thus provide input for an overall design guideline for persuasive games that promote a sustainable society. The three subquestions, including descriptions of the corresponding case studies, can be found below.

As the COM-B model shows, the components *Capability* and *Motivation* influence the component *Behaviour*. Interestingly, according to the model, *Capability* also directly influences *Motivation*. Strengthening one's knowledge and skills concerning a specific behavior could thus enhance one's intention to act accordingly.

When people are in the very first stage of behavioral change, they can be uninformed or underinformed about the consequences of their behavior (Prochaska & Velicer, 1997). They might overestimate their knowledge and skills and do not intend to take action in the foreseeable future. It seems crucial to make them aware of their possible incapabilities before their behavioral intentions can be successfully strengthened. According to Prochaska & Velicer (1997), this first stage should involve *Recontemplation*, focusing on increasing awareness about the causes, consequences, and cures for particular behavior. The first subquestion to the main research question was, therefore, as follows:

1. *To what extent can a persuasive game make players aware of their incapabilities?*

A mixed-methods quasi-experimental case study was conducted around listening behavior to answer this research question. Effective listening is an important prerequisite for a sustainable society. If we do not listen to understand each other, the collective action needed to tackle global crises has no chance of success at all.

This first case study involved evaluating the digital listening game *Free the Listening Mutant!*. The game was specially designed and developed for this study in collaboration with the Gamelab of the Delft University of Technology.

The study investigated to what extent the game could make higher education students aware of potential issues with their listening capabilities. Additionally, the study explored to what extent such a game could have any attitudinal and behavioral effects. Pre- and post-game surveys measured players' awareness of listening incapabilities and their listening attitude before and after the game. To rule out the possibility that any lack of results could be due to the poor quality of the game, how the players perceived the game was also measured. Furthermore, after the game, semi-structured interviews were held with players to reflect on the game and to assess to what extent they believed there had been any change in their listening behavior.

The second subquestion to the main research question involved the behavioral predictors that could narrow the attitude-behavior gap and thus increase the potential behavioral impact of persuasive games that promote a sustainable society. In addition to the importance of knowledge, the literature review in this introduction showed that changes in peoples' behavior-specific beliefs can produce corresponding changes in their attitudes, subjective norms, and perceived behavioral control. Subsequently, these changes can influence people's intentions and actions. Furthermore, personal responsibility to act turned out to be another important variable that could positively influence players' behavior after the game. The second subquestion to the main research question was, therefore, as follows:

2. *To what extent can a persuasive game increase players' knowledge, attitude, subjective norm, perceived control, and responsibility concerning specific behavior, and how does this relate to the potential behavioral change of players after the game?*

A mixed-methods experimental case study was conducted around secure information handling. Society has become highly dependent on information technology, resulting in the constant threat of cyber attacks and their potentially catastrophic consequences. Secure information handling contributes to minimizing these ongoing threats that undermine the creation of a sustainable society.

This second case study involved evaluating the cybersecurity training game *The Human Firewall* by the Dutch company Awareways. The study investigated to what extent the game could increase employees' knowledge, attitude, subjective norm, perceived control, and responsibility concerning secure information handling and to what extent the game could increase employees' secure information handling after the game. Next, correlations between the behavioral predictors addressed in the game and players' post-game behavior were analyzed. Additionally, the study included a preliminary exploration of how players' responsibility could be increased by playing a game. Pre- and post-game surveys measured players' knowledge, attitude, subjective norm, perceived control, responsibility, and behavior before and after the game. Players' perception of the

game was also measured to rule out the possibility that any lack of results could be due to the game's poor quality. Next, a follow-up survey measured the concrete behaviors of employees on the job one week after the game session. Lastly, semi-structured interviews were conducted and used to support and explain the survey data results.

Of the behavioral predictors examined in the second case study, responsibility, in particular, seems to play an important role in issues related to a sustainable society and the associated attitude-behavior gap. However, little is known about how persuasive games can increase players' responsibility for specific behavior and to what extent this could lead to long-term behavioral change after the game. The third and last subquestion to the main research question was, therefore, as follows:

3. *What is the effect of explicitly including a game design element for responsibility in a persuasive game on increasing players' post-game behavior?*

A mixed-methods quasi-experimental case study was conducted around environmentally sustainable behavior: eating less meat and dairy. Factory farming has been found to contribute to the environment negatively, and drastic reductions in consumption or replacement of meat and dairy products can counter these negative effects.

This third case study involved evaluating the board game *Promise Me* by the artist Manuela Viezzer. The study investigated the effect of including promises as a game design element on player's post-game eating behavior. Next, the relationship between the game's implemented promises and players' responsibility for vegan eating behavior was analyzed. Pre- and post-game surveys measured players' responsibility toward a vegan diet. To rule out the possibility that any lack of results could be due to the poor quality of the game, how the players perceived the game was also measured. Finally, one week after the game, a third survey measured the behavioral effect of the promises.

1.8 Outline of dissertation

The three case studies that examined the three subquestions to the main research question are described in the following three chapters (Chapters 2, 3, and 4). After the extensive description of the three different case studies, a discussion follows (Chapter 5). This chapter discusses the three case studies in relation to the more generally formulated subquestions, including learnings from the three case studies and suggestions for future work. To conclude, a final short chapter presents the conclusions that can be drawn from this dissertation (Chapter 6).

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2. Making players aware of their incapabilities

Case study 1

Free the Listening Mutant!

A digital listening game for higher education

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(raw data sets and complete surveys)

> *"The scarcest resource is not oil, metals, clean air, capital, labour, or technology. It is our willingness to listen to each other."*
>
> Donella Meadows
> *Systems analyst*

2.1 Introduction

Listening skills are considered as one of the core life skills (Wolvin & Lim, 2022). The process of listening can be defined as *"receiving, constructing meaning from, and responding to spoken and/or nonverbal messages"* (Verderber & MacGeorge, 2016). Of all communication activities, it is the most widely used daily activity (Janusik & Wolvin, 2009).

Listening plays a vital role throughout our lives (Wolvin, 2012). First and foremost, we maintain our human connections by listening (Wolvin & Lim, 2022). In addition, it is one of the most needed skills in the workplace (Brink & Costigan, 2015; Spataro & Bloch, 2018) and, furthermore, is considered to be a critical academic skill (Eggenberger, 2021).

Teachers have long believed that students who listen better are better students (Beall et al., 2008). Research indeed shows that higher-education students who are effective listeners achieve more academic success than those who listen less effectively in the classroom (Bommelje et al., 2003; Eggenberger, 2021). Additionally, Bond (2012) confirms that ineffective listening skills of students can lead to a lack of understanding in educational settings.

2.1.1 Students' listening incapability

Students generally acknowledge the importance of listening (Eggenberger, 2021) but tend to overestimate their listening skills (Zabava-Ford et al., 2000). Students often associate paying attention with listening, neglecting the need to understand (Bond, 2012). They are unaware that listening is an active process they can control and enhance (Imhof, 1998).

Improving students' listening skills can lead to increased understanding (Zembylas & Michaelides, 2004). This will benefit not only students' academic success but also their subsequent success in the professional workplace (Eggenberger, 2021; Wolvin & Lim, 2022), as listening also positively impacts social contexts and networking (Crosling & Ward, 2000).

Since higher education institutes are tasked with graduating competent students ready to enter the workforce, paying attention to students' listening skills is essential (Eggenberger, 2021). As Wolvin (2012) states: *"Oral communication (including listening) is at the core of 21st-century life. We owe it to our students to equip them with the communication competencies to function effectively in this information-overloaded world."*

2.1.2 Higher education's underestimation of listening as a distinct skill

Goby and Lewis (2000) emphasize that people often regard listening as an automatic process rather than a skill. They argue that there is hardly any realization that listening is a prerequisite for successfully practicing speaking and writing skills. However, listening is a complex skill that requires training and development (Wolvin & Lim, 2022).

The underestimation of listening as a distinct skill is reflected in higher education. Generally, little time is spent teaching students to become better listeners

(Beall, 2008; Wolvin, 2012). Listening is even one of the least taught skills in higher education, although students spend 50% to 75% of their classroom time listening to their teachers, peers, or audiovisual materials (Jalongo, 2010). Several reasons are presented why there is little or no emphasis on listening in higher education. Examples are the lack of relevant materials, the time consumption it requires, and inadequately trained teachers (Janusik & Wolvin, 2002).

If attention is paid to listening in higher education, it is commonly constrained, misunderstood, or ambiguous (Bond, 2012). Basic communication courses often only provide students with a short introduction to the listening process and some listening strategies (Morreale et al., 1999). There seems to be little room for discussion about the topic, and the material's content does not always reflect the current academic understanding of listening skills (Adams & Cox, 2010). It is important for higher education to value listening more as a skill to be taught to students: without its instruction, listening becomes a perfunctory task, hindering the critical thinking process (Bond, 2012).

2.1.3 Classroom listening interventions' ambiguous impact

Suggestions have been made about how educators can train and improve students' listening skills. For example, interventions could include self-assessment of listening styles, leaderless group discussion, and oral presentation followed by a question-and-answer session (Spataro & Bloch, 2018; Costigan & Brink, 2020).

One concrete example of a listening intervention across the higher education curriculum is *The Integrative Listening Model* (created by Alverno College in 1973). It moves students through several stages: preparing to listen, applying the listening process model, self-assessment, and establishing new listening goals (Thompson et al., 2004). Another, more intimate example of a classroom listening intervention is *Bonnie's Problem*, which allows students to observe how a troubled friend reacts to seven different listening responses (Rester, 2012). All responses are unhelpful (interrupting, unrelated comments, focusing on self, discounting, blaming, evaluating, and giving advice). Later, during the activity, students also have the opportunity to experience how compassionate responses and paraphrasing can convey empathy and understanding (Rester, 2012). Lastly, a more recent example is from Spataro and Bloch (2018), who present a procedure for teaching listening in online, hybrid, or face-to-face settings. It includes online materials, articles to read, video clips, and written exercises that guide students through a process of understanding and practicing.

Despite the availability of classroom listening interventions, it does not appear easy to make students better listeners. The impact of listening instructions on actual listening skills is rather ambiguous (Beall et al., 2008). Several causes for this inconsistency in research results are provided in the literature. First, listening is a complex type of behavior to asses (Brownell, 1994). Also, the fact that students differ in listening styles complicates matters (Beall et al., 2008). People are generally inflexible regarding their listening preference(s). In particular, individuals

tend to continue using their preferred listening style(s) even when a different one could help them better receive and retain information (Bostrom, 1990). Another explanation for the ambiguity in the evaluation results of listening interventions is that listening is a difficult skill to learn because listening requires deliberate involvement from the listener to be actively engaged in the speaker's experience while staying relatively silent (Spataro & Bloch, 2018). Listening is hard to teach someone because it includes both cognitive and behavioral activities (Janusik, 2010). Lastly, as one of the most complex human behaviors, listening requires training and development (Wolvin & Lim, 2022), so one could question to what extent you can expect significant results from a single (one-time) intervention. The ambiguous impact of classroom listening interventions shows the need for their improvement. Additional research is needed to further develop the teaching method and materials (Wolvin & Lim, 2022).

2.1.4 Game-based learning to enhance listening education

The method of instruction to teach students about listening may play a role in improving their listening skills (Beall et al., 2008). Game-based learning (gameplay with defined learning outcomes, Shaffer et al., 2005) may offer a welcome contribution to the available classroom listening interventions within higher education.

2.1.4.1 Benefits of using digital games for listening instruction

Digital games can positively impact knowledge acquisition, motivation, and engagement (Perrotta et al., 2013). They provide virtual worlds that are effective learning contexts. Acting in such worlds allows learners to develop social practices (Perrotta et al., 2013). Apart from these general benefits of digital games, they seem to be an appropriate medium for listening instruction in higher education in particular.

To become a better listener, Spataro & Bloch (2018) suggest internalizing listening beyond simply knowing what it is, why it is important, and how to do it. Pearce et al. (1995), in turn, emphasize that helping students internalize listening skills is best done interactively: games are interactive by nature. Also, for complex skills like listening, learners can benefit from *scaffolding* (structured support for learners as they grow), which is well applicable to game-based learning (Van de Pol et al., 2010; Weppel et al., 2012). Games can efficiently be designed to provide helpful step-by-step feedback based on the student's listening skill level.

Lastly, digital games also have practical benefits that fit the context of higher education. They have the advantage that they can be applied to large groups of players and can be played repeatedly. Also, they often require less teacher guidance than more traditional educational methods. This way, games can assist teachers, who must try to reach all students in a limited time (Beall et al., 2008).

2.1.4.2 Earlier studies with digital listening games

The internet is full of game ideas to teach higher education students (and adults in general) to listen more effectively to others. However, few comprehensive eval-

uation studies have been done on the behavioral effects of using digital listening games within higher education. Academic research on the effects of listening games in an educational setting is often focused on non-digital games (Aynsley et al., 2019; Syafii et al., 2020) and/or applied in the contexts of primary or high schools (Dickson & Patterson, 2009; Takarroucht et al., 2022).

One study by Hwang et al. (2016), for example, used high school students as participants in their study with game-based learning activities designed to facilitate students' listening and speaking skills. An experiment with a pre-test and post-test was set up where the experimental group used a mobile system, and the control group used traditional methods. In terms of content, these methods were similar. The results showed an increase in students' speaking skills for both groups, where the students in the experimental group significantly outperformed the control group students. Concerning listening skills, however, no learning appeared to be gained. The result of the experiment by Hwang et al. (2016) seems to confirm that listening is a complex behavior that is not easily changed. The researchers suggest that critically evaluating the content of listening games could help improve their intended behavioral effects.

2.1.4.3 Focus on awareness of listening incapabilities

When developing digital listening games in educational settings, the desired behavioral change, in terms of students listening more effectively, seems insufficient. The content of the games often only focuses on the improvement of listening skills, while the importance of the students' listening attitude often seems forgotten. However, the role of attitudes can not be neglected for the effects of games that aim to change behavior (Kors et al., 2015).

Following Imhof (2008), making students aware of their current personal listening behavior and its efficiency can strengthen their listening attitude. Since students tend to overestimate their listening skills (Zabava-Ford et al., 2000), it seems important that they become aware of their listening incompetence (and its consequences) before they are instructed on new listening skills. This awareness may motivate students to improve their listening skills. As Imhof (2008) states: *"Reflection of one's listening behavior can be considered a first step toward developing goals, modification, and improvement."*

Thus, in addition to training listening skills, listening games for higher education students should also enable a more realistic appraisal of students' listening skills to increase the likelihood that they will become better listeners. Earlier studies already showed students could have a more realistic appraisal of their listening skills after a listening intervention (Zabava-Ford et al., 2000; Johnson & Long, 2007), from regarding oneself as a very effective listener before the intervention to reporting significantly lower levels of perceived listening skills afterward. The extent to which a digital listening game can have such an effect appears not to have been studied before.

2.1.5 Research question and research design

Based on the above literature review, a quasi-experimental case study with a digital listening game was conducted to improve classroom listening interventions for higher education. Especially for this study, the new game *Free the Listening Mutant!* was designed and developed in collaboration with the Gamelab of the Delft University of Technology. Participants were 188 first-year students in the first week of the university's bachelor program. The study was guided by the following research question:

To what extent can a digital listening game make higher education students aware of their listening incapabilities?

Additionally, the study explored to what extent the listening game would have any attitudinal and behavioral effects.

The case study involved a mixed-methods quasi-experimental research design. Pre- and post-game surveys were distributed to measure students' awareness of listening incapabilities and their listening attitude before and after the game. Furthermore, after the game (including the post-game survey and debrief), semi-structured interviews were held with several students to reflect on the game and to assess to what extent students believed there had been any change in their listening behavior. The outline of this chapter is as follows: first, the theoretical background and gameplay of the developed listening game are described, followed by the case study's methodology. Next, results from the study are presented and discussed, including limitations and future work, and conclusions are drawn.

2.2 Background

This section provides some relevant background on the design of the digital listening game *Free the Listening Mutant!*, as used in the case study. First, the theoretical foundations for the game's content based on listening literature are discussed, followed by the main elements of the game design. Finally, the actual gameplay is described.

2.2.1 Theoretical foundation of *Free the Listening Mutant!*

When it is stated that students are not the most effective listeners (Eggenberger, 2021), it means that they are not the best at *active* listening as opposed to *passive* listening. Active listening was first introduced in the 1950s by the well-known clinical psychologist Carl Rogers (Rogers, 1951). It involves behavior or a process where the listener actively tries to grasp both the content of a message and the underlying feeling or attitude to the message (Rogers & Farson, 1957). Active listening also includes communicating interest (verbally and non-verbally) to the speaker (McNaughton et al., 2008). Active listening is thus person-oriented and surpasses passive listening (time, action, or content-oriented) to establish a deeper connection between speaker and listener, as the listener gives the speaker full attention via inquiry, reflection, respect, and empathy (Spataro & Bloch, 2018). As mentioned

in 2.1.1, many students do not clearly understand listening as an active process they can control. This also explains why listening education is not always as effective as desired because students may feel they have no control over their listening skills (Imhof, 1998). Therefore, students must understand the difference between active and passive listening (Bond, 2012).

Much has been written, and much is known about active listening (Rogers, 1951; Robertson, 2005; McNaughton et al., 2008). However, a listening intervention like a listening game can not easily include all the elements associated with the concept. Moreover, a game must be comprehensible to increase the chances of the learning objective coming across to the players (Siriaraya et al., 2018). Therefore, for this study, only two aspects of active listening that are most relevant to the context of higher education were identified.

First, the listeners' responses to the speaker are crucial because perceptions of active listening are tied to the response patterns (Hall, 2012). As active listening is person-oriented, the responses involve reflecting on the speakers' messages and asking questions to encourage elaboration and further details (Weger et al., 2010). Five active listening response styles are identified: Advising/Evaluating, Analyzing/Interpreting, Reassuring /Supporting, Questioning /Probing, and Paraphrasing/Understanding (Johnson, 1996). Person-oriented responses positively impact immediate communication and the relationships among those communicating (Hall, 2012). Second, an essential element of active listening is keeping an open, curious, and non-judgmental mindset (Tzchakov & Grau, 2020). Active listeners strive to identify and question assumptions while respecting the speaker (Ferrari, 2012).

2.2.2 Main elements of game design

The theoretical insights from the literature review determined, together with the practical context of the game, the main elements of the game design of *Free the Listening Mutant!*. As far as possible, all design choices were aligned with the game's main goal of making players aware of their listening incapabilities.

The design process resulted in a short, single-player mobile game with the structure of a two-layered escape room. The game revolves around conversations with game characters, who form the basis of solving a puzzle. Only by listening attentionally to the game characters can players discover the clues for solving the puzzle and 'winning' the game. The game, however, has a time limit. This limit creates a trade-off for players, where different listening styles will affect their ability to get the clues while staying within the time limit. The following subsections detail the use of conversations in the game, the game format, and the structure of the game.

2.2.2.1 Simulations of conversations

The literature review on active listening provided a theoretical foundation for the content of the digital listening game. It showed that the game should enable students to:

1. experience the difference between active and passive listening;
2. discover what person-oriented responses are and their implications for a conversation;
3. experience what listening with an open attitude to the speaker entails.

These implications for the game design resulted in the creation of five simulations of conversations. Through these simulations, players could meet animated game characters to 'converse' with and thus listen to. Actors voiced all the conversations, so the game would literally revolve around listening. Also, that way the emotions of the characters' stories could be conveyed to the students.

Each conversation starts with an audio snippet where the game character speaks to the player. After listening to the snippet, the player can choose to reply to the character from written response options. These options consist of person-oriented responses, representing an active listening style, and time, action, and content-oriented responses, representing a passive listening style. After the player selects an answer, the character again reacts to this with a new audio snippet, and so on. The player can also choose not to continue to listen to the character and instead walk around till they encounter another character.

The characters' responses depend on the player's listening style. After person-oriented reactions from the player, the game characters react positively. These options often portray an open attitude, with no judgment, representing a curious, respectful attitude toward the character. The characters respond positively to this because they feel seen, heard, or understood. They engage with what the player asks or says to them. They also nonverbally show their reactions by changing facial expressions (for example, smiling). This listening style shows the player that it opens up a conversation about more personal matters, and a connection between the player and the character unfolds. In contrast, the responses of the game characters to a passive listening style are less positive; they do not feel seen, heard, or understood. This is noticeable in their spoken and nonverbal reactions (for example, looking annoyed or turning their back to the player). This way, no personal contact can emerge. The result is that no 'real' connection is made between the player and the characters.

The simulated conversations enable players to experience the consequences of their listening styles in a simple, reasonably fast way. However, the distinction between active and passive listening is not always as simple as one might think, despite the help of one character who gives cryptic hints about active listening. Players can also choose answer options that initially seem to correspond to an active listening style but, in fact, do not—for example, giving unsolicited advice or nevertheless filling in for the other. Also, with one character, regardless of the active listening style of the player, no connection can be made. This character does not listen to the player at all. This way, players can discover that active listening also has its limits, and it helps them think about those limits in real life.

2.2.2.2 Single-player mobile game with built-in debrief

In addition to the literature review, other design choices were based on the game's setting. The number of first-year students is often high. Therefore, a single-player game seemed most appropriate for this classroom context. By making the game browser-based, students could easily use their smartphones to play the game. This made it unnecessary to download a separate application, which kept it low-key to play. Smartphones are familiar and popular devices for students, which they generally always have on hand. But if the situation would call for it, the game could also easily be played on a student's laptop. Making the listening game a single-player mobile game keeps playing the game with a large group of students manageable for teachers and attractive to students.

Also, since the available time in the curriculum for listening education is often limited, the game was deliberately kept short. Regardless of whether students would finish the game, after 15 minutes, the game would end. The relatively short duration of the listening game leaves room for teachers to provide instruction beforehand and to debrief with the students on their experiences and insights after they played the game.

Still, the game design also included a simple built-in debriefing moment to ensure that students get the essentials of the game's message and reflect on their game experience regardless of the further educational embedding around the game session. This debriefing moment consisted of several open questions about listening at the end of the game, personally addressed to the player (see 2.2.3).

2.2.2.3 Game structure: two-layered escape room

The general game structure was kept simple and was based on the principle of an escape room, linking the five simulated conversations. For many students, an escape room seems a familiar concept that hardly needs any additional explanation to start the game. In this game, however, the escape room is slightly different than players would expect because it consists of two layers. Players encounter this (or not) as the game progresses.

1st layer of the listening game All five characters are in the same room together with the player. Except for a large door, the space is empty. The player can randomly start conversations with the different characters in the room. In each conversation, the player can ask for more information about the door. If the player listens carefully, three of the five characters share useful information about the door. The player can find the 'key' to open the door by connecting this information. Next, the player might think they won the game because 'the mission' seems to be completed, but there is more to discover after the door opens.

2nd layer of the listening game After the door opens and the player goes through the open door, nothing seems to have changed. The situation is still the same. Again, all five characters are in the same room with the player, and again, the space is empty except for the same large door. As before, the player can randomly

start conversations with the different characters in the room. Again, the player can ask for more information about the door in each conversation (resulting in the same loop). However, the player can also listen differently than the first time by choosing different answer options that are not directly focused on the door (and are more associated with active listening). These answer options engage more with what the characters say and include personal, empathic questions or remarks in response to the characters' stories. This approach may not seem logical to the player if they want to open the door (thinking that is the only way to escape from the room). However, it turns out to be the way to 'escape': through active listening (person-oriented), the player frees themself from being a passive listener (time, action, content-oriented). With this approach, the room's walls disappear, and the player has escaped the confinement of the room.

Message to player The two-layered escape room holds the following message to the player: there is no right or wrong in listening, but there are different ways of listening (active and passive), each with its own effects. Passive listening (time, action, content-oriented) can bring you what you want (opening the door), but it often does not lead to something new (the same room all over again). Because of the selective way of listening, you will miss a large part of the other person's message. You will not make real connections with people. Active listening (person-oriented), on the other hand, can enrich your life. It expands your world (freed from the constraining room), you discover other views, and you connect with people. Still, the game also shows that there are limits to active listening. One of the characters, for example, is much harder to interact with, and it is even impossible to establish an engaging conversation with that character. The bandwidth of active listening is different for each person.

2.2.3 Gameplay of *Free the Listening Mutant!*

To start the game, the player follows an online link. A home page appears, showing the game's name, a big industrial door, and a start button. The player is reminded to turn on the smartphone's sound. After clicking *start*, the player hears a dispassionate voice in reverberant acoustics that describes the setting in which they find themselves: a room where five characters are standing, one of them in front of the big closed door. Next, a message appears: *MISSION: Free the Listening Mutant! You have 10 minutes. Listen carefully to the people you encounter, but be aware of the time*. The actual game starts as soon as the player continues, and a clock begins ticking at the top right of the screen.

The player has 10 minutes to complete the mission. The player hears industrial background noise and is in the room with the five other characters. By swiping, they can choose one of the characters to talk to. All characters are hand-drawn black-and-white figures. Every character's conversation unfolds depending on the player's responses: the player can receive hints about opening the door, insights into the character's inner world, or no information at all.

When the player receives hints about opening the door, this is accompanied by auditory feedback of a tool sound. If this happens three times, the player has gathered the right information to open the door. But the door only leads back to the same room.... where the player is again given the same task! But this time, the player only has five minutes to complete the mission (all characters and answer options remain the same).

In the case of receiving insights into the character's inner world, the player hears a checkmark sound, and the character who is speaking acquires a little more color. By the third time this happens, the character is completely colored. When the first three characters are all colored, the player is presented with a button saying *I free the Listening Mutant*. After pressing the button, the room's walls disappear, and it becomes clear that the player has freed themself from the room: the player is the Listening Mutant!

If the player does not hear three tool sounds or does not color three characters after nine minutes, a loud alarm goes off, warning them that the 10 minutes are almost over. One minute later, the player automatically starts the same mission again, with five minutes on the clock. When these last five minutes are up, the game is over. To conclude, the player gets to read a text with some open questions to reflect on their listening behavior in the game.

Figure 2.1-a
Response options:
reflecting active and passive listening

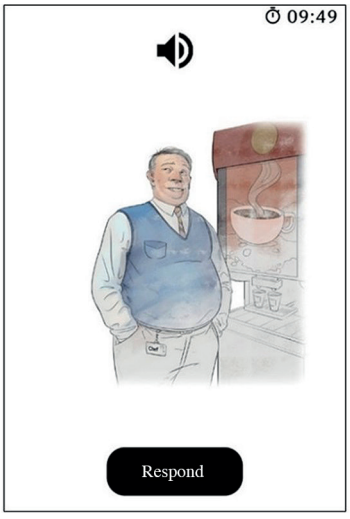

Figure 2.1-b
The character is slowly getting some color:
a connection arises

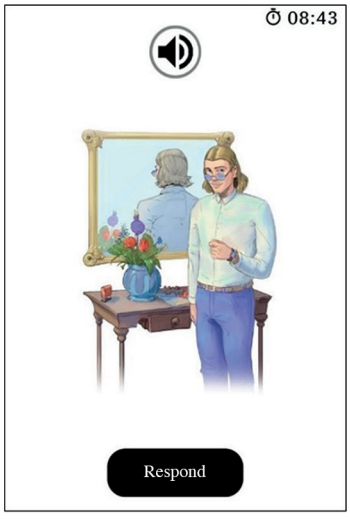

Figure 2.1-c
The character gained color:
feels seen and heard

Depending on the experience of the game, these questions are the following:

- **debrief 1** (when the door is not opened):
  How did you listen? Did you get caught up in a net of bureaucracy and confusion of speech? Can you recognize your missed listening opportunities?

- **debrief 2** (when the door is opened):
  What has listening brought you? Has the Listening Mutant been liberated? Can you also listen to really connect?

- **debrief 3** (when the Listening Mutant is freed):
  Where lies the limit of listening for you? Do you consider yourself a good listener? Will you listen differently from now on?

2.3 Methods

After approval by the Human Research Ethical Committee (HREC) of the Delft University of Technology, the quasi-experimental case study with *Free the Listening Mutant!* followed a pre-test/post-test design. A mixed-methods approach (with surveys and interviews) was used to verify and explore the game's effects. Before describing the materials and the procedure, the participant characteristics, sampling procedure, and sample size are discussed.

2.3.1 Participants

Initially, over 300 participants from the Delft University of Technology participated in the experiment. All participants were Dutch-speaking and first-year students of the BSc program at the Faculty of Technology, Policy, and Management. The experiment with the listening game was presented as a workshop as part of a mandatory class about 'teamwork' in the first week of the BSc program. All students were part of existing project groups of five students each. At the time, students were randomly assigned to these groups. For the case study, the first 36 project groups were assigned to a first workshop (morning) and the other 30 project groups to a second workshop (afternoon).

Survey and interview samples Eventually, two different samples were used for the statistical analyses within the study. First, the pre-and post-surveys were merged based on the personal e-mail addresses of the students. Corrections were made for typos and case sensitivity in the addresses for optimal merging. This resulted in 369 cases (1st workshop: 159 cases, 2nd workshop: 210 cases). Next, a selection was made of cases that had completed both surveys up to 85% or higher. This way, a final sample of 188 cases was obtained.

However, during the first workshop (morning class), several students indicated that the game crashed after opening 'the first door.' They then had to restart the game. At the time, it could not be verified per student if they experienced this bug during the workshop. For the 159 merged cases of the morning session,

it could not be ruled out that participants had experienced the bug. Since the bug could have affected the game experience, an extra item was added to the post-game survey of the second workshop (afternoon), which verified whether students had experienced this bug during the game. 25 students of the second workshop indicated they had experienced the bug. Next, a 'clean' selection was created, of which it was certain that students did not experience the bug. Of these 303 cases, 265 filled in the survey, at least up to 85%. Of these 265 cases, the 159 cases of the first workshop (possibility of bug) and the 25 cases of the second workshop (those who reported they experienced the bug) were removed. This resulted in a second sample of 81 cases, of which it was certain that students had not experienced any bug while playing the game. For most analyses, it was decided to use the sample of 188 cases based on the argumentation that restarting the game does not seem to directly impact experiencing the game's message. However, when explicitly analyzing the results regarding general game experience, the sample of 88 cases was used.

Of the 188 cases, 38 participants indicated in the post-game survey that they were open to an online interview with one of the researchers. Based on the survey answers, the researchers then selected eight students from the sample to be interviewed. In the selection process, consideration was given to creating a group of interviewees with a broadly distributed gaming experience, and the selection included participants who experienced the bug and those who did not.

2.3.2 Materials

To answer the research question, quantitative and qualitative data were collected using surveys and semi-structured interviews. In addition to the built-in debrief in the game, a separate debrief was held to explore how this could complement the game. This debrief was deliberately held after the post-game survey to prevent the debrief from affecting this measurement. That way, the mere functioning of the game itself could be analyzed. Figure 2.2 shows the time frame and order in which the research data was collected.

2.3.2.1 Pre- and post-game surveys

Before and after the game, the students' perception of their listening skills was measured. By comparing the scores of these two measurements, any increased awareness of students' listening incapabilities could be identified. Additionally,

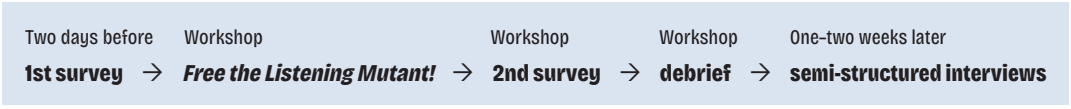

Figure 2.2
Time frame and order of data collection

in both surveys, students were asked about their listening attitude to explore whether this attitude was possibly strengthened after the game. The post-game survey also asked about students' general game experience and several other effects the game might have. Both surveys were provided online with the use of Qualtrics™.

1st survey (pre-game) The first survey included 31 items, of which 17 items were used for this study. The items primarily measured students' perception of their listening skills, derived from the validated Active Listening Attitude Scale (ALAS) (Mishima et al., 2000). The ALAS officially measures 'person-centered attitude' and 'active listening' after active listening training. As mentioned, the listening game in this case study was not designed to specifically train listening skills, but the focus of the ALAS items still matched the research context. The scope and wording of most items seemed adequate to measure students' perception of their listening skills since all items describe the application of listening skills or lack thereof. For this study, the items of two of the three ALAS subscales were included in the survey because they were the most relevant to the aim of this study. The first subscale, *Listening Attitude*, refers to 'empathic understanding'. It includes negatively formulated statements that describe non-empathic listening behavior (e.g., *I tend to persist in my opinion while talking with others*). Eight of the original 12 items were included in the survey based on their consistency with the game's content or general theme. The second subscale, *Listening Skill*, refers to more technical aspects of active listening. It includes positively formulated statements that describe the application of active listening skills (e.g., *I listen to the other person, paying attention to his/her unexpressed feelings*). Six of the original ten items of this subscale were included in the survey. The same selection criteria applied as for the first subscale items. All 14 items were scored on a 7-point Likert scale (ranging from *totally disagree* to *totally agree*). Students were asked to choose the responses that best reflected their everyday listening style. In addition to the selected ALAS items, one item was added to the survey to measure students' perception of their listening skills. This item included assigning a rating on a 1–10 scale to one's current listening skills, with the question: *If you could give yourself a grade for 'listening', what grade would you give?*

To measure how much students valued 'listening', the survey included one ranking item that requested to rank 'listening skills' among four other 'life skills' (decision-making, persuasion, creativity, critical thinking) based on the perceived importance of the students. Lastly, as mentioned, the students' e-mail addresses were requested to merge the pre-game survey data with the post-game survey data.

2nd survey (post-game) The post-game survey included 54 items, of which 45 items were used for this study. Again, this survey included the same 14 ALAS items to measure any differences in students' scores before and after the game. For the same reason, the pre-game survey's rating and ranking items were also

included. Furthermore, the survey included items measuring listening attitude, students' general game experience, and other game effects.

To complement the ranking item regarding the value of 'listening skills', the post-game survey included four additional items. These items explored to what extent the listening game made students realize that listening attentively to others is valuable to them or society and to what extent students felt more responsible for listening attentively to others (e.g., *Through the listening game … I realize that listening attentively to others is valuable to myself*) with a 5-point Likert scale. Also, as part of one multiple-response item, one item explored whether the game could convince students of the value of active listening.

To measure how students experienced the game, 14 items from the Game Experience Questionnaire (GEQ), specifically the In-Game items, were used (IJsselsteijn et al., 2013). These items measured students' feelings and thoughts while playing the listening game (e.g., *I was interested in the game's story*) with a 7-point Likert scale. The In-Game items assess players' game experience on seven components: Immersion, Flow, Competence, Positive and Negative affect, Tension, and Challenge. Additionally, one item checked if students indeed discovered through the game that there are different ways to listen to someone (using a 5-point Likert scale), one item asked students whether they would recommend the game to others, and one item included an open question about the students' game experience.

Lastly, the post-game survey explored to what extent students were made to think more about 'listening' by playing the game (three items, 5-point Likert scale, e.g., *It made me think about my own way(s) of listening*), and to what extent they became motivated to learn more about listening and improve their listening skills (three items, 5-point Likert scale, e.g., *I became motivated to start improving my listening skills*). Again, the students' e-mail addresses were requested to enable the merging of the post-game survey data with the pre-game survey data. The last two items asked about participating in the semi-structured interviews.

2.3.2.2 Debrief

As described, the relatively short duration of *Free the Listening Mutant!* leaves room for teachers to debrief the students on their experiences and insights after they play the game. This debrief must fit within the higher education setting where many students often follow the same class. Therefore, the debrief within this study used written assignments that each participating project group could complete. Multiple project groups could then discuss the completed assignments under the guidance of a facilitator.

The debrief assignments were divided into two rounds: the first round asked general questions about active listening (e.g., *Why is it important to listen to others?*), and the second round consisted of questions that more specifically addressed concrete listening situations within the project group (e.g., *Name at least three reasons why listening to each other will not always be successful*).

2.3.2.3 Semi-structured interviews

The main purpose of the interviews was to explore to what extent the students had improved their daily listening behavior due to the game. In addition, the interviews served to possibly explain or support the quantitative results that emerged from the survey data. For each interview, an interview guide with three questions was used (e.g., *To what extent have you listened differently in recent weeks?*). In parallel with those questions, there was also room for the interviewer to ask follow-up questions in response to the interviewees' answers or (other) topics suggested by the interviewees. The interviews were conducted online using Microsoft Teams™ after the interviewee's verbal consent to record the session. Next, all interviews were transcribed and later coded based on recurring themes in the interview data.

The attached appendices show all pre-and post-game survey items (Appendix 2.A), debrief questions (Appendix 2.B), and the interview guide (Appendix 2.C), as used for the quasi-experimental case study with *Free the Listening Mutant!*.

2.3.3 Procedure

The case study with *Free the Listening Mutant!* was set up as a quasi-experiment. All participants belonged to the same homogeneous group. They all played the listening game at the same time. All participants completed the same surveys before and after the game workshop. Students' individual differences in survey scores before and after the game were analyzed to examine the game's effects. To complement the survey data, several semi-structured interviews were conducted online.

2.3.3.1 Data collection method

All 369 first-year BSc students received an online link to the first survey (10 minutes, including informed consent) through their online learning platform. On the day of the experiment, existing project groups were divided into different classrooms (this had to do with the COVID-19 rules in effect at the time). In each classroom, a facilitator was present. The researchers had contact with the different classrooms via a live stream. First, the researchers briefly explained what the 'workshop' would entail and double-checked that all participating students had completed the first survey. It was emphasized that the survey data would be anonymized after analysis and safely stored and that no student data would be saved during the game.

Next, the students started to play the game *Free the Listening Mutant!* using a QR code on the classroom screen. The game sessions lasted for about 15 minutes. In some cases, two students played the game together if, for example, a headset or phone was not present. During the game sessions, the researchers and other facilitators walked around in case of questions about the game. After the 15-minute gameplay, students could start the second online survey (10 minutes) using another QR code on the classroom screen. Regardless of whether they fin-

ished the game, all students were asked to complete this survey, which included the request for an online interview (10 minutes) with one of the researchers about the participant's game experience.

After all participants filled in the second survey, the debrief was carried out via the live stream. All the project groups were asked to fill out a printed form with three questions about active listening in general (round 1) and three questions about active listening within their project group (round 2). After each round, the facilitators in each classroom supervised a brief discussion concerning the questions. One week after the game workshop, the semi-structured interviews were conducted online. With the approval of the interviewees, the interviews were recorded for transcription purposes.

2.3.3.2 Data analysis strategy

Quantitative analyses were performed using SPSS™. First, the mean scores and standard deviations of the student's scores on the GEQ items were analyzed to assess the general game experience. Next, Paired Samples t-tests were used to compare students' pre- and post-game scores on the survey items that measured 'perception of listening skills' and the rating of personal listening skills. Concerning 'empathic understanding' (*Listening Attitude* subscale of the ALAS survey), it was hypothesized that students' scores on these items (negatively formulated) would increase (without rescoring) after the game because students would become aware of their active listening incapabilities. For the same reason, a slight decrease in students' scores was expected for the items measuring the more technical aspects of active listening (*Listening Skill* subscale of the ALAS survey). Also, the personal rating for their current listening skills was hypothesized to be lower than before the game due to the increased awareness of one's listening incompetence as a result of the game. A Friedman's ANOVA was used for the mean rank of listening skills compared to four other life skills before and after the game. Frequency tables were used to analyze the post-game items with a 5-point Likert scale. All interviews were recorded and transcribed by the researchers. Next, based on overlapping themes, the data was coded.

2.4 Results

In this section, the results of the quantitative data analysis are presented, complemented by the results of the qualitative data analysis. After presenting the students' general game experience of *Free the Listening Mutant!*, the results that enable answering the main research question of this case study are discussed. Next, the exploration of students' listening attitude after the game, other game effects, the outcome of the debrief, and students' post-game listening behavior are reported.

2.4.1 General game experience of *Free the Listening Mutant!*

Most mean scores of the In-Game items of the Game Experience Questionnaire (7-point Likert scale) ranged between 3 (*somewhat disagree*) and 4 (*neither dis-*

Component (N = 62)	Item	M	SD
Positive affect	I felt content.	4.86	1.57
	I felt good.	4.49	1.36
Negative affect	I felt bored.	4.57	1.67
	I found it tiresome.	3.72	1.60
Tension	I felt frustrated.	3.96	1.64
	I felt irritable.	3.96	1.60
Sensory and imaginative immersion	I was interested in the training's story.	4.51	1.64
	I found it impressive.	3.27	1.47
Challenge	I felt challenged.	3.19	1.72
	I had to put a lot of effort into it.	2.83	1.51
Competence	I felt successful.	3.38	1.45
	I felt skillful.	3.56	1.45
Flow	I forgot everything around me.	4.70	1.24
	I felt completely absorbed.	4.57	1.36

Table 2.1
Means and standard deviations of GEQ items (7-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (7))

agree nor agree). However, all standard deviations were higher than 1, indicating large differences between students' scores (see Table 2.1). So, the game seems to have been experienced in different ways. This is also visible in the answers to whether players would recommend the game to others: 48.1% of the students would recommend the game, while 25.9% would not recommend the game, and another 25.9% did not know. One possible explanation for students' varied game experience is that not all players discovered through the game that you can listen to someone in different ways (the *aha* moment of the game): this applied to 65.5% of the students. However, 16% still did not have this discovery, and another 18.5% responded indifferently to this question. Additional qualitative results were used to further interpret these findings regarding the variety of players' game experiences.

Supporting qualitative results The qualitative outcomes concerning players' game experience supported the presented quantitative outcomes. First, the responses to the open-ended survey item (*Would you like to say something yourself about your experience of the listening game?*) reflected diverse experiences that were reduced to two opposing groups. The first group of players described an enjoyable experience and seemed to understand the goal and message of the game:

- *"It was fun, challenging, and unusual."*
- *"The goal was kept vague, which makes you listen better."*
- *"I find the insight that you can listen in two ways impressive."*

- *"Was nice to experience; did have a similar listening method already."*
- *"Funny and different from other games, did make you curious, but once you knew what to do, it was easy."*

In contrast to this first group, the second group of players indicated a less enjoyable experience. Moreover, this group seemed not to have fully grasped the goal and message of the game:

- *"I found it a bit vague; you were instructed to open the door, but it turned out to be wrong?"*
- *"Didn't get the character behind the info desk colored. "*
- *"There were generally contradicting signals within the game that did not always clarify the goal. This frustrated me somewhat."*
- *"It is implied that time, action, or content-oriented listening is the wrong way to listen, while I disagree."*

The interview data also revealed that players' game experience was divided. Most interviewees had a positive game experience, as one commented:

- *"I really enjoyed it. I tried to give the 'right' answers to the game characters. But that was still quite difficult, which made it a lot of fun. Your expectations of a person turn out not to be entirely true. You must observe how you deal with the person and what you answer. I found that very interesting and fun to play with."*

Also, two interviewees shared the game after the workshop with their family members and recommended them to play it, too:

- *"I had saved the link, so I had my brother and sisters all play the game too to see what they thought."*
- *"My mother is mainly a 'passive listener,' who listens mostly very quickly. So I knew she couldn't finish the game. "*

Still, it was also pointed out why the game was not such a positive experience for everyone:

- *"Not everyone in my group took it seriously because it remains a game. So, people perceive it as a game and not as something more than that. But once you realize it is much more than a game, then it starts to be really fun."*

Altogether, it can be concluded that the general game experience of *Free the Listening Mutant!* differed among the players. Students who got the idea of different ways of listening to someone (active versus passive), and regarded the game as more than 'a game', seemed to enjoy playing the game more than those who did not.

2.4.2 Awareness of listening incapabilities

After examining the players' overall game experience, the following analyses focused on answering the main research question: *To what extent can a digital listening game make higher education students aware of their listening incapabilities?*

2.4.2.1 Pre- and post-game scores of ALAS items

A substantial correlation between the items existed (.707, p<.001); however, Cronbach's alpha's for both subscales did not reach the minimum of .700 (.590 for *Listening Attitude* and .659 for *Listening Skill*). The further statistical analyses of the ALAS survey items, therefore, were based on item level.

Two of the eight items of the subscale *Listening Attitude* showed a significant increase (as expected) in pre- and post-game scores (p = .003): *I tend to deny the other person's opinion when it's different from mine* and *I tend to hurry the other person into talking faster* (see Table 2.2). The significance level of these items is notable compared to the other six items that show no significance at all between players' pre- and post-game scores (Sig. ranging between .101 and .829). Possibly, the content of the significant items connected more directly to the player's concrete experience in the game than the other items. However, although the

Item ALAS-subscale *Listening Attitude* (N = 188)	M pre-game	SD pre-game	M post-game	SD post-game	Sig.
I tend to persist in my opinion while talking with others.	4.21	1.53	4.19	1.47	.829
I listen to another person absent-mindedly.	3.27	1.40	3.36	1.35	.393
When I want to say something, I talk about it, even if I interrupt the other person.	3.01	1.34	3.11	1.36	.302
While listening, I get irritated from not understanding the other person's feelings.	3.28	1.55	3.44	1.47	.183
I inadvertently see the other person from a critical viewpoint.	3.94	1.36	4.08	1.35	.136
I begin to talk before the other person finishes talking.	3.62	1.56	3.46	1.58	.101
I tend to hurry the other person into talking faster.	2.48	1.33	2.74	1.39	**.003**
I tend to deny the other person's opinion when it's different from mine.	2.36	1.17	2.64	1.21	**.003**

Table 2.2
Results Paired Samples t-test of ALAS items, subscale *Listening Attitude* (7-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (7))

Item ALAS-subscale *Listening Skill* (N = 188)	M pre-game	SD pre-game	M post-game	SD post-game	Sig.
I listen to the other person, paying attention to his/her unexpressed feelings.	4.90	1.24	4.93	1.25	.684
I listen to the other person, putting myself in his/her shoes.	5.36	1.11	5.27	1.21	.202
I am aware of my own feelings while I am listening to others.	5.29	1.05	5.18	1.09	.170
I tend to listen to others seriously.	5.78	.801	5.69	.809	.120
I sometimes give the other person a brief summary of what he/she has said.	4.30	1.60	4.15	1.69	.062
I listen to the other person calmly while he/she is speaking.	5.59	.923	5.40	1.126	**.041**

Table 2.3
Results Paired Samples t-test of ALAS items, subscale *Listening Skill* (7-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (7))

students seem to have become a little bit more aware of their (self-perceived) listening incapabilities concerning denying another's opinion and hurrying one another into talking faster, they still *disagree* with the statements. It can, therefore, be concluded that after the listening game, students hardly became more aware of their incompetent listening skills and their efficiency concerning 'empathic understanding'.

Next, one of the six items of the subscale *Listening Skill* showed a significant decrease (as expected) in pre- and post-game scores (p = .041): *I listen to the other person calmly while he/she is speaking* (see Table 2.3). This means the game made students realize they do not listen as calmly to others as they indicated before they played the game. This could indicate some awareness among the students that they are not as good at listening calmly to another person as they thought. Still, they *somewhat agree* with the statement, as before the game. However, it is notable that this result seems to correspond with the earlier finding that students became a little more aware of their tendency to hurry the other person into talking faster.

2.4.2.2 Pre- and post-game rating of personal listening skills

No significant difference (p = .586) between the mean rating scores of the pre-game rating (M = 7.17, SD = 1.08) and the post-game rating (M = 7.22, SD = 1.12) of students' personal listening skills was found. It can be concluded that the rating remained practically the same: both before and after the game, students rated their listening skills as *more than sufficient*.

This outcome seems to be consistent with the results of the ALAS survey items, showing students became hardly aware of their listening incapabilities through

the game. They still seem to overestimate their listening skills after the game, as described in the introduction of this paper (Zabava-Ford et al., 2000).

2.4.2.3 Contrasting interview data

The interview data showed that, in contrast to survey items scores, some interviewees did become aware of their listening incapabilities through the game:

- *"During the conversation with the game character Claudio, my first reaction was immediately giving advice. That is indeed a thing I do. So maybe I should stop doing that and rather listen to a story and check if someone wants advice. Sometimes, people just want to tell their story and not an analysis of how they feel."*
- *"You don't normally think, 'Am I really listening?'. You either understand someone, or you don't. Now, indeed, you think, 'I can improve on that'. I think that can help quite a bit: proper listening skills."*
- *"I think the answer options pretty much summed up what I would answer. But then it's weird to hear that, indeed, that might not be the best way to communicate or talk."*
- *"I did find it funny that I felt that I conversed very well and didn't immediately asked what I wanted, but the feedback showed I did anyway."*

Interestingly, later during the debrief, the listening incapabilities of others became apparent too, as one interviewee stated:

- *"I also started looking at it the other way. How well do people actually listen to what I have to say? Certainly, one girl in my group was very much into forcing her opinion. She didn't listen to me when I had a point for improvement. She got defensive and explained why I wasn't right. Instead of understanding my point."*

Regarding students' awareness of their listening incapabilities as an effect of the game, the qualitative and quantitative results seem to contradict each other. One explanation for this may be that the statements of the ALAS survey items did not match one-on-one to the concrete experiences students had in the game. There was possibly too big a gap between the straightforward, specifically formulated statements in the survey and the players' game experiences concerning their listening capacities in the game. During the interviews, the interviewees could speak much more freely and generally about their insights. This is, for example, reflected in the mention of giving unsolicited advice as a listening incapability (which was not included in the survey). Another possible explanation for the found contradiction in results is the a-selective sampling of the interviewees, as that did not make them representative of the large survey group.

2.4.3 Listening attitude

Next, it was explored to what extent students considerd listening skills and listening more important after the game than before.

Life skill (N = 188)	M pre-game	M post-game	Sig.
1. critical thinking	1.97	2.38	**<.001**
2. listening skills	2.84	2.53	**<.001**
3. decision-making	2.94	2.87	.361
4. persuasion	3.20	3.07	.095
5. creativity	4.05	4.14	.205

Table 2.4
Results Paired Samples t-test of pre-and post-game ranking of listening skills

2.4.3.1 Pre- and post-game scores of ranking 'listening skills'

For the ranking item, all skills remained in the same ranking position after the game as before the game, with 'listening skills' in second place after 'critical thinking' (see Table 2.4.) However, a Paired Samples t-test showed significant changes in the pre- and post-game mean ranks of 'critical thinking' and 'listening skills'. These results show that 'critical thinking' became somewhat less important for students after the game (from 1.97 to 2.38), and 'listening skills' became somewhat more important (from 2.84 to 2.53).

2.4.3.2 Results post-game attitude items

The post-game survey items measuring students' listening attitude showed contradicting results (using a 5-point Likert scale). On the one hand, most students indicated that the game did not convince them of the value of listening (87.5%). On the other hand, the majority of the students also indicated that through the game they...:

- ... realized that listening attentively to others is valuable to themselves. (74,5 %)
- ... realized that listening attentively to each other is valuable to society. (64,9%)
- ... felt more responsible for listening attentively to others. (54,3%)

These contradicting results can be explained by the fact that students were already convinced of the value of listening before they played the game (as described in 2.1.1). As a result, there was little room for change in this regard. This is also reflected in the ranking item, where students before the game already ranked 'listening skills' high compared to other skills a person may possess. Still, the game did make the large majority of students aware of their existing valuation of listening and made over half of them even feel more responsible for listening attentively to others.

2.4.3.3 Additional interview data

The interviewees reported that they find listening valuable and important. Whether this was specifically due to the effect of the game was not always made

explicit. Again, it seems to be evident that students thought listening was important even before they started playing the game:

- *"I do think it's important. Especially nowadays. I am curious about what moves people or what their message is, but you do notice that a lot of people sometimes also listen with their own agenda."*

Still, the game did seem able to strengthen interviewees' listening attitude somewhat:

- *"You do start thinking about listening skills; yes, it is important, and it would be useful to know more about it."*
- *"Normally, in a team meeting, you want to push your own agenda, or at least you want to do it your way. Yet you also need to hear how others see it. Instead of just doing your own thing. That's what I did learn from the game: sometimes listening is more important than not listening."*

The exploration confirms that students generally have a positive listening attitude (Eggenberger, 2021). Therefore, there seemed to be little room for the game to strengthen this attitude. However, playing the game did make students (more) aware of their existing positive attitude. Additionally, it increased the feeling of responsibility for most students to listen attentively to others. So even though students' listening attitude was already positive before the game, it seems to have strengthened somewhat after playing it.

2.4.4 Other effects of game

Two other possible effects were explored besides the exploration concerning students' listening attitude. First, the extent to which students were made to think more about listening through the game:

- It made me realize more of the consequences of my way of listening. (70,2%)*
- It got me thinking about how people listen to each other. (53,2%)*
- It made me think about my own way(s) of listening. (27,9%)

* Percentual scores for *agree* and *totally agree* are shown.

These results show that, by playing the game, the majority of students realized what the consequences of their own listening behavior could be and started to think about how people listen to each other. As one interviewee described:

- *"The game indicated, 'You are a good listener if you also listen to other people'. I thought about that a lot. Indeed, when you listen, it has to come from both sides. Not just listening to yourself. But also to the intention of the other person. I still think about it."*

Interestingly, most students did not start to think about their own way(s) of listening. This last result is not surprising and aligns with the previous results. As described earlier, students rated their listening skills as *more than sufficient* before and after the game. So, for the students, there is nothing 'wrong' with their listening skills, and it does not seem logical for them to think about it any further.

The second exploration, concerning the extent to which students became motivated to improve their listening skills or to learn more about listening through the game, showed the following results:

- The game got me motivated to start improving my listening skills. (36,1%)*
- Through the game, I plan to listen better to others from now on by letting go of my own goals, judgments, and expectations. (35,1%)*
- It sparked my curiosity to learn more about listening to others. (20,7%)

* Percentual scores for *agree* and *totally agree* are shown.

It can be concluded that the majority of the students did not become motivated to improve their listening skills or learn more about listening by playing the game. The interview data also confirmed this because this was hardly mentioned during the interviews. Again, the explanation here seems to be that the students have no reason to change anything since their perceived listening skills are 'more than sufficient'.

2.4.5 Results of debrief

Almost all project groups correctly completed the answers to the debrief assignments. For example, many diverse reasons were given as to why it is important to listen to others: *"... to understand each other, to learn from each other, to help each other, to collaborate, to form correct opinions, to prevent miscommunication, to inspire each other, out of respect, to connect..."*. Notably, some groups answered this question much more extensively than others. Also, many characteristics of a good listener were described: *"... summarizing what the other is saying, letting the other finish, asking relevant questions, not bringing the story on yourself, paying attention, making eye contact..."*. Possibly, this knowledge was present among the students before the game, but it was notable that elements of the game (direct and indirect) were often identified. Even though the previous quantitative results showed that not all students had experienced the game's message, the debrief revealed that joint project groups understood the game in general. The group assignments may have ensured that diverse game experiences were shared and discussed between project group members.

During the discussions held after completing the assignments, in particular, the limit of active listening was an interesting discussion topic. To illustrate this issue, the game character who was not listening to the player (but just rattled on) was referred to. Students discovered that for some people, the limit at which they stop listening is reached much faster than for others. The discussion seemed to encourage students to think about their listening behavior. This type of reflec-

tion did not appear much during the gameplay, as the results described earlier. Therefore, it can be concluded that the debrief added value to playing the listening game.

2.4.6 Post-game listening behavior

Lastly, the extent to which students' listening behavior improved after the game was explored. Based on the previous quantitative results, it did not seem likely that students would change their listening behavior after the game; before and after the game, students considered their listening skills *more than sufficient*. Indeed, the interview data confirmed that no big changes in students' listening behavior were made after the game. Still, the interviews provided additional insights that present a more nuanced picture. First of all, it turned out that some people did intend to listen in a different way after the game workshop (gameplay including the debrief) but ended up not doing it:

- *"During the game and afterward, I thought, 'Oh, this would be useful to apply', but then I didn't, I guess. Not consciously, anyway. I just forgot about it."*

Next, two interviewees indicated that they had focused on improving specific elements of active listening that could use some improvement in their perception.

- *"I started paying attention to whether I was indeed going to give less advice and not thinking about solutions in advance. But instead of just accepting what people have to say."*
- *"Sometimes, I do try to distance myself a little more from the conversation. To really look at it more openly. I am pretty good at that."*

Some interviewees also indicated that they generally felt that group members listened better to each other in their project group meetings after the game workshop. The debrief seems to have played an important role in this. After all, in the debrief, the game's content was discussed in concrete terms.

- *"I don't think so consciously because we played that game; we do it that way now. But more because we've learned about it and we've talked about it. That it's always in the back of your mind. That you just want to listen to each other."*

Yet it was also recognized that the debrief is not self-contained and that the game could make players think about listening and motivate behavioral change provided that players 'understood' the game.

- *"I really think that game helped you to think in a different way. You just go into a conversation in a very different way. If you really see the game for the purpose for which it was made."*

After playing the listening game, the students did not immediately change their listening behavior. Although the intention had arisen to apply active listening in daily life after the game, this was often forgotten. Yet, for some participants, small changes in their listening behavior seem to have occurred.

2.5 Discussion

Taken together, the results indicate that it is challenging to make higher education students aware of their listening incapabilities using a digital listening game. Students' perception of their listening skills proved persistent. Still, the game does seem to have triggered the students to be more engaged in listening than before the game. In this section, the main results of the experiment and its limitations are discussed, and suggestions for future work are provided.

2.5.1 Divided game experience and importance of debriefing

First of all, the listening game was not able to 'reach' all participating students. One group of students discovered and understood the two layers of the game, while another group completely missed the game's message. This came as no surprise. In game design, one can not expect to create something that suits all players (Orji et al., 2017). Besides, with the specific design of *Free the Listening Mutant!* it was not expected that all students would finish the game (and thus experience the *aha* moment).

However, the group that was not reached during the game (despite the in-game debrief) got more involved in the topic of listening during the debrief after the game. Having students discuss their game experiences together helped them better understand the game's message. Next, a concrete link to the daily practice was made by discussing relevant listening situations from the students' project groups. The results show that the debrief enabled students to reflect on their listening behavior. It can, therefore, be concluded that when educational institutions want to include a listening game workshop within their curriculum, it is recommended to include a debrief session.

2.5.2 Students' persistent perception of listening skills

The experiment's results show that students hardly became (more) aware of their listening incapabilities by participating in the game workshop. Even after the game, students still seem to overestimate their listening skills. Based on teacher experience and literature (Zabava-Ford et al., 2000), students have more incompetence than they admitted in their pre-game and post-game responses.

Although students hardly became aware of their own listening incapabilities, the experiment revealed that students do notice the listening incapabilities of others. Apparently, observing an imperfection in another is easier than in yourself. This can be explained by the psychological phenomenon called *illusory superiority*. This is a condition of cognitive bias wherein a person overestimates their own abilities and qualities in relation to the same abilities and qualities of others (Hoorens, 1993).

Interestingly, for the survey items with a significant difference between pre- and post-game scores (showing some awareness of listening incompetence), the content seemed to directly match the game content more than the other survey items. An example is time pressure, which plays a major role in the game. This might explain why some awareness of incompetence was only experienced for those items. Elements of active listening that were only indirectly included in the game experience were possibly too subtle for students to notice and reflect on. This is something to consider for future listening game designs.

2.5.3 Attitudinal and behavioral effects of the listening game

The results confirmed that students already had a positive attitude toward listening, as was already stated in previous research (Eggenberger, 2021). The game, therefore, had its limits to reinforce this attitude. Still, the game seemed to have strengthened students' listening attitude somewhat. Interestingly, playing the game made students (extra) aware of their existing positive attitude. Possibly this will influence their listening behavior later during daily conversations because the attitude has been brought more to their attention by the game than before, and attitudes are seen as critical behavioral predictors (Fishbein & Ajzen, 1975). Besides, the game increased the responsibility of the majority of the students to listen attentively to others. This might also increase the likelihood of improved future listening behavior.

The positive listening attitude of students could explain why they barely reported any awareness of listening incapabilities. Because students thus believe that listening is important, it may be difficult for them to admit that they are not very good at it. This contradiction can cause unconscious discomfort. That means there may be some *cognitive dissonance* (Festinger, 1957) in this context. After playing the listening game, the students did not immediately change their listening behavior. Based on the other research results, this was expected. Yet, very small behavioral changes have occurred, mainly observed in the post-game interviews and the group debrief.

2.5.4 Research limitations

In addition to the discussion points described concerning the research findings, several limitations can be noted from the experiment. First, the survey items measuring students' perception of their listening skills did not appear to match well with students' actual experiences during the game. Some statements in the survey described listening behavior that only subtly appeared in the game. Still, focusing on students' awareness of their listening incapabilities was relevant because this awareness seems to be better assessable than actual listening behavior (as often measured in previous listening studies). Self-reporting surveys remain an adequate way to map participants' awareness in a relatively simple, fast, and direct way. In addition, the interviews provided the opportunity to elaborate more on players' game experience.

Another limitation to note is the moments of measurement within the study. The research design did not include a second post-game measurement after the collective debrief. That way, the effects of the entire workshop, which the game was part of, could have been measured and analyzed. For this study, the focus was on the stand-alone game experience, but the role of the debrief appeared of such importance that an additional measurement would have been interesting. Next, even though the bug that occurred during the game was relatively minor, it potentially affected the students' game experience. This resulted in the distinction in sample sizes to rule out the effects of the bug on the results completely. Also, it remains probable that students may have given socially desirable answers to the survey items. Although it was emphasized that participants' answers were only accessed by the researchers and there was no 'good or bad', it still seems possible that students felt it is undesirable to admit they are not as good a listener.

Something else that may have influenced the data collection is that students were obligated to participate in the workshop because it was part of their curriculum. Because of this, they may not have been fully motivated to participate seriously and did not fill out the surveys with full attention. However, the alternative of having students voluntarily participate in the workshop would result in an unrepresentative group of participants. Lastly, the interviewees did voluntarily participate in the interviews. They were enthusiastic enough about their gaming experience to want to talk about it. This makes the interviewees a group that is not representative of the entire sample. As a result, the interview data may thus have given a subjective picture of the experience of *Free the Listening Mutant!*. Yet, the interview data is considered valuable to the study. The interviews allowed the students to discuss their experience in more detail and mention things that did not appear in the surveys.

2.5.5 Suggestions for future work

Based on the discussed research results and the research limitations, suggestions for future research can be made. To start, a larger group of students who appreciate the game and get the game's message could perhaps be reached when the conversations in the game better reflect the students' perceptions. This involves not only the topic and storyline of the conversations with the game characters but also finding the right tone of voice with which students can identify. An adequate way to achieve this is co-creation, where students can learn about listening even by making the game (Arnab et al., 2017).

Also, future research could use a more elaborate survey with items more directly linked to players' game experience. Lastly, measuring participants' game experience and insights after the debrief and even a couple of weeks after the workshop is highly recommended. There will have been enough situations in the participants' daily lives in which active listening has played a role and possibly insights from the game have been applied or considered. At least, the participants will have had more time to let the game sink in.

2.6 Conclusion

Higher education students generally acknowledge the importance of listening (Eggenberger, 2021), but tend to overestimate their listening skills (Zabava-Ford et al., 2000). To contribute to the need to further develop the teaching method and materials to enhance students' listening skills, a quasi-experimental mixed-methods case study was conducted with the digital listening game *Free the Listening Mutant!*. The study investigated to what extent a digital listening game can make higher education students aware of their listening incapabilities. Additionally, the study explored to what extent such a game could have any attitudinal and behavioral effects.

Results show that students hardly became aware of their listening incapabilities by playing the listening game. Both before and after the game, students rated their listening skills as *more than sufficient*. Acknowledging others' poor listening habits turned out to be easier for participants. Still, some awareness was found of listening behaviors that occurred directly in the game. The interviews also revealed awareness of specific listening issues. Next, the exploration confirmed that students had a positive listening attitude before the game, explaining why they barely reported any awareness of listening incapabilities. If students value listening, it may be uncomfortable to admit that they are not very good at it (cognitive dissonance). Although there was little room for the game to reinforce students' listening attitude, the game made most students (extra) aware of their existing value of listening. Also, a large half of the students felt more responsible for listening attentively to others after the game. Furthermore, the exploration revealed very small behavioral changes to have occurred. Still, students' strengthened listening attitude could positively influence their future listening behavior.

Listening is one of the most complex human behaviors (Wolvin & Lim, 2022), so it is not surprising that the results of this study are moderate. Still, it can be concluded that the conducted experiment offers a valuable contribution to the needed research on teaching methods and materials to enhance higher education students' listening skills. Game-based learning allowed for the required room for discussion, which was still lacking in listening education. The debrief proved of great value in this regard. Although students found it difficult to reflect on their listening behavior, the small results found in this study can still be considered the first steps toward developing goals, modification, and improvement.

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Appendix 2.A
Pre- and post-game survey items

1st survey (pre-game)

1. **The following statements relate to a situation where you are in a conversation with someone.**
For each statement, please indicate the extent to which you agree or disagree.

NB: 7-point Likert scale, ranging from *totally disagree* (1) to *totally agree* (7)

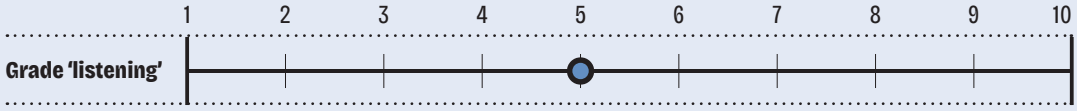
[*Listening Attitude* subscale derived from the Active Listening Attitude Scale – Mishima et al., 2000]

- I begin to talk before the other person finishes talking. [Q2]
- I inadvertently see the other person from a critical viewpoint. [Q3]
- When I want to say something, I talk about it, even if I interrupt the other person. [Q4]
- I tend to hurry the other person by talking faster. [Q5]
- I tend to deny the other person's opinion when it's different from mine. [Q6]
- I tend to persist in my opinion while talking with others. [Q7]
- While listening, I get irritated from not understanding the other person's feelings. [Q8]
- I listen to him/her absent-mindedly. [Q9]

[*Listening Skill* subscale derived from the Active Listening Attitude Scale – Mishima et al, 2000]

- I listen to the other person calmly, while he/she is speaking. [Q10]
- I listen to the other person, putting myself in his/her shoes. [Q11]
- I sometimes give the other person a brief summary of what he/she said. [Q12]
- I tend to listen seriously to someone. [Q13]
- I am aware of my own feelings, while I am listening to others. [Q14]
- I listen to the other person, paying attention to his/her unexpressed feelings. [Q15]

2. **If you could give yourself a grade for 'listening', what grade would you give?** [Q1]
Use the slider below.



3. **Rank the following skills according to how important they are for you to possess.** [Q16]
Choose 1 for 'most important' to 5 for 'least important'.

- decision-making
- persuasion
- creativity
- listening skills
- critical thinking

4. **What is your e-mail address?** [Q31]

.....

2nd survey (post-game)

All items of the first survey were again presented in the second survey (see 1 to 4 of pre-game survey items). In addition, the following items included the post-game survey:

1. **What has the listening game done to you?** [Q34]
Please tick below what applies to you (multiple answers possible):

- ☐ it convinced me of the value of listening to others
- ☐ it made me think about my own way(s) of listening
- ☐ it sparked my curiosity to learn more about listening to others
- ☐ it has done little for me
- ☐ other, namely: .....

2. **The following statements describe how you felt during the listening game.**
For each statement, please indicate the extent to which you agree or disagree:

NB: 7-point Likert scale, ranging from *totally disagree* (1) to *totally agree* (7)

[In-Game items derived from the Game Experience Questionnaire – IJsselsteijn et al., 2013]

[Positive affect]
- I felt content. [Q46]
- I felt good. [Q49]

[Negative affect]
- I felt bored. [Q38]
- I found it tiresome. [Q42]

[Tension]
- I felt frustrated. [Q41]
- I felt irritable. [Q43]

[Sensory and imaginative immersion]
- I was interested in the game's story. [Q36]
- I found it impressive. [Q39]

[Challenge]
- I felt challenged. [Q47]
- I had to put a lot of effort into it. [Q48]

[Competence]
- I felt successful. [Q37]
- I felt skillful. [Q44]

[Flow]
- I forgot everything around me. [Q40]
- I felt completely absorbed. [Q45]

3. **Would you recommend the game to someone else?** [Q50]

- ☐ yes
- ☐ no
- ☐ different

4. **Anything else you want to say about your experience of the listening game?** [Q51]

.....

5. **For each statement, indicate the extent to which you agree or disagree.** [Q35]

NB: 7-point Likert scale, ranging from *totally disagree* (1) to *totally agree* (7)

Through the listening game...
... I discovered there are different ways to listen to others.
... got me thinking about how people listen to each other.
... I am more aware of the possible consequences of my way of listening.
... I realize that listening attentively to others is valuable to myself.
... I realize that listening attentively to each other is valuable to society.
... I became motivated to start improving my listening skills.
... I intend to listen 'better' to others from now on by letting go of my own goals, judgments and expectations.
... feel more responsible to listen attentively to others.

6 **May we approach you for a short online interview (10 min. max.) about your experience with the listening game?** [Q32]

☐ yes, that's fine
☐ no, rather not

May we see your answers to the surveys for this purpose?

☐ yes, that's fine
☐ no, rather not
☐ not applicable

Appendix 2.B
Debrief questions

Round 1

Question 1	**Why is it important to listen to others?**
Question 2	**What are the characteristics of a good listener?**
Question 3	**Sometimes, you have to stop listening and take action. Where is the line for you?**

Round 2

Question 1	**Suppose you are working as a group on a governance project. In order to do justice to everyone's skills and ideas, you try to listen to each other carefully. But sometimes, that does not work out. Name at least three reasons why listening to each other will not always be successful.**
Question 2	**Come up with a solution for each of the three reasons from question 1 so that people will still listen. Without wasting too much time on discussions and not meeting the project deadline.**

Appendix 2.C
Interview guide

1. **How did you experience the game?**

2. **What has stuck with you from the game?**

3. **To what extent have you listened differently in recent weeks?**

   Follow-up question
   Can you give an example of that?

3. Increasing players' knowledge, attitude, subjective norm, perceived control, and responsibility

Case study 2

The Human Firewall

A cybersecurity training game

doi: 10.4121/d667dde4-ac0a-43f0-868a-8ef3aedfbdc1
(raw data sets and complete surveys)

> *"We're all going to have to change how we think about data protection."*
>
> Elizabeth Denham

3.1 Introduction

Cybersecurity is considered a worldwide issue and concern (Ramlo & Nicholas, 2021) and can be defined as *"the organization and collection of resources, processes, and structures used to protect cyberspace and cyberspace-enabled systems from occurrences that misalign de jure from de facto property rights"* (Craigen et al., 2014).

The development of information technologies in the past decades transformed everyday life in society (Sulich et al., 2021). Meanwhile, society has become largely dependent on information technology (Albladi & Weir, 2020). As this dependence increases, so does the threat of cyberattacks and their potentially catastrophic impact (Jang-Jaccard & Nepal, 2014; Pollini et al., 2022). Strong measures (legal, regulatory, and organizational) to control cybersecurity are therefore paramount (Gupta et al., 2018; Sulich et al., 2021).

Despite the attention and acceptance of cybersecurity, gaps and weaknesses remain (Evans et al., 2016). Security and risk management leaders face technological, organizational, and human malfunctions (Gartner, 2024). Significant security incidents and data breaches are, therefore, still prevalent (Jang-Jaccard & Nepal, 2014; Edwards et al., 2016). Particularly, human factors are considered one of the main causes of vulnerabilities in an organization's information security (ENISA, 2020).

3.1.1 Human factor and social engineering

According to Kemper (2019), 90% of cybersecurity incidents are related to human errors. This makes employees the weakest link in a company's security chain (Krombholz et al., 2015; Salahdine & Kaabouch, 2019). Most incidents result from insecure (software) settings at work without malicious intent (Reason, 2000). Hackers like to take advantage of this human factor in cybersecurity by focusing more and more on the exploitation of human pitfalls, also known as *social engineering* (Wang et al., 2020; Syafitri et al., 2022).

Social engineering attacks are cybersecurity's biggest threats (Breda et al., 2017). With methods like phishing (fraudulent e-mails), vishing (voice phishing), and smishing (text message phishing), hackers try to access sensitive information for specific purposes or to be resold (Salahdine & Kaabouch, 2019; Syafitri et al., 2022). In addition to these methods, hackers are also operating in the physical world (Wang et al., 2020; Montañez et al., 2022). They might, for example, pose as subcontractors to a company, stake out offices to see whether they can obtain sensitive information, or leave USB sticks with malware at workplaces.

Social engineers understand how people think and act only to abuse it. Therefore, their methods often involve implementing various psychological influence techniques (Krombholz et al., 2015; Ferreira et al., 2015). Particularly, the 'seven principles of persuasion' by Cialdini (2008) are widely applied: Reciprocity, Consistency, Social Proof, Liking, Authority, Unity, and Scarcity. Concerning phishing, for example, often the principles of Authority (people tend to comply with orders from someone believed to be an authority figure) and Reciprocation (people tend to feel obligated to return favors from others) are used (Wang & Lutchkus, 2023).

The fact that hackers target human pitfalls often seems to be overlooked (Krombholz et al., 2015). Technical measures are relied upon to detect and prevent cyberthreats and attacks, but technology can achieve this only to a limited extent (Gupta et al., 2018; Campbell, 2019; Furnell & Dowling, 2019). Next to the implementation of, for example, firewalls, anti-virus software systems, and cryptography methods, the prevention of social engineering remains challenging because the human pitfalls that hackers exploit will always exist (Luo et al., 2013; Conteh & Schmick, 2016; Salahdine & Kaabouch, 2019).

3.1.2 Need for effective employee information security awareness training

Social engineering attacks will still be unpredictable for unsuspected victims (Syafitri et al., 2022). Next to software and hardware solutions to counter these attacks, it is therefore crucial to invest in employees' awareness of online and offline threats and the ever-changing techniques of attackers (He & Zhang, 2019; Aldawood & Skinner, 2019; Dahabiyeh, 2021). Additionally, educating particularly the non-tech-savvy employees, including training employees' accountability (complying with the company's security policy) and ongoing training are emphasized (Campbell, 2019).

Information security awareness training has been developing as the threats of social engineering attacks are increasing (Aldawood & Skinner, 2019). Several types of training are employed, with advantages and disadvantages (Dahabiyeh, 2021). First, the most traditional is face-to-face instructor-based training. This type of training allows for interactive (tailored) discussion and explanation (Tschakert & Ngamsuriyaroj, 2019), but it is also practically challenging and costly to implement on a large scale (Dahabiyeh, 2021). Second, a less expensive type of training is text-based, conducted through e-mails and newsletters (Abawajy, 2014). However, this method does not verify whether employees get the required information (Kumaraguru et al., 2008). Next, computer-based training enables employees to take it at their own pace (Furnell et al., 2003), but it is also a relatively passive way to transfer information to employees. The same holds for the fourth training type: video-based training. Lastly, the most recent type of training is game-based. This type of training can provide employees with various scenarios and is considered the most immersive of all training types (Awojana et al., 2018).

The type of training plays a significant role in its overall impact (Abawajy, 2014). Due to a lack of training budget, companies can not always offer their employees the type of training that is most desired and appropriate (Aldawood & Skinner, 2019). The intended training result is, therefore, not always achieved. In addition, the average impact of awareness training is debatable (Alruwaili, 2019). Research results show positive effects of training employees about proper security practices (McCrohan et al., 2010; Alotaibi et al., 2016; Prümmer et al., 2024), but also little to no behavioral change after awareness training is found (Caldwall, 2016; Alruwaili, 2019; Bada et al., 2019). Suggestions to enhance the impact of information security awareness training include customization (Alruwaili, 2019), follow-up training (Sarker et al., 2024), and employee motivation (He & Zhang, 2019). Concerning the latter, it is observed

that employees are often bored during training and lack the enthusiasm to participate, resulting in limited training impact (He & Zhang, 2019). Game-based training, with its immersive and interactive nature, is therefore often recommended and preferred over other training types (Wolfenden, 2019; Prümmer et al., 2024). It can be complemented by instruction-led or computer-based security training (Abawajy, 2014; Hart et al., 2020).

3.1.3 Cybersecurity training games for employees

The use of games for employee information security awareness training is still a developing field, but its popularity continues to grow (Alotaibi et al., 2016; Aladawy et al., 2018; Hart et al., 2020). Many games aim to simulate real-world security situations, and players can explore how to handle these situations without fear of failure or negative consequences (Gáliková et al., 2021; Yasin et al., 2019). Next, players' progress in the game is often based on how they face challenges and solve problems in the game (Stockhardt et al., 2016).

Examples of existing cybersecurity training games applicable in the corporate sector are *CyberCIEGE* (Cone et al., 2006), *Playing Safe* (Newbould & Furnell, 2009), *SEAG* (Olanrewaju & Zakaria, 2015), *CyberPhishing* (Hale et al., 2015), *Persuaded* (Aladawy et al., 2018), *CSRAG* (Yasin et al., 2019) and *Riskio* (Hart et al., 2020). The latter and most recent game, *Riskio*, was specifically designed to address detected limitations exhibited by earlier cybersecurity training games. According to Hart et al. (2020), these limitations are:

1. not making players aware of the extent of cyberattacks and the possible defenses against them;
2. not allowing players to practice offensive and defensive skills;
3. not easily adaptable or modifiable.

It resulted in the game *Riskio*, a tabletop card game (3–5 players) set around an imaginary company designed for employees with no technological expertise. A game facilitator, an experienced cybersecurity professional, guides the players. During the game, players take the roles of both attacker and defender. Evaluation of the game showed that employees who played the game had confidence that *Riskio* could increase their awareness of cybersecurity issues. The employees indicated they enjoyed the game rules and mechanics and could relate the game scenario to their organization (Hart et al., 2020).

Alotaibi et al. (2016) conducted a literature review of various studies on games like *Riskio* and their effectiveness in creating cybersecurity awareness. It was concluded that most of the evaluated games were effective in creating player awareness. Yet the researchers also indicated that *"there is a need for in-depth and robust evaluations to conclude the effectiveness of serious games for cybersecurity"* (Alotaibi et al., 2016). Accordingly, suggestions are made to improve these evaluations. Prümmer et al. (2024) note that in most evaluation studies of cybersecurity training (including games), the objective post-training behavior of employees is

hardly measured but should be included. If employees' secure handling of information is measured at all, it is often immediately after a single training session, without a follow-up measurement (Prümmer et al., 2024; Sarker et al., 2024). Also, it is suggested that more evaluations should be conducted with the employees for whom the games are designed rather than students, who are more accessible to recruit as research subjects (Prümmer et al., 2024).

Apart from suggestions to improve the evaluations of cybersecurity training games, suggestions are also made regarding their game design to enhance the behavioral impact of the games. For example, Nagarajan et al. (2012) recommend customized games that focus on the specific needs and security policies of the players' organization and games that stimulate players to reflect and apply secure information handling in real-time. Also, it is suggested that cybersecurity training (including games) would benefit from a more substantial theoretical basis concerning players' behavior (Prümmer et al., 2024).

3.1.4 Beyond increasing players' knowledge: targeting behavioral predictors

So far, little use is made of behavioral theories when developing cybersecurity training (Prümmer et al., 2024). Most training games seem to focus mainly on creating awareness among employees by increasing employees' knowledge of cybersecurity (Shaw et al., 2011; Arain et al., 2019). Greater knowledge is indeed connected to employees' level of cyberthreat awareness (Zwilling et al., 2022). Still, this knowledge does not necessarily need to be reflected in people's behavior (Albladi & Weir, 2020). Therefore, Prümmer et al. (2024) suggest a more theory-driven approach to enhance the behavioral impact of cybersecurity training games, using theories such as the Theory of Planned Behaviour (Ajzen, 1991).

The well-known Theory of Planned Behaviour (TPB) states that behavioral intention is the most direct determinant of human behavior. Next, the theory describes three main factors that could directly strengthen one's behavioral intention: one's perception of the importance of the behavior (attitude), one's perception of the group norm concerning the behavior (subjective norm), and one's perception of the amount of control concerning the behavior (perceived control). To increase the likelihood that cybersecurity training games lead to employees handling information more securely, it seems reasonable to aim for a cybersecurity training game to influence these factors positively.

An earlier study by Parsons et al. (2015) showed the importance of actively targeting employees' attitude toward their organizations' policies and procedures concerning cybersecurity. The survey (N = 500) results suggested that cybersecurity training can be more effective if it clearly emphasizes why the expected secure behavior is important, next to simply providing knowledge of what is expected of employees. In another study, Hadlington (2018) even found a significant negative correlation between employees' attitudes toward cybersecurity and their unsecured behavior, with more negative attitudes linked to higher levels of unsecure behavior. Also, Van Steen & Deeleman (2021) showed with their study that a cyber-

security game can positively influence players' subjective norm. Additionally, research by Saridakis et al. (2016) emphasizes individuals' perceived control concerning cybersecurity as a significant predictor of their secure behavior. Feeling competent to control information appeared to predict the individuals' ability to detect cyberthreats and risks.

In addition to actively targeting employees' knowledge, attitude, subjective norm, and perceived control in cybersecurity games, targeting employees' responsibility seems relevant too to increasing employees' secure behavior (Boehmer et al., 2015). Employees' responsibility for secure information handling could reduce the possible gap between employees' intention to act and their behavior (Hines et al., 1987; Blake, 1999; Godin et al., 2005). A preliminary study by Filipczuk et al. (2019) evaluated a game that aimed to provoke players' perceptions of who is responsible for cybersecurity in organizations. It was found that players accepted the great responsibility placed on them in the game. Further research could explore how playing a cybersecurity training game could increase players' responsibility for secure information handling in practice. Building on previous research, it is suggested that this could be achieved by personally addressing players (Latané & Nida, 1981; Boehmer et al., 2015), emphasizing the urgency of the matter (De Vries, 2019), and simply naming players' responsibility in concrete terms (Boehmer et al., 2015; De Vries, 2019).

3.1.5 Research design and research questions

Based on the above literature review, an experimental case study was conducted with the existing cybersecurity training game *The Human Firewall* from the Dutch company Awareways. It concerns a browser-based training game developed by a game designer, psychologist, and security expert. The game is created to train employees with no specific background in cybersecurity and covers the secure handling of information to mitigate cyberthreats and attacks. The game format is easily customized for each group of employees so that the content matches the security policies of the employees' organization. Primarily, the training game aims to make employees aware of the importance of secure information handling by increasing employees' knowledge on the topic. However, the game's ultimate goal is for employees to handle information more securely after playing it. Based on the TPB, the game, therefore, also aims to increase employees' attitude, subjective norm, and perceived control concerning the secure handling of information.

The case study with *The Human Firewall* used a pre-test/post-test design with two experimental groups of participants. Participants were 62 employees at the Delft University of Technology, with a secretary position. To explore how employees' responsibility for secure information handling could be increased by playing the game, the researchers created a modified version of the game next to the original. In this version, players were addressed more personally, the urgency of secure information handling was emphasized more, and employees' responsibility for secure information handling was appointed more literally. It was expected that players of this modified version would experience more responsibility than those who played the original version.

A mixed-methods approach was used to analyze the effects of the game. Before and after a game session, employees' knowledge, attitude, subjective norm, perceived control, responsibility, and behavior were measured with surveys. Next, a follow-up survey measured more concrete behaviors of employees one week after the game session. Lastly, semi-structured interviews were held two weeks after the game session to possibly support and explain the survey data results.

The following research questions guided the case study with *The Human Firewall*:

1.a To what extent can a training game increase players' knowledge, attitude, subjective norm, perceived control, and responsibility concerning secure information handling after the game ?
1.b How do players of the modified version of the game differ from players of the original version in their responsibility for secure information handling after the game?
2. To what extent can that game increase players' secure information handling after the game?
3. To what extent can correlations be found between the behavioral predictors addressed in the game and players' behavior after the game?

The outline of this chapter is as follows: first, more background of *The Human Firewall* is provided (including the modified version), followed by the methodology of the experiment. Next, results from the experiment are presented and discussed, including limitations and future work, and conclusions are drawn.

3.2 Background

In the training game *The Human Firewall*, players go through a storyline in which hackers attack their university. Only if all employees manage to complete the tasks (adapted to the context of the Delft University of Technology), can the university be saved. This ultimately creates a human firewall, which protects the university from further attacks. The tasks involve strong passwords, data classification and minimization, vishing, and (spear)phishing, as well as physical threats. They are always introduced by videos (in which players are addressed personally) and pieces of theory. Afterward, short feedback is provided explaining why certain behavior is preferred. The players are also given concrete, practical tips to get started in their work environments (such as installing a password manager). The game consists of four phases unlocked in stages over the course of a week. This allows players to reflect and apply secure information handling in practice while playing the game. This section describes the general gameplay of *The Human Firewall* and the textual changes in the modified version.

3.2.1 Gameplay of *The Human Firewall*

With an online link, players log in, and the game starts. First, inspector Jack Duval is introduced in a video in which he explains that hackers are actively break-

ing into the Delft University of Technology's information systems. He has been assigned to solve this as quickly as possible and asks the players to help by completing various tasks. The action plan is for all employees (the players) to create a human firewall together to defeat the hackers.

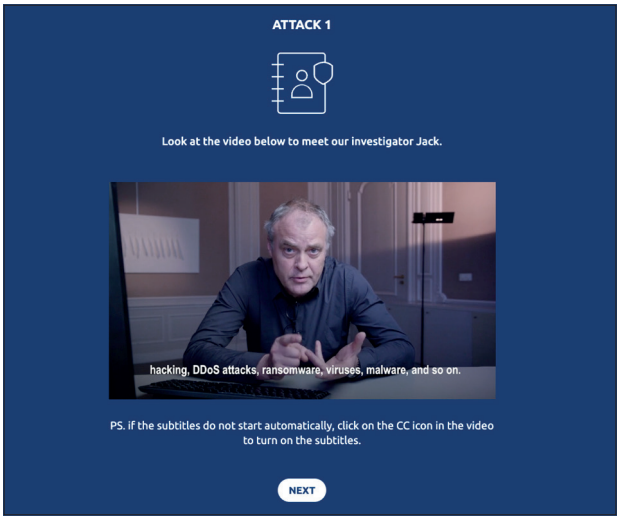


Figure 3.1
Introduction video with inspector Jack Duval asking the player for help

Phase 1 (unlocked on day 1 of the training game) The game starts with a short checklist about *passwords*. Players read that their answers will give Jack insight into possible vulnerabilities on the players' devices and/or systems. Vulnerabilities that the hackers may have used to infiltrate. It is emphasized that there are no right or wrong answers in the checklist; in fact, it could help the players elevate their security to a higher level. The checklist consists of five questions (yes or no) with informative feedback after the answer is given.

Apart from information on password use, Jack also needs to know how the players deal with risks in and around their workplace. Next, the players are presented with four multiple-choice questions about *physical threats and screen locking*.

Phase 2 (unlocked on day 3 of the training game) The second phase of the game starts with a new video of Jack. He is looking for files with sensitive information so the hackers can not access them. Jack does not have time to do it all himself and asks for the help of players to sift through files. Next, players get tasked with investigating an online environment and finding a file that does not belong there. After that, another task about *data classification* is presented in which players have 90 seconds to review a pile of documents and categorize them as public, internal, or confidential. After completion, it is emphasized that in case of

doubt, one should always treat information as confidential. Next, two questions are asked about *external data sharing*, followed by a written update from Jack, saying that through the help of the players, the necessary measures have been taken to secure the systems but that, in the meantime, there is no time to lose.

The second part of phase 2 starts with another video of Jack sharing camera footage of the hackers. It seems they are trying to crack colleagues' passwords to access the university's data. Next, a funny, classic little game called *Password Shooter* is presented. Players must shoot all weak and strong passwords that pass by (NB: the longer the password, the harder it is to destroy). After the game, the players are introduced to the use of a so-called passphrase. Phase 2 ends with three multiple-choice questions about *biometric security*.

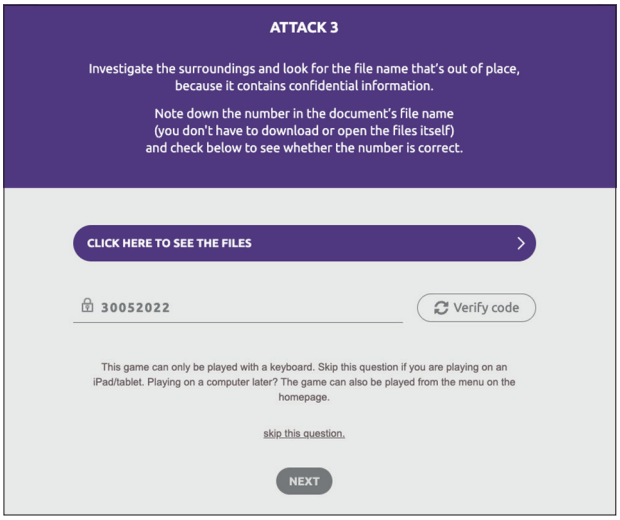


Figure 3.2
Introduction of the players' task to sift through files for sensitive information

Phase 3 (unlocked on day 5 of the training game) The term *social engineering* is introduced. Then, players are presented with a task about *vishing* that involves two audio fragments of phone calls with a fictitious colleague at the university. Following these calls, players get three multiple-choice questions about whether or not the calls involved vishing and how it worked. After the task, players receive more detailed information about the seven influencing principles of Cialdini (2008), how to identify vishing, and what to do in case of (suspicion) of vishing.

Next, a new video of Jack is presented. The hackers obtained access to the university's internal files. The university's ICT security team receives many reports, so players are asked for help. They need to inspect a series of spreadsheets for incorrect information and find a code. After the task, information on *data integrity* is provided.

Next, players get one multiple-choice question about *data minimization*. In between, players receive another video of Jack with an update about his investigation: it is going in the right direction, but it seems the hackers discovered the investigation and might want to exploit these internal updates for a large-scale phishing operation. Lastly, phase 3 concludes with two multiple-choice questions about *spear phishing*.

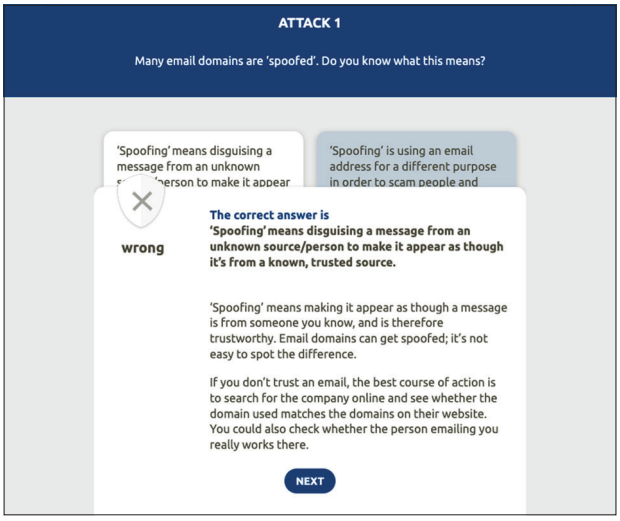


Figure 3.3
Example of feedback after the players answer a multiple-choice question

Phase 4 (unlocked on day 7 of the training game) The last phase of the game, phase 4, starts with a written update of Jack. He explains that the hackers seem to be attacking from outside the university environment as well. Someone even created a LinkedIn account with his name. Players are asked to help the investigation by protecting their personal media channels. First, five multiple-choice questions are asked that involve *LinkedIn use*, *privacy by design and default*, and *two-factor authentication*.

A new video of Jack is presented, explaining that the hackers are trying to damage the Delft University of Technology's reputation by creating fake news. Next, players are tasked to find all the fake news messages about the Delft University of Technology on a recreated website. After completion, a written update from Jack shows the investigation is going well thanks to the help of all employees, and only a couple of tasks are needed to close the human firewall fully.

Players then get one multiple-choice question about *flex working and working on the go* and one about *reporting incidents*. Lastly, the final task is presented to the players in which all the topics and information from the game are summarized. It involves 10 questions that take 30 seconds to answer.

After this final task, players are informed that they are now actively part of the human firewall of the Delft University of Technology. All data seems to be secure again, and because of the attack, it is now clear to all colleagues how it can be prevented in the future. Players can download a certificate of the game and watch Jack's last closing video, in which he congratulates and thanks the players for their help.

3.2.2 Modified version of *The Human Firewall*

To explore how players' responsibility for secure information handling could be increased by playing a game, a modified version of the original game was created (as described in 3.1.5). This modified version of *The Human Firewall* retained the same structure and content as the original version. Only three adjustments within the text were made.

The first adjustment was the way players were addressed. This was made less general than in the original version but more personal and relevant. For example: *"Dear employee of the Delft University of Technology, we …"* (original version) was adjusted to *"Dear secretary of the Delft University of Technology, you …"* (modified version). The second adjustment included emphasizing the urgency of the secure handling of information. For example: *"We must move on."* (original version) was adjusted to *"You must move on quickly because there is no time to waste!"* (modified version). The final textual adjustment in the modified version of *The Human Firewall* was addressing players' responsibility for secure information handling more literally. This mainly involved adding some extra text here and there. For example: *"Thank you for your help! We are moving in the right direction."* (original version) versus *"Thank you for your help! Good that you are taking your responsibility. We are moving in the right direction to form a Delft University of Technology Human Firewall together!"* (modified version).

3.3 Methods

After approval by the Human Research Ethical Committee (HREC) of the Delft University of Technology, the experimental case study with *The Human Firewall* followed a pre-test/post-test design. A mixed-methods approach (with surveys and interviews) was used to analyze the effects of the training game. Before describing the materials and the experimental procedure, the participant characteristics, sampling procedure, and sample size are discussed.

3.3.1 Participants

All participants were employed at the Delft University of Technology within management support in the position of secretary (Dutch spoken, among different faculties). Most participants were between 40 and 60 years old (54.8%). About a quarter of the participants were under 40 (25.8%), and 10 were over 60 (16.1%). Most participants perceived their computer skills as average (62%). Next, 35.5% indicated they were somewhat handy with computers, and only one participant considered himself a computer expert.

Potential participants were contacted by e-mail by the umbrella network of the university secretaries and, in some cases, directly by the researchers. They were invited "*to follow and evaluate the online cybersecurity training* The Human Firewall" (NB: the word game was deliberately not used but 'training' instead because this would potentially appeal to a larger group of participants). Two game sessions were held, each with a two-week participant recruitment period. The secretaries who signed up for the first game session (36) were assigned to the experimental group playing the modified version of *The Human Firewall* (group 1). Next, applicants for the second game session (39) were assigned to the second experimental group playing the original version of *The Human Firewall* (group 2). The researchers also intended to form a control group (that would receive the game's content by PDF), but this could not be realized due to insufficient applications. Many potential participants who were contacted indicated they would have liked to participate (because of their perceived relevance of the topic) but refrained from doing so because of their current workload.

The final sample sizes used for analysis differed for the two experimental groups. Group 1 (modified version) consisted of 34 cases that completed the pre-and post-game survey. For group 2 (original version), this was the case for 28 cases. By the time of the third survey (post-game), group 1 still consisted of 34 participants, but the sample size of group 2 was reduced to 24.

3.3.2 Materials

To answer the research questions, quantitative and qualitative data were collected using surveys and semi-structured interviews. Participants were presented with three surveys during their participation in the experiment. Figure 3.4 shows the time frame and order in which the research data was collected.

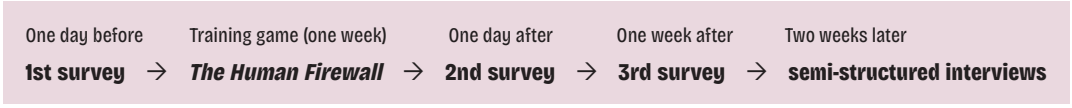


Figure 3.4
Time frame and order of data collection

3.3.2.1 Pre- and post-game surveys

The first two surveys were used to compare participants' pre- and post-game scores to explore significant differences regarding participants' knowledge, attitude, subjective norm, perceived control, responsibility, and behavior concerning secure information handling. The third survey, a week after the game session, again measured participants' behavior but was limited to a few essential concrete behaviors in the workplace. All participants received the same surveys, regardless of their experimental group. All three surveys were provided online with the use of Qualtrics™.

1st survey (pre-game) The first survey consisted of 69 items, of which 56 items were used for this study. The first part was derived from a validated survey developed by Awareways. This included nine items measuring participants' knowledge (e.g., *I know the rules for secure information handling*), eight items measuring participants' attitude (e.g., *I think it is important to learn how to handle information securely*), seven items measuring participants' subjective norm (e.g., *All the people I work with follow secure information handling rules*), five items measuring participants' perceived control (e.g., *I am sure that if I walk away from my workplace, no one can get to my data*), and 14 items measuring participants' behavior (e.g., *I use different passwords at home and at work*). All items were scored on a 7-point Likert scale (ranging from *totally disagree* to *totally agree*).

Next, ten items (7-point Likert scale) were added to the first survey to measure participants' responsibility for secure information handling. Eight of these items were based on the earlier work of Mergler & Shield (2016), who developed a measurement scale for personal responsibility. The generally formulated statements from Mergler and Shield were rewritten to statements focusing on secure information handling. Only one item was kept general (*The motto 'think before you act' relates to me*). The eight items measured four subdimensions of responsibility (two items per subdimension):

1. awareness of and control over own thoughts and feelings (e.g., *When I think of cybersecurity, certain emotions come to mind*);
2. awareness of and control over the choices made regarding behavior (e.g., *I do not think about the possible consequences of my way of secure information handling*);
3. willingness to be accountable for the behavior performed and its consequence (e.g., *If I have done something clumsy, I accept the possible punishment that follows*);
4. awareness of and concern about the impact of own behavior on others (e.g. *If I handle information carelessly, it can affect me and my colleagues*).

A fifth subdimension (two items) was added:

5. motivation to process information attentively (e.g., *I am motivated to read cybersecurity information attentively*).

As earlier work on persuasion describes how one's motivation to carefully process information about a topic is related to one's responsibility for that topic (O'Keefe, 2002).

A validation study with random university employees (N = 80) was conducted before the experiment to test the validity and reliability of the newly created measurement scale for responsibility toward secure information handling. A Confirmatory Factor Analysis confirmed four of the five subdimensions of responsibility (Cronbach's alpha >.70 for all items). The factor loadings on the subdimension *awareness of and concern about the impact of own behavior on others*

were found to be too low to show sufficient internal consistency. Still, after reformulation, it was decided to include the two items related to this subdimension in the experiment.

Lastly, the pre-game survey included items about age and self-perceived computer skills. To link the survey data with that of the second survey, the participants' e-mail addresses were requested.

2nd survey (post-game) The second survey consisted of 86 items, of which 75 were used for this study. The survey included the same survey items as the pre-game survey that measured knowledge, attitude, subjective norm, perceived control, responsibility, and behavior. This way, differences in participants' scores before and after the game could be detected.

Next, to measure how participants generally experienced the game, 14 items (7-point Likert scale) from the Game Experience Questionnaire (GEQ), specifically the In-Game items, were used (IJsselsteijn et al., 2013). These items measured participants' feelings and thoughts during the game (e.g., *I was interested in the training's story*). The In-Game items assess players' game experience on seven components: Immersion, Flow, Competence, Positive and Negative affect, Tension, and Challenge. Additionally, three survey items measured to what extent participants experienced the manipulated elements to convey a more personal approach, the urgency of secure information handling, and their responsibility for this during the game.

Also, one item inquired whether participants would recommend the game to a colleague, and one open question about participants' general game experience was included. Next, two items contained an invitation for an online interview after *The Human Firewall*. Lastly, to link the survey data with that of the first survey, the participants' e-mail addresses were requested again.

3rd survey (post-game) The third survey consisted of six items. A multiple-response item asked about participants' use of a password manager. An open question was attached to explain why they did or did not use a password manager after the game. Three other multiple response items involved clean desk behavior, locking the computer screen, and data minimization.

3.3.2.2 Semi-structured interviews

To support and explain the results of the survey data analyses, eight semi-structured interviews (four participants from each experimental group) were conducted two weeks after the game. The eight interviewees were randomly selected from the group of interview applicants. An interview guide was set up with questions concerning participants' motivation and expectations before the game and their prior experience and knowledge of secure information handling. Next, the guide included questions about participants' game experience and what possible effects the game had on their information handling. The interviews were conducted online using Microsoft Teams™ after the interviewee's verbal consent to

record the session. Next, all interviews were transcribed and later coded based on recurring themes in the interview data.

The attached appendices show all pre-and post-game survey items (Appendix 3.A) and the interview guide (3.B), as used for the experimental case study with *The Human Firewall*.

3.3.3 Procedure

The case study with the training game *The Human Firewall* was set up as an experiment. Participants were divided into two experimental groups in which they either played the modified version of the game (group 1) or the original version (group 2). Before and after the game, participants filled out the online surveys. Individual differences in survey scores before and after the game were analyzed to examine the game's effects. Additionally, score differences between the two experimental groups were examined. To complement the survey data, several semi-structured interviews were conducted online.

3.3.3.1 Data collection method

After online registration, participants received an instructional e-mail about their participation in the study. This e-mail clarified that participants could take the 'training' at their own time and pace, either at home or at work. In addition, the following details were given: the training itself would last one week and would consist of four phases. Participants could do one phase every other day (15 minutes) or do it all at once if that would be more convenient. Completing the entire training would take not more than one hour.

The day before the training game officially started, participants received the online link to the first survey (15 minutes, including informed consent). It was emphasized that participants could not start the game until they completed the survey. The next day, participants received the online link to the game's first phase. Then, every other workday, participants received the links to the subsequent phases of the game. Meanwhile, the researchers remained online available during working hours to answer participants' technical or content-related questions. After participants completed the game up to phase 4, they could fill in the second online survey (20 minutes). This survey included the request for an online interview (10 minutes) with one of the researchers about the participant's game experience.

One week later, participants received the online link to the third survey (5 minutes). Subsequently, the semi-structured interviews were conducted online. With the approval of the interviewees, the interviews were recorded for transcription purposes.

3.3.3.2 Data analysis strategy

Quantitative analyses were performed using SPSS™. First, the mean scores and standard deviations of the participants' scores on the GEQ items were analyzed

to assess the general experience of the game. A Mann-Whitney U test was used to analyze significant score differences between the two experimental groups.

Next, Paired Samples t-tests were used to compare participants' pre- and post-game scores on the variables knowledge, attitude, subjective norm, perceived control, responsibility, and behavior. It was hypothesized that participants' scores on all of these five variables would increase after the game in both groups. Again, a Mann-Whitney U test was used to analyze significant score differences on responsibility between the two experimental groups. It was hypothesized that the responsibility for secure information handling of experimental group 1 (modified version) would increase significantly more than that of experimental group 2 (original version). Also, for the survey items inquiring about participants' experience of the manipulated text elements in the game, a Mann-Whitney U test was run. It was hypothesized that, during the game, experimental group 1 would significantly experience more emphasis on responsibility and urgency for secure information handling and feel more personally addressed than experimental group 2. To examine correlations between increased knowledge, attitude, subjective norm, perceived control, and responsibility *and* increased behavior after the game, a Spearman's Rank Correlation test was used. Correlations were expected, but only in case of significant variable increases after the game.

The interviews were transcribed by the researchers and coded based on overlapping themes. The interview data was used to support or explain the quantitative results of the survey data whenever possible.

3.4 Results

In this section, the results of the survey data analyses are presented, complemented by the results of the semi-structured interviews. After presenting the participants' general game experience of *The Human Firewall* in section 3.4.1, the results to answer the research questions are presented. Sections 3.4.2, 3.4,3, 3.4.4, 3.4.5, and 3.4.6.1 describe to what extent *The Human Firewall* increased players' knowledge, attitude, subjective norm, perceived control, and responsibility concerning secure information handling after the game. Next, section 3.4.6.2 describes how the experimental groups differed in their responsibility for secure information handling after the game. Subsequently, section 3.4.7 reports to what extent players' secure information handling was increased after the game (3.4.7.1) and to what extent players' increased behavior correlated with the increased behavioral predictors addressed in the game (3.4.7.2). Lastly, the results from the third survey concerning participants' behavioral changes and intentions one week after the training game and suggestions for long-term behavioral change based on the research data are presented (3.4.7.3).

3.4.1 General game experience of *The Human Firewall*

The results for the GEQ item scores are listed in Table 3.1. It can be concluded that participants experienced somewhat positive feelings during the game (Positive affect). In addition, no negative feelings or tension were experienced (Negative

affect and Tension). Next, on average, participants seemed somewhat interested in the game's story. To what extent the game was also experienced as impressive seemed to have varied per participant (Sensory and imaginative immersion). Also, participants indicated they felt somewhat challenged. At the same time, playing the game did not cost the participants much effort (Challenge). During the game, in general, participants felt somewhat successful. Whether they also felt skillful appeared to be less apparent and varied more among participants (Competence). Lastly, the results show participants hardly forgot everything around them during the game or felt completely absorbed (Flow). The participants' general experience of *The Human Firewall* did not significantly differ between the two experimental groups.

Although cybersecurity training can be perceived as tedious and tiring (He & Zhang, 2019), participants generally seemed to have enjoyed the training game *The Human Firewall*. As interviewees indicate:

- *"In standard training, you wander off. Now you actively participate and respond."*
- *"I really enjoyed it this way. You are doing it yourself, and there is a storyline."*
- *"It wasn't all that dry. You could have that with security very quickly."*

Participants' general positive experience is also reflected by the fact that 85% of the participants would recommend *The Human Firewall* to a colleague:

Component (N = 62)	Item	M	SD
Positive affect	I felt content.	5.24	.94
	I felt good.	5.32	.92
Negative affect	I felt bored.	2.37	1.06
	I found it tiresome.	2.21	.96
Tension	I felt frustrated.	2.56	1.46
	I felt irritable.	2.08	1.06
Sensory and imaginative immersion	I was interested in the training's story.	5.58	1.05
	I found it impressive.	4.85	1.24
Challenge	I felt challenged.	5.42	1.10
	I had to put a lot of effort into it.	3.21	1.24
Competence	I felt successful.	5.08	1.09
	I felt skillful.	4.81	1.28
Flow	I forgot everything around me.	3.37	1.51
	I felt completely absorbed.	3.50	1.55

Table 3.1
Means and standard deviations of GEQ items (7-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (7))

- *"I recommend the training to any colleague who works with confidential data: it playfully increases your awareness and lets you look beyond the risks of the well-known phishing actions that everyone knows by now. Many people are not aware of the influence of their behavior on security."*

The perceived degree of challenge and competence varied among the participants. This can be explained by participants' varying experiences with earlier training in working securely with information. Even though participants held the same type of position, some had more prior training (and thus knowledge) than others. This may have caused those participants to feel less challenged than others and to feel relatively competent, resulting in fewer 'gains' in that regard. As one interviewee shared:

- *"The training contains many things that are already clear, such as whether or not you should report something. Nevertheless, it is good that you are constantly reminded of this."*

The fact that hardly any flow was experienced during the game can be explained by the game's design. Because of the separate four phases of only about 15 minutes, it seemed hardly possible to enter a real state of flow.

3.4.2 Knowledge

Although the results of the general game experience suggest some participants had prior knowledge about secure information handling, there still seemed to be enough opportunity for improvement. Seven of the nine survey items measuring participants' knowledge showed a strong significant increase in knowledge after playing the game (see Table 3.2). Four of those seven items involve knowledge that was not (sufficiently) present among participants and seems to have been acquired through the game (a significant shift from *neither disagree nor agree* to *somewhat agree*). Remarkably, this mainly involves knowledge about acting in urgent situations: what to do in the event of a data breach, when something goes wrong with handling information, and who to report to if something goes wrong. Interview data confirms that for some participants, the game presented knowledge that was new to them:

- *"Some issues were explained very well. I also learned something from the training. That's nice because sometimes, if you talk to someone who knows a lot about the topic of security, it's so specialized that you don't quite understand it."*

For the other items with significant pre- and post-game score differences, the participants' knowledge was somewhat present before and seemed reinforced after the game. These items involve knowledge about rules for secure information handling. Notable in this regard is that, especially in creating a strong password,

***Knowledge*-survey items (N = 62)**	**M pre-game**	**SD pre-game**	**M post-game**	**SD post-game**	**Sig.**
I know what information is secret/confidential.	5.92	1.029	6.03 .	652	.349
I know how to handle personal data according to the Privacy Act.	5.45	1.066	`5.79	.727	.007
I know enough about the methods criminals (hackers) use to steal information.	4.15	1.389	5.05	1.16	**<.001**
I know enough to work securely with the internet and e-mail.	5.00	1.159	5.58	1.05	**<.001**
I know the rules for secure information handling.	5.21	.994	5.73	.705	**<.001**
I know what to do in the event of a suspected data breach.	4.29	1.653	5.61	.998	**<.001**
I know what to do if something goes wrong when dealing with information.	4.44	1.398	5.65	.925	**<.001**
I know what the rules are for a strong password.	5.85	.865	6.26	.571	**<.001**
I know who to turn to if something goes wrong when dealing with information.	4.87	1.373	5.87	.799	**<.001**

Table 3.2
Results of Paired Samples t-test for participants' pre-and post-game scores on 'knowledge about secure information handling' (7-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (7))

participants are significantly more confident in their knowledge after the game (from *somewhat agree* to *agree*). As one interviewee indicated:

- *"I didn't really get any new information, but I did get the necessary additions. For example, I knew that something like a password manager existed, but I never thought about whether I could use it. That was just that additional information I needed: this is how it works, and this is the password you could set up. So that you could put a phrase or spaces in it. That's great."*

Notably, the standard deviation became smaller for all items after the game; that is, participants were more like-minded on the knowledge statements after the game.

3.4.3 Attitude

Table 3.3 shows the analysis results of the eight survey items that measured participants' attitude toward secure information handling. The first thing to note is that participants considered the topic of secure information handling important even before they played *The Human Firewall*. Before the game, participants rated all survey items with a 5 or 6, corresponding to *somewhat agree* and *agree*. This positive attitude is not a surprising result since the participants voluntarily par-

ticipated in the study, so they probably considered it an important issue anyway. As interview data confirms:

- *"I think it's important; that's why I wanted to finish the training."*
- *"I know it can happen in no time, and hackers are getting more and more savvy. So I found it interesting to participate."*

What is also noticeable are the standard deviations for the pre-game scores. Except for one item, all scores are below 1, indicating that participants are fairly aligned concerning their attitude (and after the game, even more in most cases).

Three of the eight items showed a significant attitude increase after the game. In all three cases, the post-game scores stayed within the same response scale as

***Attitude*-survey items (N = 62)**	**M pre-game**	**SD pre-game**	**M post-game**	**SD post-game**	**Sig.**
I think it is important that all employees follow the rules for secure information handling.	6.03	.746	6.10	.564	.470
I consider it essential that there are rules within the Delft University of Technology for secure information handling.	6.47	.593	6.40	.613	.375
I think strict controls on secure information handling are important for the good name of the Delft University of Technology.	5.89	.960	5.87	.905	.357
I think learning how to handle information securely is important.	6.45	.563	6.37	.520	.255
Reporting unsecure situations immediately is very important.	6.29	.584	6.42	.497	.073
I find it important to comply with the rules for secure information handling.	6.13	.839	6.34	.510	**.041**
I find it important at work to discuss secure information handling often, for example, during work meetings.	5.65	.977	5.90	.783	**.017**
I think it is important to do my best when coming up with a new, strong password.	5.47	1.155	5.85	.903	**.002**

Table 3.3
Results of Paired Samples t-test for participants' pre-and post-game scores on 'attitude toward secure information handling' (7-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (7))

the pre-game scores, which, as mentioned, were already fairly high. Still, participants found it significantly more important after the game to discuss secure information handling. Also, participants' general belief in the importance of complying with the rules was reinforced, and participants found it even more important to create a secure password after the game. Interestingly, these last two results seem consistent with the earlier findings of participants' increased general knowledge concerning the rules for secure information handling and, more specifically, their increased knowledge about creating a strong password.

The quantitative finding that participants consider secure information handling to be more important after *The Human Firewall* is confirmed by qualitative data from the interviews. Interviewees indicated that the game made them more aware of the importance of secure information handling:

- *"You do notice that you just have to be careful. Documents lying on your desk are also part of that. Those kinds of elements I started thinking more deeply about."*
- *"People tend to shrug their shoulders and think, 'It always works out anyway'. But it only has to go wrong once. So, awareness is step one. That's what landed with me in particular."*

3.4.4 Subjective norm

Table 3.4 shows the analysis results of the seven survey items that measured participants' subjective norm for secure information handling. This variable might seem more difficult to influence by playing a game because it concerns the perceived behavior of others outside the game. However, in *The Human Firewall*, players could experience the extent to which their employer wants them to handle information securely. The content of the game directly matched reality in this case.

Three of the seven items showed a significant increase in participants' subjective norm after the game. The strongest increase was found concerning the accountability of colleagues in case they do not handle information securely. Before the game, participants were, on average, neutral about this, but after the game, participants somewhat agreed that it is normal to hold colleagues accountable for secure information handling. Also, before and after the game, participants, on average, somewhat agreed that there are consequences if they do not follow the rules for secure information handling. Still, this belief was significantly reinforced after the game. This result seems in line with the earlier found reinforced attitude concerning compliance with the rules. Lastly, after the game, participants significantly agreed more with the statement that their supervisor regularly stresses the importance of secure information handling. Although participants, on average, were still neutral about this statement, it is a notable result because this was not part of the content of the game. This increase of the subjective norm may have been caused not only by the game itself but also simply by the work time between the game phases. As a reaction to the game, there may have been more discussion and reflection on supervisors' expectations.

During the interviews, participants' subjective norm for secure information handling hardly came up. One participant mentioned that the university values secure information handling:

- *"I think it's right that the university presents it as an important thing."*

3.4.5 Perceived control

Table 3.5 shows the analysis results of the five survey items that measured participants' perceived control concerning secure information handling. Before the game, participants indicated that they, on average, felt *somewhat* in control. Only their control concerning data access, if they left their workplace, was not entirely apparent.

After the game, a significant increase in perceived control arose for four of the five measured items. First, the participants were not neutral anymore toward their control of data access if they left their workplace; they *somewhat agreed* with the statement after the game. Next, participants became significantly more

***Subjective norm*-survey items (N = 62)**	**M pre-game**	**SD pre-game**	**M post-game**	**SD post-game**	**Sig.**
My supervisor sets a good example for the secure handling of information.	4.94	1.266	4.94	1.279	1.00
The management of my department regularly. stresses the importance of handling information securely.	3.95	1.360	4.10	1.302	.360
All the people I work with follow secure handling of information rules.	4.40	1.180	4.55	.986	.296
The management of my department sets a good example for the secure handling of information.	4.53	1.302	4.76	1.183	.109
My supervisor regularly stresses the importance of handling information securely.	3.66	1.330	4.08	1.334	**.015**
If I do not follow the rules for secure information handling, there are consequences for me.	5.00	1.187	5.48	1.020	**.004**
It is normal to hold colleagues accountable if they do not handle information securely, such as if they do not lock their computers.	4.81	1.341	5.40	1.016	**<.001**

Table 3.4
Results of Paired Samples t-test for participants' pre-and post-game scores on 'subjective norm for secure information handling' (7-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (7))

Perceived control-survey items (N = 62)	M pre-game	SD pre-game	M post-game	SD post-game	Sig.
If I follow the rules for secure handling information, strangers can not access files from my work.	5.32	1.21	5.56	1.17	.164
My behavior affects the information security within the Delft University of Technology.	5.60	1.31	6.00	.747	**.008**
I am sure that no one can access my data if I walk away from my workplace.	4.71	1.56	5.29	1.23	**.001**
If I use the rules for securely handling information, the chances of something going wrong are much less.	5.97	.677	6.34	.542	**<.001**
I have an important role in secure information handling at Delft University of Technology.	5.44	1.21	5.87	.949	**<.001**

Table 3.5
Results of Paired Samples t-test for participants' pre-and post-game scores on 'perceived control of secure information handling' (7-point Likert scale varying from *totally disagree* (1) to *totally agree* (7))

aware of their behavioral influence within the information security of the Delft University of Technology and of how following the rules minimizes the chances of things that can go wrong, from *somewhat agreeing* on these items to *agreeing*. Remarkably, that last result seems consistent with participants' increased knowledge and attitude concerning the rules for secure information handling. Lastly, a significant increase, but still *somewhat agreeing*, was participants' perceived control concerning their role in secure information handling within the Delft University of Technology.

3.4.6 Responsibility

This section first shows the results of participants' pre-and post-game scores on their responsibility for secure information handling. Together with the results of the participants' pre-and post-game scores on knowledge (3.4.2), attitude (3.4.3), subjective norm (3.4.4), and perceived control (3.4.5) concerning secure information handling, these results answer research question 1a. To answer research question 1b., this section shows the results of the exploration of possible differences in responsibility between the two experimental groups after playing *The Human Firewall*.

3.4.6.1 Pre- and post-game scores

Table 3.6 shows the analysis results of the ten survey items that measured participants' responsibility toward secure information handling. Before the game, the participants generally indicated feeling somewhat responsible for secure

information handling, except for three items that participants were more neutral about. After the game, three of the ten items showed a significant increase in mean scores.

Interestingly, two of these increased items form a subdimension of the construct 'responsibility': *awareness of and control over choices made regarding behavior*. For the first statement, *The motto 'think before you act'* relates to me, both before and after the game, participants indicated to *somewhat agree* with the statement. This can be explained by the formulation of the statement, which is rather general. It is possible that participants, therefore, did not know how to interpret this statement. When one interprets it as a personality trait, it makes sense that after the game, it has not changed a lot. For the second statement of the same subdimension, *I do not think about the possible consequences of my way of securely handling information*, a more significant increase was found: after the game, participants disagreed with the statement even more, resulting in total disagreement. This finding aligns with the earlier finding of participants' increased

***Responsibility*-survey items (N = 62)**	**M pre-game**	**SD pre-game**	**M post-game**	**SD post-game**	**Sig.**
I find it interesting to learn more about cybersecurity.	5.74	.828	5.74	.745	1.000
If something goes wrong because I handle information, I take responsibility for it.	5.77	.612	5.74	.848	.775
That my way of handling information securely can also affect my colleagues worries me.	4.44	1.34	4.60	1.45	.442
When I think of 'cybersecurity', certain emotions come to mind.	4.15	.142	4.37	1.428	.219
I am motivated to read cybersecurity information carefully.	5.69	.841	5.85	.623	.150
I accept the possible punishment if I have done something clumsy.	4.82	1.15	5.08	1.26	.096
Cybersecurity does not evoke any specific feelings in me.	3.89	1.69	3.50	1.54	.078
The motto 'think before you act' relates to me.	5.10	1.27	5.44	1.11	**.041**
If I handle information carelessly, it can affect me and my colleagues.	5.81	.902	6.03	.724	**.026**
I do not think about the possible consequences of my way of securely handling information.	2.44	1.34	1.98	.932	**.005**

Table 3.6
Results of Paired Samples t-test for participants' pre-and post-game scores on 'responsibility for secure information handling' (7-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (7))

perceived control concerning the effects of their behavior on information security within the Delft University of Technology. Lastly, participants also became significantly more aware of the consequences of their mistakes when handling information, not only for themselves but also for their colleagues.

3.4.6.2 Differences in responsibility between experimental groups

To explore how players' responsibility for secure information handling could be increased by playing the game, the modified version of the game addressed players more personally, emphasized the urgency of secure information handling more, and appointed employees' responsibility for secure information handling more literally. Contrary to expectations, no significant differences between the two experimental groups were found concerning their experience of the modified textual elements within the game. All participants experienced that *The Human Firewall* emphasized their responsibility to handle information securely (M = 6.15, SD = .507). They either *somewhat agreed* (6.5%), *agreed* (72.6%), or *totally agreed* with that statement (21%). Also, all participants experienced that the game emphasized the urgency of secure information handling (M = 6.10, SD = .534). Again, they either *somewhat agreed* (9.7%), *agreed* (71%), or *totally agreed* with that statement (19.4%). To what extent participants felt personally addressed within the game varied more among participants (M = 5.50, S = .988); 88.7% felt that way. Based on these findings, it can be concluded that the original version of *The Human Firewall* equally ensured that players experienced emphasized responsibility, experienced the matter's urgency, and felt personally addressed. This means the textual modifications in the modified version of the game were possibly too subtle, and therefore, no significant difference in the experience of the modified textual elements within the game between the two experimental groups was found.

However, further analysis of participants' pre-and post-scores on responsibility (see Table 3.6) did reveal two significant differences between the two experimental groups. The results showed that experimental group 1 (modified version) experienced significantly more responsibility than experimental group 2 (original version) concerning the third subdimension of the construct 'responsibility': *willingness to be accountable for the behavior performed and its consequence* (note that there was no significant score increase after the game, see Table 3.6). For the first item of the subdimension, *If something goes wrong because I handle information, I take responsibility for it*, a significance was found of p = .046. For the second item, *I accept the possible punishment if I have done something clumsy*, a stronger significance was found of p = .014. For the other survey items, contrary to expectations, no significant differences between the two experimental groups were found. The previously described results already showed that the textual manipulation of the game did not have the desired effect on the game experience of participants in group 1 (modified version), so these results seem consistent with that. Again, the modified text elements might have been too subtle.

3.4.7 Behavior

This section shows the results to answer research questions 2 and 3. First, participants' pre-and post-scores concerning their secure information handling are shown. Next, correlations between participants' increased secure behavior and increased knowledge, attitude, subjective norm, perceived control, and responsibility concerning secure information handling are presented. To conclude, results from the third survey concerning participants' behavioral changes and intentions one week after the training game are presented, including several recommendations for long-term behavioral change based on the research data (3.4.7.3).

3.4.7.1 Pre-and post-game scores

Table 3.7 shows the analysis results of the 14 survey items that measured participants' self-reported behavior concerning secure information handling. For seven of the 14 items, a significant increase in secure information handling was found after the game. What stands out is that these seven items include all four statements about passwords. This aligns with the earlier findings of participants' increased knowledge and attitude toward using and creating passwords. As interviewees indicated:

- *"I always made good passwords. Not those obvious ones. I did have the same passwords at some systems all the time. I'm changing that."*
- *"I now have a password manager with a very long password. A whole sentence. Really a random sentence."*

Next, it is noticeable that the other three items with a significant increase in secure information handling specifically involve behaving more securely in the physical world; taking action when a stranger walks around the office in a place where they are not supposed to be, becoming more attentive to not talk about work in public spaces, and locking the computer when moving away from the workplace. This last result seems consistent with the earlier finding concerning perceived control, where participants indicated that they became more sure that no one could access their data if they walked away from their workplace. One interviewee explained:

- *"What I already did, but what I also sometimes forgot to do, is locking my screen. I'm doing that again fanatically now. That was another trigger of 'Wait a minute, pay attention'."*

Also, in three cases, the mean scores changed from *neither disagree nor agree* to *somewhat agree*. This means that, on average, participants changed from a relatively passive attitude to an active attitude toward the behavior described by those statements. Concerning the items where no significant shifts in mean scores were found, the results show participants were already exhibiting quite secure behavior in those cases.

***Behavior*-survey items (N = 62)**	**M pre-game**	**SD pre-game**	**M post-game**	**SD post-game**	**Sig. post-game**
I take great care not to leave documents on the copier or in the printer.	6.40	.689	6.39	.636	.849
I sometimes e-mail files from my work to my private e-mail so I can easily work elsewhere.	1.98	1.465	1.95	1.207	.816
I report unsecure online and offline situations that I notice when handling information.	6.10	1.315	6.13	1.094	.811
I take my laptop, phone, and documents with me when I get out of my car.	6.11	1.282	6.03	1.055	.675
I use the particular container/shredder/blue bin to dispose of secret/confidential documents.	6.08	1.485	6.34	1.086	.233
I open an attachment in an e-mail only if I trust the content and sender.	6.29	.876	6.15	.956	.228
I report unsecure situations, both online and offline, that I notice when dealing with information.	5.74	1.159	5.94	.956	.176
I use different passwords at home and at work.	5.21	2.001	5.61	1.497	**.044**
I write down passwords to remember them (outside of a password safe).	3.82	2.053	3.40	1.937	**.033**
I take action when I see a stranger walking around the office in a place where it is not supposed to be.	4.92	1.284	5.29	1.453	**.028**
I give my password to a colleague when necessary.	3.02	2.053	2.66	1.975	**.003**
I lock my computer when I walk away from my workstation, including when I go to the restroom.	4.98	1.979	5.60	1.520	**.003**
If I need to renew a password, I come up with a good and completely new.	4.60	1.624	5.27	1.381	**.001**
I talk about the content of my work in public spaces, such as the train or on a terrace.	2.98	1.520	2.23	1.122	**<.001**

Table 3.7
Results of Paired Samples t-test for participants' pre-and post-game scores on 'behavior regarding secure information handling' (7-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (7))

In addition to confirming the quantitative results found concerning participants' post-game behavior, the interview data also showed that participants experienced general alertness after the game, like additional verification of situations (on the phone) and more frequent reporting of unsecured situations to the IT department.

- *"I was always pretty careful. Maybe just a little more so now."*
- *"At one point, the training had an exercise of a phone conversation about the university's rector, and that was so real! It was so appealing that I was like, 'Yeah, you*

could just fall for that.' But now I'm more alert in these kinds of situations, and I don't go along with that. "

- *"I am extra vigilant. If I even think something is wrong, I won't even look further. Then I immediately send it to abuse@tudelft.nl."*
- *"I am more alert. If I got strange e-mails, I was already going to report it to IT, but with the idea that they might get sick of me. I am often reporting, and sometimes I thought: 'Maybe I shouldn't do that anymore'. After the training, I thought, 'I should keep doing it because it's a good thing to do'."*

3.4.7.2 Correlations between knowledge, attitude, subjective norm, perceived control, and responsibility

Participants' pre-game scores on knowledge, attitude, perceived control, and, to a lesser extent, responsibility showed that participants generally already scored fairly high on these variables before they played *The Human Firewall* (note that for the players' subjective norm, this was not found). Next, the results of the Paired Samples t-tests showed that significant increases in participants' scores of those first three variables listed generally occurred in cases where there seemed to be room for improvement. The same holds for participants' secure behavior; participants generally already scored fairly high before the game. Afterward, primarily, the scores of the items where improvement appeared possible significantly increased.

To examine possible relations between the significant increases in participants' knowledge, attitude, subjective norm, perceived control, and responsibility and participants' increases in secure behavior after the game, correlations were calculated. Table 3.8 shows the *Behavior*-survey items used for these correlation tests.

Correlations between behavior and knowledge Table 3.9 shows the results of the measured correlations between participants' increased secure behavior and

Item	*Behavior*-survey items
Q1	I write down passwords to remember them (outside of a password safe).
Q4	I lock my computer when I walk away from my workstation, including when I go to the restroom.
Q7	I use different passwords at home and at work.
Q8	I give my password to a colleague when necessary.
Q9	If I need to renew a password, I come up with a good and completely new one.
Q12	I take action when I see a stranger walking around the office in a place where it is not supposed to be.
Q13	I talk about the content of my work in public spaces, such as the train or on a terrace.

Table 3.8
Overview of *Behavior*-survey items, with significantly increased participants' scores after playing *The Human Firewall*, including survey item numbers

***Knowledge*-survey items (N = 62)**		**Q1**	**Q4**	**Q7**	**Q8**	**Q9**	**Q12**	**Q13**
Q17 I know enough about the methods criminals (hackers) use to steal information.	r_s	–.005	–2.07	–.017	–.027	.191	–.043	–.221
	Sig.	.967	.106	.894	.833	.138	.738	.084
Q21 I know enough to work securely with the internet and e-mail.	r_s	–.048	–.156	.130	–.074	.243	–.057	.001
	Sig.	.708	.225	.315	.567	.057	.661	.991
Q27 I know the rules for secure information handling.	r_s	–.062	–.083	–.180	.194	.154	.220	–.060
	Sig.	.634	.519	.161	.131	.231	.086	.643
Q32 I know what to do in the event of a suspected data breach.	r_s	.199	–.237	–.194	–.069	.047	–.041	–.035
	Sig.	.121	.064	.131	.593	.718	.754	.789
Q34 I know what to do if something goes wrong when dealing with information.	r_s	.107	–.139	–.159	.036	.114	.230	–.006
	Sig.	.408	2.80	.217	.779	.377	.072	.962
Q38 I know what the rules are for a strong password.	r_s	.122	–.163	–.096	.099	.160	.029	–.144
	Sig.	.346	.205	.459	.455	.215	.821	.264
Q46 I know who to turn to if something goes wrong when dealing with information.	r_s	.279	–.212	.040	.094	.044	.019	.064
	Sig.	**.028**	.097	.755	.468	.737	.882	.620

Table 3.9
Results of Spearman's Rank Correlation test with *Behavior*- and *Knowledge*-survey items (see Table 3.8 for an overview of *Behavior*-survey items)

increased knowledge after the game. One significant positive correlation was found between the item *I write down passwords to remember them (outside of a password safe)* (Q1) (note that it is negatively formulated) and the item *I know who to turn to if something goes wrong when dealing with information* (Q46): $r_s(60) = .279$, $p = .028$. This means that participants who found out through the game who to turn to if something goes wrong when handling information tended to also behave more securely after the game concerning writing down passwords. This might not seem to be an evident relation at first sight, but it shows that generally newly acquired knowledge concerning secure information handling can correlate with an increase in secure information handling. No further correlations were found between participants' increased knowledge and increased secure behavior. This can be explained by the observation that many participants already had quite some knowledge before playing the game and already displayed reasonably secure behavior. Therefore, only a limited number of participants increased their scores. As an example, the non-significant correlation between the item *If I need to renew a password, I come up with a good and completely new one* (Q9) and the item *I know what the rules are for a strong password* (Q38) was explored. The

average score before the game for Q9 was 4.60, and 5.85 for Q38. Both scores went up on average after the game; Q9 with 0.67 points and Q38 with 0.41 points on the 7-point scale. Many participants, however, still had the same pre-game and post-game scores for Q9 (39%) or Q38 (48%), of which 17% had the same score for both questions. Since in the majority of cases one of the delta variables used for calculating the correlation is zero, the correlation coefficient becomes unstable and obtains a bad significance. When expressed in words for Q9 and Q38: many participants already had a decent score for knowledge, yet were able to improve their behavior, while others had a good score for behavior, yet were able to learn something about good passwords from the game. Few participants did both.

Correlations between behavior and attitude Two significant correlations between participants' increased secure behavior and increased attitude after the game were found (see Table 3.10). The first is a significant positive correlation between the item *If I need to renew a password, I come up with a good and completely new one* (Q9) and the item *I think it is important to do my best when coming up with a new, strong password* (Q29): rs (60) = .288, p = .023. So, participants who valued secure passwords more through the game tended also to change their behavior accordingly. This is a clear example of an increased attitude concerning a specific behavior (creating secure passwords) related to an increase in that same behavior. The second correlation is a significant negative one between the item *I use different passwords at home and at work* (Q7) and the item *I find it important at work to discuss secure information handling often, for example, during work meetings* (Q49): rs (60) = –.262, p = .039. This would mean that participants who valued discussing secure information handling more after the game tended to behave less securely concerning the use of different passwords after the game and vice versa. To explain this negative correlation, the correlation between participants'

***Attitude*-survey items (N = 62)**		**Q1**	**Q4**	**Q7**	**Q8**	**Q9**	**Q12**	**Q13**
Q23 I find it important to comply with the rules to secure information handling.	r_s	–.038	.065	–.163	.059	–.020	.051	–.122
	Sig.	.768	.618	.206	.650	.879	.695	.344
Q29 I think it is important to do my best when coming up with a new, strong password.	r_s	–.134	.060	–.014	–.056	.288	.009	.110
	Sig.	.299	.644	.913	.668	**.023**	.943	.394
Q49 I find it important at work to discuss secure information handling often, for example, during work meetings.	r_s	–.022	.083	–.262	–.016	.104	.199	–.217
	Sig.	.863	.519	**.039**	.901	.420	.120	.090

Table 3.10
Results of Spearman's Rank Correlation test with *Behavior*- and *Attitude*-survey items (see Table 3.8 for an overview of *Behavior*-survey items)

Subjective norm-survey items (N = 62)		Q1	Q4	Q7	Q8	Q9	Q12	Q13
Q20 It is normal to hold colleagues accountable if they do not handle information securely, such as if they do not lock their computers.	r_s	.056	.114	–.016	.044	.067	.177	–.031
	Sig.	.666	.379	.902	.733	.604	.169	.812
Q30 If I do not follow the rules for secure information handling, there are consequences for me.	r_s	.033	.057	1.32	–.099	.137	.095	–.116
	Sig.	.799	.660	–.308	.444	.289	.464	.368
Q51 My supervisor regularly stresses the importance of handling information securely.	r_s	–.022	–.027	.014	.095	.084	–.077	.092
	Sig.	.864	.833	.917	.462	.517	.552	.475

Table 3.11
Results of Spearman's Rank Correlation test with *Behavior*- and *Subjective norm*-survey items (see Table 3.8 for an overview of *Behavior*-survey items)

post-game scores of the two items was examined. It appeared that no relationship between the two items existed in the first place: rs (60) = .127, p = .327. Any correlation between the increased scores of both items, therefore, seems meaningless. Why no further correlations were found between participants' increased attitude and increased secure behavior can again be explained by already decent scores for attitude and behavior, leading to few situations where both could be increased by playing the game.

Correlations between behavior and subjective norm As shown in Table 3.11, no significant correlations were found between participants' increased secure behavior and increased subjective norm after playing *The Human Firewall*.

Correlations between behavior and perceived control Five significant correlations were found between participants' increased secure behavior and increased perceived control after the game (see Table 3.12). The first correlation is another significant negative correlation, again with the item *I use different passwords at home and at work* (Q7). This time the correlation was found with the item *My behavior affects the information security within the Delft University of Technology* (Q22): rs (60) = –.257, p = .044. The correlation between the post-game scores of the two items was examined: rs (60) = .099, p = .446. Again, this shows no relationship between the two items in the first place, so it was concluded that the negative correlation between the two increased items was meaningless.

The second correlation was found between the item *I lock my computer when I walk away from my workstation, including when I go to the restroom* (Q4) and the item *I have an important role in secure information handling at the Delft University of Technology* (Q37): rs (60) = .256, p = .045. This means that participants who started to lock their computers after the game tended to also experience more control concerning their role in secure information handling at the univer-

sity. The game possibly pointed out to participants that the relatively simple and concrete action of locking their computer is something they are in control of.

Interestingly, three other positive correlations involve three different *Behavior*-items that all correlate with the same *Perceived control*-item. This item, *I am sure that no one can access my data if I walk away from my workplace* (Q50), strongly correlated with the item *I lock my computer when I walk away from my workstation, including when I go to the restroom* (Q4): rs (60) = .476, p = <.001. So, participants who started to lock their computers after the game tended to also experience control over their data access. This strong correlation seems to make sense because the action of locking a computer seems a very direct demonstration of experiencing control over one's data access. Second, item Q50 correlated with the item *I use different passwords at home and at work* (Q7):): rs (60) = .275, p = .030. This means participants who increased their use of different passwords after the game tended to also experience control over their data access. Again, this correlation seems rather clear since the use of different passwords seems a sign of experiencing control over one's data access. Lastly, item Q50 correlated with the item *I take action when I see a stranger walking around the office in a place where it is not supposed to be* (Q12): rs (60) = .353, p = .005. So participants who began approaching strangers at the university in places where no strangers are supposed to come, tended to also experience control over their data access. Like the other correlations with Q50, this correlation can also be explained by the fact that approaching strangers is one of the actions one can take to gain more control over data access.

***Perceived control*-survey items (N = 62)**		**Q1**	**Q4**	**Q7**	**Q8**	**Q9**	**Q12**	**Q13**
Q22 My behavior affects the information security within the Delft University of Technology.	r_s	.086	.108	-.257	.064	-.036	.059	.010
	Sig.	.505	.403	**.044**	.622	.782	.647	.942
Q33 If I use the rules for securely handling information, the chances of something going wrong are much less.	r_s	-.082	.157	-.130	-.147	-.041	-.133	-.030
	Sig.	.525	.224	.315	.255	.751	.302	.815
Q37 I have an important role in secure information handling at the Delft University of Technology.	r_s	-.119	.256	-.038	-.127	-.020	-.007	-.117
	Sig.	.356	**.045**	.772	.327	.874	.957	.364
Q50 I am sure that no one can access my data if I walk away from my workplace.	r_s	.106	.476	.275	-.101	.061	.353	-.067
	Sig.	.411	**<.001**	**.030**	.437	.637	**.005**	.606

Table 3.12
Results of Spearman's Rank Correlation test with *Behavior*- and *Perceived control*-survey items (see Table 3.8 for an overview of *Behavior*- survey items)

Responsibility-survey items (N = 62)		Q1	Q4	Q7	Q8	Q9	Q12	Q13
Q58 I do not think about the possible consequences of my way of secure information handling.	r_s	.026	.187	.027	–.086	–.089	–.145	.142
	Sig.	.844	.147	.838	.508	.489	.262	.271
Q61 The motto 'think before you act' relates to me.	r_s	–.013	.081	.028	.047	–.119	.253	.068
	Sig.	.922	.533	.831	.715	.358	**.048**	.599
Q62 If I handle information carelessly, it can affect me and my colleagues.	r_s	–.043	–.056	.067	.007	.139	.156	–.089
	Sig.	.743	.665	.604	.958	.280	.227	.491

Table 3.13
Results of Spearman's Rank Correlation test with *Behavior*- and *Responsibility*-survey items (see Table 3.8 for an overview of *Behavior*-survey items)

Correlations between behavior and responsibility Lastly, one significant positive correlation between participants' increased secure behavior and increased responsibility after the game was found (see Table 3.13). The item *I take action when I see a stranger walking around the office in a place where it is not supposed to be* (Q12) correlated with the item *The motto 'think before you act' relates to me.* (Q61): rs (60)=.253, p=.048. This would mean participants who started to take more action in approaching strangers after the game tended to also feel more related to the motto 'think before you act'. However, as described earlier (see 3.4.6.1), Q61 could have been interpreted as a generic question by the players, therefore not relating directly to the gameplay. Therefore, it is hard to draw conclusions from this correlation.

3.4.7.3 Participants' secure information handling one week after the game

To investigate the lasting effects of participants' secure information handling after they played *The Human Firewall*, the results of the third survey (N = 58) researched participants' behavioral changes and intentions one week after the training game. The results showed that participants lock their computer when they walk away from their workstation due to the game; 67.9 % of the participants reported this (of which 24.5 % only do this when they work at the university). Next, the results showed that 94.3% of the participants pay attention that they do not leave confidential information in the workplace as a result of the game (69.8 % have started doing it more, 13 % have started with it and 11.3 % only do this when they work at the university).

- *"Now I pay attention to documents and so on, I hadn't thought about how that could be taken as well. Normally, our office is locked, but quite a few people can get in there."*

Interestingly, participants were less convinced to engage in more secure behavior regarding password management and data minimization. 63% did not download a recommended password manager, and 66 % did not delete or move unnecessary data from e-mail boxes or folders. Still, participants did indicate that they intend to engage in these behaviors later: 53% intend to download a password manager, and 56.5 % intend to clean their e-mailboxes and folders. Several reasons are given as to why participants have not yet installed a password manager. By far, the most frequently reported argument is lack of time, but doubts about the password managers' security and uncertainty about which software is best were also mentioned.

- *"The fact that you can download a password manager made me think, 'I have to do that'. Every time I think, 'I must do that', but then nothing comes of it."*

To increase the likelihood that participants will maintain their more secure ways of information handling after *The Human Firewall* and that their intended secure behavior will stay in the future, the research data provides several suggestions. The survey data showed that participants find it important to discuss secure information handling at work. This suggests that the game could be complemented by an in-person debrief. This allows employees to ask questions about things that are unclear. Also, employees can compare experiences, and important insights can be reiterated. Moreover, one can discuss with each other what obstacles people may face in working securely and how to tackle these. Next, the interview data provided two other recommendations. It was suggested that the employer could organize real-life simulations of unsecured scenarios after the game. That way, the game acts as the starting point of a larger set of interventions. By repeating the content of the game later in different ways, the likelihood of the information to stick with the employees might be increased.

- *"As far as I'm concerned, from ICT they just organize such a cyber accident twice a year. We also have an evacuation exercise once a year. So why not? For example, if we have a meeting, something happens suddenly. Then we can see how people react."*

Also, the importance of setting norms by the employer to stimulate good behavior was emphasized. It was suggested that employers should demonstrate the value placed on secure information handling to employees, possibly even daily. In other words, setting a good example without pointing fingers. Altogether, it can be concluded that participants changed their way of secure information handling after *The Human Firewall* to a certain extent. Also, several significant correlations were found with participants' increased knowledge, attitude, perceived control, and responsibility toward secure information handling. In many situations, participants already seemed to exhibit secure behavior, and therefore, there was little room for improvement, but where behavior could be more secure,

participants seemed to have changed their behavior for the better. In particular, participant's behavior in creating and using passwords improved remarkably. In addition, participants made minor positive adjustments in their behavior concerning physical threats and experienced general alertness concerning secure information handling. Still, more than half of the participants indicated that they intend to improve their secure behavior but have not yet done so, mainly due to lack of time. To increase the likelihood that participants will maintain their more secure way of information handling after the game, and that their intended behavior will be continued in the future, several recommendations were made: complementing the training game with a debrief, making the game part of a larger set of interventions, and having employers convey the importance of secure information handling.

3.5 Discussion

The results of the qualitative and quantitative data analysis provide a comprehensive picture of the effects of *The Human Firewall* on participants' knowledge, attitude, subjective norm, perceived control, responsibility, and behavior concerning secure information handling. Overall, it can be concluded that the training game had the expected outcomes, contributing to the increase of secure handling of information by the university secretaries. Where there was room for improvement, in many cases, an increase was found in participants' scores after the game. Also, several correlations were found between participants' increased secure behavior and increased behavioral predictors. The modified version of the game, however, hardly yielded the expected effect. Hardly any differences were found between the effects of the regular version of the game and those of the modified version of the game. In this section, the main results and the limitations of the experimental case study with *The Human Firewall* are discussed, and suggestions for future work are provided.

3.5.1 Predictors of secure information handling

Significant increases in participants' scores were found for all five measured predictors of participants' secure information handling.

3.5.1.1 Knowledge

Although the participants already possessed quite some knowledge about secure information handling, the game significantly increased certain knowledge. Remarkably, participants specifically acquired new knowledge about acting in urgent situations. Some of this knowledge positively correlated with an increase in participants' secure handling of information. Also, participants' knowledge about the rules for secure information handling, specifically those for creating a strong password, was reinforced.

Knowing what information is secret or confidential and how to handle personal data was unchanged after the game. This can be explained by the fact that this involves knowledge of situations that participants face daily. For matters like

acting in urgent situations and creating passwords, the necessary knowledge is not applied daily and, as a result, more variable. Therefore, it makes sense that participants' knowledge increased in those areas because there was more room for improvement.

3.5.1.2 Attitude

In line with participants' reinforced knowledge after the game about the rules for secure information handling in general and creating a strong password in particular, participants' attitude toward these issues significantly increased as well. It is therefore plausible that as a result of participants' reinforced knowledge, participants recognized the importance of complying with the rules and creating a strong password even more. In addition, a positive correlation was found between participant's increased attitude and increased behavior concerning the creation of secure passwords.

Also, participants found it significantly more important after the game to discuss secure information handling at work, for example, during work meetings. This is remarkable because the issue was not directly addressed in the game. To what extent participants already discuss secure information handling at work is unknown, but it indicates that participants feel a need to talk to others about it. Possibly, participants believe those discussions can contribute to broader support for the topic in the workplace. It could strengthen joint group responsibility, as *The Human Firewall*'s storyline emphasizes. More specifically, concrete, real-life experiences can be shared and evaluated to improve the overall security of the university. In addition, it could also be that participants need occasional confirmation that they are correctly applying the secure handling of information to stay motivated and keep doing it. As suggested earlier (see 3.4.7.3), this need for discussion can be translated into a debrief right after the game as an addition to the game session when the topic is still fresh in their mind.

3.5.1.3 Subjective norm

As mentioned earlier (see 3.4.4), this behavioral predictor seemed more difficult to positively influence behavior by playing a game than players' knowledge, attitude, perceived control, and responsibility concerning secure information handling. Someone's subjective norm of secure information handling concerns what that person thinks about how others (in their immediate environment) consider secure information handling. It is a subjective, individual experience, but it is based on experiencing the behavior of others, and that behavior seems to take place outside the game rather than in the game. In *The Human Firewall*, however, the customized game content directly matched the reality of the participants' work situation. So, participants could indeed experience in some way the extent to which their employer or colleagues wanted them to handle information securely. It resulted in significant increases after the game concerning the perceived accountability of colleagues and the perceived importance of secure information handling stressed by their supervisor. Also, interestingly, in line

with the reinforced attitude concerning compliance with the rules, participants' perception of the consequences for themselves after unsecure behavior was significantly increased.

Yet it must be taken into account that, most likely, other factors, in addition to playing the game, played a role in the observed increase of participants' subjective norm. As already mentioned (see 3.4.4), the working hours between the game phases may also have been influential here. This also applies, of course, to the results found for the other behavioral predictors. Still, in the case of participants' subjective norm concerning secure information handling, it might have had a greater influence because, during those working hours, the behavior of colleagues was observable in practice. This is also demonstrated by the fact that, unlike the other behavioral predictors, participants' subjective norm generally did not score fairly high prior to the game, and thus, there was room for improvement. Yet the extent of reinforcement after the game for the participants' subjective norm was less than observed for other variables. A possible explanation is given by Tam et al. (2022), who found that for employees with enough knowledge about (in)secure behavior (like the participants in this study), subjective norms become less important for increasing behavioral intentions. This would mean that the results for the scores of the participants' subjective norm after the game should not necessarily be considered disappointing.

3.5.1.4 Perceived control

Before the game, participants generally felt somewhat in control to handle information securely. Still, the game was able to reinforce participant's perceived control significantly. Interestingly, in line with the earlier findings of increased knowledge, attitude, and subjective norm regarding the rules for secure information handling, participants agreed even more after the game that when they follow the rules, the chances of things going wrong are much lower. However, participants, both before and after the game, only somewhat agreed that following the rules means that strangers can not access participant's work files. So, in that respect, their control remained the same. This is explainable because it is impossible to rule out hacker attacks completely. Participants seem to realize that.

Of all measured predictors of secure information handling, participants' increased perceived control after the game was found to positively correlate the most with participants' increased secure behavior after the game. This suggests that emphasizing players' control more in games that aim to change behavior is advisable. Notable in particular was that participants who experienced control over their data access after the game also tended to implement three concrete secure behaviors directly related to data protection.

3.5.1.5 Responsibility

Participants who felt more in control after the game concerning the effects of their behavior on the information security within the Delft University of Technology also felt more responsible for those effects. In addition, participants also felt more

responsible for those consequences in relation to their colleagues. The game's storyline, where the players fictitiously build a human firewall with colleagues, might have contributed to this.

The responsibility of the participants in experimental group 1 (manipulated version) increased significantly more after the game than that of the participants in experimental group 2 (original version) concerning the *willingness to be accountable for the behavior performed and its consequence*. Participants' general increase in this subdimension of responsibility, however, was not significant. Still, this result suggests that the manipulated text elements might have influenced the participants in group 1 a little bit after all. Whether this is due to specific textual adjustments or, rather, to all the adjustments together is impossible to determine. Nevertheless, no further significant score differences were found between the two experimental groups concerning their perceived responsibility. So, whether the observed significant difference is entirely due to the modified version of *The Human Firewall* is questionable.

The fact that hardly any differences were found between the experimental groups concerning participants' responsibility for secure information handling can have several reasons. First of all, as mentioned before, the modified text elements might have been too subtle. Secondly, at the same time, the original training game (as designed by Awareways) possibly already adequately addressed people's responsibility; after all, you do not create a human firewall alone. Also, in his videos, Jack personally addressed all players, regardless of their experimental group. Overall, it must be emphasized that the modified version of *The Human Firewall*, as used for this experimental case study, was used to explore how players' responsibility for secure information handling could be increased by playing a game. It has been a first step and has yielded interesting results that follow-up research can build on. To elaborate on this exploration, for example, future work could focus on more pronounced manipulated text elements.

3.5.2 Participants' secure information handling after *The Human Firewall*

It can be concluded that participants changed their way of secure information handling after the training game to a certain extent. In particular, their behavior in terms of creating and using passwords improved remarkably. Since the game had strengthened both participants' knowledge and attitude concerning passwords, this behavioral change was in line with the expectations. It seems participants could improve on this specific matter more than other issues concerning secure information handling. In addition, it may have played a role that the subject of passwords occurred repeatedly in the game, including the little game *Password Shooter*.

Furthermore, the results showed participants behaved more securely in the physical world after the game. It is possible that participants' previous training (as far as they had previous training) tended to focus primarily on online risks while acting securely in the physical world is just as important. *The Human Firewall* seems successful in making participants aware of this. This behavior is

also more easily observable by others in the workplace, so it might contribute to colleagues' subjective norm and perhaps inspire them to behave the same way.

Also, the general alertness created by the game resulted in more action concerning secure information handling. Interestingly, the game's specific content seemed to have contributed to that alertness. For many interviewees, the customized vishing exercise was so realistic that it made the intended impact. This finding emphasizes the importance of realistic and relevant simulations for players of training games like *The Human Firewall*.

Despite the positive results, it is still unknown to what extent the reported behavioral change will last. Also, whether or not the intended future behavior will be carried out by the participants remains unclear. Still, the fact that a relatively short and easy online game can result in small but key behavioral changes in employees' secure information handling is encouraging.

3.5.3 Research limitations

Besides the promising results of the experimental case study conducted with *The Human Firewall*, some limitations of the study can be identified. Firstly, the group sizes of the experimental groups should have been larger. During the recruiting of participants, many potential participants indicated they value the topic of secure information handling but decided not to sign up to participate in the experiment because of their high workload and the accompanying lack of time. It is a pity that this group has not been reached, also because it seems precisely that employees who have high workloads are more likely to make errors, possibly with information security consequences. Secondly, because it was not possible to recruit more participants, a control group could not be formed. It would have been valuable if a control group had been part of the study. That way it could have been tested whether the effects found were indeed due to the game or that the effects could just as well be obtained with another form of training. Thirdly, the distribution of enrolled participants between the two experimental groups ideally would have been more random. For practical reasons, however, the allocation was based on the moment of participants' application to participate in the study. Fourthly, the use of surveys involves self-reporting and, moreover, it can involve social desirability in answering the questions. Also, for practical reasons, the first survey was conducted one day before the start of the training game. Ideally, there would have been more time between this survey and the game, so that the content of the survey items would be less likely to affect the game experience, which could then influence the results of the second and third survey. As a final limitation, it should be mentioned that the semi-structured interviews were conducted by the researchers themselves, which can not rule out a possible researcher bias.

3.5.4 Suggestions for future work

The experimental case study with *The Human Firewall* provided results that encourage follow-up research. Several recommendations can be made for possible new studies elaborating on the conducted study. Firstly, as mentioned in 3.5.3,

future work should aim for larger experimental groups, including a control group and a more random distribution of participants across the conditions. Secondly, as discussed in 3.4.7.3 and 3.5.1.2, adding a debrief to a game session could have a reinforcing effect on the potential impact of the game. So, future studies could conduct effect measurements after this debrief has taken place with the players to explore the influence of such a debrief on the overall effects of the game. Thirdly, to examine what becomes of players' behavioral intentions after the game in practice, future work could conduct an additional measurement after, for example, a month or even later. This could provide interesting insights into the gap between players' behavioral intentions and actual behavior. For example, participants could answer the question of why the intended behavior is not performed. Fourthly, it would be interesting to examine the behavioral effect of the game when it functions as a starting point for a larger set of interventions, as described in 3.4.7.3. Lastly, concerning the game content, future work could use a stronger manipulated version, as suggested in 3.5.1.5, to further explore how players' responsibility toward secure information handling can be increased. Also, it is recommended to include more personal and realistic simulations in the game, as suggested in 3.5.2.

3.6 Conclusion

Based on the need for effective employee information security awareness training with the use of games, an experimental case study was conducted with the cybersecurity training game *The Human Firewall*. Participants were secretaries of the Delft University of Technology, who were divided into two experimental groups and either played the original or a modified version of the game. The modified version was created to explore how employees' responsibility for secure information handling could be increased by playing the game. The study followed a pretest/post-test design with a mixed-methods approach (surveys and interviews) to analyze the effects of the training game.

Results showed the game was able to increase players' knowledge, attitude, subjective norm, perceived control, and responsibility concerning secure information handling. These increases occurred mainly on the issues where there was still room for improvement, like password use and general rules for secure information handling. Concerning responsibility, however, hardly any significant differences were found between the two experimental groups. In addition to successfully reinforcing behavioral predictors, participants improved their secure information handling after the game. In particular, participants' behavior in creating and using passwords improved remarkably. Also, participants made adjustments in their behavior concerning physical threats and experienced general alertness concerning secure information handling. Finally, correlations were found between increased behavioral predictors and increased secure behavior. This research shows that a training game to improve employees' secure information handling is able to actively target and influence behavioral predictors and consequently achieves not only the common awareness but actual behavioral change.

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Appendix 3.A
Pre- and post-game survey items

1st survey (pre-game)

1. **For the following statements, please indicate the extent to which you agree or disagree.**

NB: 7-point Likert scale, ranging from *totally disagree* (1) to *totally agree* (7)

[*Behavior*-items, derived from Awareways]

- I write down passwords to remember them (outside of a password safe). [Q1]
- I sometimes e-mail files from my work to my private e-mail so I can easily work elsewhere. [Q5]
- I use the particular container/shredder/blue bin to dispose of secret/confidential documents. [Q6]
- I lock my computer when I walk away from my workstation, including when I go to the restroom. [Q7]
- I take my laptop, phone, and documents with me when I get out of my car. [Q8]
- I open an attachment in an e-mail only if I trust the content and sender. [Q9]
- I use different passwords at home and at work. [Q10]
- I give my password to a colleague when necessary. [Q11]
- If I need to renew a password, I come up with a good and completely new one. [Q12]

- I report unsecure situations, both online and offline, that I notice when handling information. [Q13]
- I immediately report a potentially unsecure (dangerous) e-mail I receive at work. [Q14]
- I take action when I see a stranger walking around the office in a place where it is not supposed to be. [Q15]
- I talk about the content of my work in public spaces, such as the train or on a terrace. [Q16]
- I take great care not to leave documents on the copier or in the printer. [Q17]

[*Knowledge*-items, derived from Awareways]

- I know how to handle personal data according to the Privacy Act. [Q18]
- I know what information is secret/confidential. [Q19]
- I know the rules for secure information handling. [Q30]
- I know what to do in the event of a suspected data breach. [Q35]
- I know enough about the methods criminals (hackers) use to steal information. [Q20]
- I know who to turn to if something goes wrong when dealing with information. [Q49]
- I know what the rules are for a strong password. [Q41]
- I know enough to work securely with the internet and e-mail. [Q24]
- I know what to do if something goes wrong when dealing with information. [Q37]

[*Attitude*-items, derived from Awareways]

- I think it is essential that there are rules within the Delft University of Technology for the secure handling of information. [Q22]
- I believe it is important to adhere to the rules for secure information handling. [Q26]
- I think learning how to handle information securely is important. [Q27]
- I think it is important to do my best when coming up with a new, strong password. [Q32]
- I believe that strict controls on secure information handling are important for the good name of the Delft University of Technology. [Q39]
- I believe it is important for all employees to adhere to secure information handling rules. [Q45]
- Reporting unsecure situations immediately is very important. [Q51]
- I think it is important that information security is regularly brought to the attention, for example, during a work meeting. [Q52]

[*Subjective norm*-items, derived from Awareways]

- My supervisor sets a good example for the secure handling of information. [Q31]
- The management of my department regularly stresses the importance of handling information securely. [Q42]
- All the people I work with follow secure handling of information rules. [Q47]

- The management of my department sets a good example for the secure handling of information. [Q29]
- My supervisor regularly stresses the importance of handling information securely. [Q54]
- If I do not follow the rules for secure information handling, there are consequences for me. [Q33]
- It is normal to hold colleagues accountable if they do not handle information securely, such as if they do not lock their computers. [Q23]

[*Percieved control*-items, derived from Awareways]

- My behavior affects information security within the Delft University of Technology. [Q25]
- If I use the rules for secure information handling, the chances of something going wrong are much less. [Q36]
- I have an important role in secure information handling at the Delft University of Technology. [Q40]
- If I follow the rules for secure information handling, strangers can not access files from my work. [Q50]
- I am sure that no one can access my data if I walk away from my workplace. [Q53]

[*Responsibility*-items, based on earlier work of Mergler & Shield (2016)]

[subdimension *Awareness of and control over own thoughts and feelings*]

- When I think of cybersecurity, certain emotions come to mind. [Q58]
- Cybersecurity does not evoke any specific feelings in me. [Q60]

[subdimension *Awareness of and control over the choices made with respect to behavior*]

- The motto 'think before you act' relates to me. [Q65]
- I do not think about the possible consequences of my way of secure information handling. [Q61]

[subdimension *Willingness to be accountable for the behavior performed and its consequence*]

- If something goes wrong because I handle information, I take responsibility for it. [Q56]
- I accept the possible punishment if I have done something clumsy. [Q59]

[subdimension *Awareness of and concern for the impact of own behavior on others*]

- That my way of handling information securely can also affect my colleagues worries me. [Q62]
- If I handle information carelessly, it can affect me and my colleagues. [Q66]

[subdimension *Motivation to process information attentively*]

- I am motivated to read cybersecurity information carefully. [Q63]
- I find it interesting to learn more about cybersecurity. [Q64]

2. **My age is:**

18–29 / 30–39 / 40–49 / 50–59 / 60+ / I would rather not say

3. **How would you describe yourself in terms of your computer skills?** [Q71]

- ☐ I am a computer layman
- ☐ I am pretty clumsy with computers
- ☐ I have an average dexterity with computers
- ☐ I am pretty handy with computers
- ☐ I am a computer expert

4. **Please enter your Delft University of Technology e-mail address here:** [Q72]

.....

2nd survey (post-game)

Most of the items of the first survey were again presented in the second survey (see 1 and 4 of pre-game survey items). Note that they can have different question numbers. In addition, the following items were included in the second survey:

1. **The following statements are about how you felt during the training *The Human Firewall*.**
Please indicate the extent to which you agree or disagree with a statement.
NB: 7-point Likert scale, ranging from *totally disagree* (1) to *totally agree* (7)
[In-Game items derived from the Game Experience Questionnaire – IJsselsteijn et al., 2013]

- I was interested in the game's story. [Q1]
- I felt successful. [Q2]
- I felt bored. [Q3]
- I found it impressive. [Q4]
- I forgot everything around me. [Q5]
- I felt frustrated. [Q6]
- I found it tiresome. [Q7]
- I felt irritable. [Q8]
- I felt skillful. [Q9]
- I felt completely absorbed. [Q10]
- I felt content. [Q11]
- I felt challenged. [Q12]
- I had to put a lot of effort into it. [Q13]
- I felt good. [Q14]

2. **For the following three statements, please indicate to what extent you agree or disagree.**

NB: 7-point Likert scale, ranging from *totally disagree* (1) to *totally agree* (7)

- The training emphasized my responsibility to handle information securely at work. [Q15]
- I felt personally addressed by the training. [Q16]
- The training emphasized the urgency that I handle information securely at work. [Q17]

3. **Would you recommend the training to a collegue?** [Q18]

- ☐ yes
- ☐ no
- ☐ I do not know

4. **Would you like to comment on your own experience of *The Human Firewall?*** [Q19]

.....

5. **May we possibly approach you for a short online interview (about 10 min.) about your experience with the training *The Human Firewall?*** [Q84]

- ☐ yes, that is okay
- ☐ no, preferably not

3rd survey (post-game)

As the first and second survey, the third survey asked for the participants' e-mail address.

1. **Did you download a password manager as a result of the training?** [Q2]

- ☐ yes, I did that during training
- ☐ yes, I did that after training
- ☐ no, I have not done that yet but plan to
- ☐ no, I have not and will not
- ☐ no, because I was already using a password manager
- ☐ other, namely: .....

2. **Can you explain why you are or are not using a password manager now?** [Q3]

.....

3. **As a result of the training, are you careful not to leave confidential information in your workplace?** [Q4]

- ☐ yes, for example, I now no longer leave confidential information on my desk at the end of the workday
- ☐ yes, but only when I work at the Delft University of Technology
- ☐ yes, I was already doing this but am paying more attention to it now than before training
- ☐ no, I do not see why this is necessary
- ☐ no, I do not think about that
- ☐ other, namely: .....

4. **As a result of the training, do you use the keyboard shortcut combination WINDOW KEY + L to lock your screen?** [Q5]

- ☐ yes, every time I leave my workplace
- ☐ yes, but only when I work at the Delft University of Technology
- ☐ no, but I do plan to do it more often
- ☐ no, I do not see why this is necessary
- ☐ no, I do not think about that
- ☐ other, namely: .....

5. **Have you deleted or moved unnecessary information from your e-mail boxes or other folders as a result of the training?** [Q6]

- ☐ yes, I cleaned out my e-mail boxes and other folders
- ☐ no, but I do plan to do so
- ☐ no, I do not see why this is necessary
- ☐ no, I do not think about that
- ☐ no, I had always minimized all my data

Appendix 3.B
Interview guide

1. **Motivation & expectations experiment**
   Why did you participate?
   What were your expectations beforehand?

2. **Prior experience & knowledge**
   What training have you already had?
   What was your experience with cybersecurity?

3. **Experience *The Human Firewall***
   How did you experience the training?

4. **Effect *The Human Firewall***
   How do you look at the issue now?
   To what extent do you behave differently?

4. Including a game design element for responsibility

Case study 3

Promise me

A board game about vegan eating behavior

doi: 10.4121/8ae50580-12e6-4430-ae01-1a10a1800c44
(raw data sets and complete surveys)

> *"Vegetarian food leaves a deep impression on our nature. If the whole world adopts vegetarianism, it can change the destiny of humankind."*
>
> Albert Einstein
> *Theoretical physicist*

4.1 Introduction

Today's societal problems demand more sustainable behavior from individuals and organizations. Worldwide, we face significant challenges, such as climate change, public health, and energy (Kuhlmann & Rip, 2018). Although technological advances may alleviate some symptoms, governments, companies, and citizens must show more sustainable behavior to overcome these urgent issues (Sharma et al., 2021; Gierszewska & Seretny, 2019).

Sustainable behavior can be summarized as *"minimizing the negative impact of one's actions on the natural and built world"* (Kollmuss & Agyeman, 2002). The Theory of Planned Behavior (TPB) (Ajzen, 1991) allows researchers to identify determinants of this behavior and target these determinants in behavioral interventions to promote sustainable behavior (Yuriev et al. 2020). According to the TPB, intention is the immediate antecedent of behavior and is a function of attitude toward the behavior, subjective norm, and perceived behavioral control (Ajzen, 2012). The completeness and efficiency of using the TPB to design interventions that promote sustainable behavior might be arguable, but when strict guidelines are followed when applying the theory, consistent results should be achieved (Yuriev et al., 2020).

Still, promoting sustainable behavior is complex (De Vries, 2019). People often acknowledge its need and have the right intentions (SCP, 2021; Krystallis et al., 2012; Buerke et al., 2017), but this does not automatically result in the behavior itself (Kollmuss & Agyeman, 2002; Landry et al., 2018). This type of gap is often referred to as the *attitude-behavior gap* (Claudy et al., 2013; Park & Lin, 2018). One of the explanations for this gap is people's lack of personal responsibility to put their intentions into action (Hines et al., 1987; Blake, 1999; De Vries, 2020). This may be caused by *diffusion of responsibility*: the more bystanders surround someone facing the same problems, the less responsible that person feels toward taking action (Latané & Nida, 1981). In global sustainability issues, one could say that those 'bystanders' are all world citizens (De Vries, 2020).

4.1.1 Games for sustainability and their behavioral impact

One promising intervention tool that promotes sustainable behavior is the deployment of games (Crookall, 2013; Chappin et al., 2017; Stanitsas et al., 2019). Games can provide players with knowledge and skills (Klabbers, 2018), arouse emotions (Hromek & Roffey, 2009), and express values (Flanagan & Nissenbaum, 2015). Among all teaching and learning methods, games are perhaps the most appropriate for addressing the 'systemic' nature of sustainability challenges (Crookall, 2013). Besides, games potentially have a wide reach and can directly tackle behavioral aspects of sustainability issues (Chappin et al., 2017).

Games are increasingly explicitly designed to facilitate the sustainability transition (Stanitsas et al., 2019). For example, the game *The Climate Action Simulation* aims to increase players' knowledge about the scale of emission reductions and policies and actions needed to address climate change (Rooney-Varga et al., 2020). In addition, more and more research is being done on the impact of these so-called *games for sustainability*.

Nguyen & Hallinger (2022) reviewed 35 experimental studies of such games and how effectively they changed the players' behavior. The review focused specifically on the role of research design. The researchers found that most interventions significantly changed the players' behavior toward more sustainable behavior. However, in many cases, strict evidence and procedures were lacking, making it hard to interpret the findings. Moreover, the studied interventions mainly changed behavior during and not after the game. Another study reviewing 77 games also identified limitations of the persuasive effects of games for sustainability (Stanitsas et al., 2019). The researchers, therefore, propose a research agenda for sustainability games that enhances holistic knowledge. In alignment with this proposal, Hallinger et al. (2020) emphasize an urgent need for more high-standard empirical studies to assess the effects of games for sustainability and how and under what conditions these effects are achieved. The scope of these studies should include design elements that influence the effectiveness of the games and explicitly focus on the behavioral effects of the games (Hallinger et al., 2020).

4.1.2 Design for transfer: exploring the potential of promises

To improve the post-game behavioral impact of games for sustainability, empirical research on game design elements bridging the gap between behavioral change in the game world and the real world (post-game) seems particularly relevant. These game elements should strengthen the 'design for transfer' and help ensure that what is 'discovered' by players is applied in the real world after the game.

An interesting example of 'design for transfer' is the social innovation game *Urgent Evoke* (by renowned game designer Jane McGonigal and The World Bank; Wichmand, 2021). To win the game, players had to complete missions and turn in an *Evokation*: a detailed plan of how the player will tackle a self-chosen challenge in the real world after the game has ended. However, no support was available for the players when they started their post-game challenge (Wichmand, 2021). It is suggested that games should not be designed to 'end' when players are asked to transfer their ideas to the real world (Wichmand, 2021). The 'magic circle' of these games should be 'perforated' in some way to mix the game and real-world reality (Castronova, 2005).

Building on the ideas of *Urgent Evoke*, it seems promising to explore the added value of promises as a game design element to improve the behavioral impact of games for sustainability. Promises about the desired sustainable post-game behavior could increase players' responsibility toward that behavior and could, therefore, potentially help narrow the attitude-behavior gap. Promises make people accountable (taking ownership to ensure that a task is satisfactorily done), and this accountability appears to be a great motivator to increase responsibility (the obligation to satisfactorily perform a task yourself) (Lerner & Tetlock, 1999; McGrath & Whitty, 2018). Also, a meta-analysis of 128 sustainable behavior research studies found (among other variables) that verbal commitment is associated with sustainable behavior (Hines et al., 1987). In many cases, promises can be interpreted as a verbal commitment. A more recent study on environmental communications

proposes three design suggestions: keep it simple, balance the message, and provide an action perspective (De Vries, 2019). Again, a promise seems to be a good way to provide that action perspective.

Making (implicit) promises in games is not new; in simulation games for training and business games, for example, players do this while preparing for implementation in practice (Larson, 2020; Forssén & Haho, 2001). The game enables them to discover which strategies do and do not work within the simulated system. They might reflect on this experience during a debrief and develop certain insights. However, the extent to which the player carries these insights into reality often remains unclear. Therefore, exploring how explicit promises can be used more intentionally as a bridging game design element to reduce the attitude-behavior gap by strengthening people's responsibility toward the sustainability of their behavior is relevant.

4.1.3 Research design and research questions

Based on the above literature review, it can be concluded that game design elements that bridge the gap between the game world and the real world seem valuable for improving the post-game behavioral impact of games for sustainability. The use of promises as a design element seems particularly relevant because promises can provide a welcome action perspective and enhance players' responsibility toward the game's topic, thus reducing the attitude-behavior gap that often occurs within sustainability issues. Therefore, a quasi-experimental case study with 30 participants was set up to explore the use of promises in games for sustainability.

A mixed-methods pre-test/post-test research design was employed with the board game *Promise Me* (Viezzer, 2019) about vegan eating behavior. Before this study, the game had been mainly deployed for artistic purposes. With designer Manuela Viezzer, adjustments were made in the game so the evaluation of *Promise Me* could answer the following research questions:

1. How can promises effectively be implemented in the design of a game for sustainability?
2. What is the effect of including promises in a game for sustainability on the desired post-game behavior?
3. What is the relation between implemented promises in a game for sustainability and players' responsibility toward the game's topic?

The outline of this chapter is as follows: first, the game design and gameplay of *Promise Me* are described, followed by the case study's methodology. Next, results from the study are presented and discussed, including limitations and future work, and conclusions are drawn.

4.2 Background

Promise Me (Viezzer, 2019) is a handmade board game that is also an artwork. It presents a simplified simulation of factory farming and its consequences and seeks to awaken players' responsibility for its continuation whenever they consume meat and dairy products. At a global level, factory farming has been found to contribute negatively to the environment and human health (Post et al., 2020). In the long term, the negative effects of animal-based food production can only be countered by drastic consumption reduction or replacement of the products, e.g., by vegan or vegetarian alternatives (Pluhar, 2010). In the Netherlands, where the case study was conducted, only 0.4 % of the population is vegan, 5% is vegetarian, and 45% of the Dutch are flexitarian, meaning that they eat meat maximally four days a week (Kloosterman et al., 2021). This means that almost 50% of the Dutch eat meat at least five days a week.

Apart from factors like culture, habits, costs, and availability related to eating meat, this 50% of meat consumers might not be sufficiently aware of the consequences of their eating behavior (for the environment, themselves, and the livestock). *Promise Me* can provide players with insights about the negative effects of animal-based food production and aims to increase players' responsibility toward the topic in a playful way and without being pedantic. In this section, the implementation of promises in the game design is first discussed, and then the general gameplay (including debrief) is presented.

4.2.1 Promise Cards in *Promise Me*

The implementation of promises within *Promise Me* was done with so-called Promise Cards. Each card holds a different promise about vegan eating behavior; for example, *I promise you I will not eat meat for one day* (see Figure 4.1; for all promises, see Appendix 4.A). The promises differ in magnitude, enabling the exploration of players' preferences for the type of promises they select. The back of the cards contains different hand-drawn portraits of pigs. Before the game starts, players select several cards from a personal deck of Promise Cards. For the gameplay, it does not matter what cards are chosen. Guided by their own preferences, players are free to choose how they select the Promise Cards: based on the content of the cards (by reading all the promises carefully), based on the appearance of the cards (the varied pig portraits), or simply randomly selecting the cards from the deck.

During the game, players can use the Promise Cards to create a path for pigs to escape from a slaughterhouse (if this is their goal). They can use as many cards as they want (including none). Before placing a Promise Card on the game board, players are invited to read aloud what is written on the card (i.e., verbal commitment). The idea behind the Promise Cards during the game is that it contributes to the link with reality. In real life, animals can also only be 'free' if people collectively change their behavior and eat less or no animal products. Perhaps more importantly, the Promise Cards can cause a discussion among players on their current (vegan or non-vegan) eating behavior. At the end of each game session,

players are invited to select one of the Promise Cards they have played to take home. From this moment, the Promise Card can stimulate the transition from what the player 'discovered' in the game to applying this in the real world.

How methods to generate accountability (like the Promise Cards) are designed could strongly affect their behavioral outcomes (Aleksovka et al., 2019). In addition to timing, the relationship between the accountability giver and the accountability holder should be considered. It was, therefore, decided to deliberately leave out that players are ordered to keep the promise from the chosen Promise Card. This way, the players are made both an accountability giver and an accountability holder at the same time. There is also no explicit mention of checking later on whether players keep their promises. These design choices for *Promise Me* aimed to stimulate players' intrinsic motivation to take steps toward vegan eating behavior.

4.2.2 Gameplay of *Promise Me*

A game session with *Promise Me* includes a facilitator and four players. The game consists of several separate elements: 64 tiles, 1 Pen, 1 Slaughterhouse, 5 Fields, 16 System Cards, four decks of 18 Promise Cards in different colors, and 15 little pigs.

4.2.2.1 Setting up the game

Before a session starts, the facilitator arranges the 64 tiles in an 8 × 8 square to form the game board; gray tiles create a square in the middle of the board, and white tiles are placed around it. The gray tiles are covered with the System Cards, with their dark side up. Once the game session starts, the facilitator invites the players to place the other game elements on the board. Next, each player chooses a deck of Promise Cards. Players select 8 Promise Cards from their deck and place them in front of them (with either the promises or pig portraits facing up).

4.2.2.2 Playing the game

Players take turns rolling a die to move the little pigs around. The goal of the game is not made explicit; players can decide this for themselves. The players' possible actions depend on how many pips they roll with the dice. Within one move, players can involve as many pigs as they want. When players roll an odd number, they must play for the System and bring the pigs to the Slaughterhouse as efficiently as possible. Pigs can be taken out of the Pen and placed on any tile adjacent to it belonging to the System Area. Outside the Pen, on any tile belonging to the System Area, the pig should be moved toward the Slaughterhouse. A pig is slaughtered and removed from the game whenever it ends up in the Slaughterhouse. When players roll an even number, they can decide whether or not to play and how many moves to make (up to the number on the die). Players must move the pigs toward the Fields if they choose to play. Whenever a pig ends up in a Field, it becomes a free pig and can not be moved further. Pigs, however, can only move on tiles covered with Promise Cards. Players can play as many Promise Cards as they want in their turn (playing a card does not count as a move). After playing Promise

Cards, any pig on the board can be moved. Pigs already in the System Area can be saved by making a one-time path with Promise Cards out of the System Area. After this path is used in one turn, it is removed. The player will then keep the cards as a set of played Promise Cards.

4.2.2.3 Ending of the game and debrief

The game ends when there are no pigs left to move because they are either freed or slaughtered by the players. This generally happens after about 30 minutes. Next, the facilitator holds a debrief for about 15 minutes after the game finishes. The following questions are asked to the players:

1. How did it go?
2. What was your aim in the game, and why?
3. How did you select and play your Promise Cards?

After a short discussion, the facilitator then asks the players to collect the Promise Cards they have been playing (each player has its own color of Promise Cards), and to take a minute to look at them and choose one to take home that appeals to them. Finally, the facilitator asks each player to choose a little pig as a gift for participating in the session.

Figure 4.1
The board game *Promise Me* (right), including Promise Cards about vegan eating behavior (left)

4.3 Methods

After approval by the Human Research Ethical Committee (HREC) of the Delft University of Technology, the quasi-experimental case study with *Promise Me* followed a pre-test/post-test design. A mixed-methods approach (with surveys and observations) was conducted to explore the added value of promises as a game design element in games for sustainability. The case study aimed to test the following hypotheses: 1. the use of the aforementioned Promise Cards is an effective way to implement promises in a game, 2. playing *Promise Me* with the Promise Cards will increase players' vegan eating behavior, and 3. keeping a promise from a Promise Card will result in an increased responsibility toward a vegan diet. Before describing the materials and the procedure, the sample size, participant characteristics, and sampling procedure are discussed.

4.3.1 Participants

Eight experimental game sessions were held in two settings to evaluate *Promise Me*: at the Delft University of Technology (in a lecture room) or the art gallery 38CC in Delft (as part of an exhibition). 30 participants (aged 17 to 59 years) participated in the experiment, each joining one of the eight game sessions. The recruitment differed by location. Participants for the sessions held at the Delft University of Technology were recruited through a personal online or live invitation by one of the researchers. These were all international master's students who followed a course in game design. To complete this group, three PhD students were also personally invited to participate. For the sessions at the art gallery, participants were invited through the online newsletter of the gallery. They were all art enthusiasts who had visited the gallery before. Next, a call to participate was posted on a Facebook group for expats in Delft to complete this group of participants.

It was aimed to ensure that all players were unaware of the exact research purpose of the game sessions. Participants gave their consent following the HREC requirements before the session. After the sessions, it was indicated that participants could receive the research results if they were interested.

4.3.2 Materials

To answer the research questions, quantitative and qualitative data were collected using surveys and observations. Participants were presented with three surveys during their participation in the experiment. Figure 4.2 shows the time frame and order in which the research data was collected.

Figure 4.2
Time frame and order of data collection

4.3.2.1 Pre- and post-game surveys

Three short online surveys (two of 10 minutes long, one of five minutes, in English) were compiled for the main data collection. The first two surveys (pre- and post-game) measured differences in players' scores concerning their responsibility toward a vegan eating behavior. A third survey was sent to the players one week after the game to receive feedback on the use of the Promise Cards and to measure the behavioral effect of the Promise Card each player selected to take home. All three surveys were provided online with the use of Qualtrics™.

1st survey (pre-game) The first survey consisted of 45 items, of which 16 were used for this study. A measuring scale of 10 items (with a 7-point Likert scale) was created to measure players' responsibility toward a vegan diet before playing *Promise Me*. These were statements about the potential impact of consuming animal products personally and socially. For example, *When I think of veganism, certain emotions come to mind* and *I accept the possible consequences for the environment and/or animal welfare when I consume meat or dairy products*. Within this construct, four subdimensions were distinguished based on the prior work of Mergler & Shield (2016) on personal responsibility measurement. These subdimensions (two items each) were:

1. awareness of and control over own thoughts and feelings;
2. awareness of and control over the choices made with respect to behavior;
3. willingness to be accountable for the behavior performed and its consequence;
4. awareness of and concern for the impact of own behavior on others.

A fifth subdimension (two items) was added:

5. motivation to process information attentively.

As earlier work on persuasion describes how one's motivation to carefully process information about a topic is related to one's responsibility for that topic (O'Keefe, 2002).

The pre-game survey also asked participants about their current diet (one item), experience with (non)digital games (two items), age (one item), and gender (one item). The question about the current diet was particularly important because it was used to filter out vegan participants. Since this group of players already takes responsibility for a vegan diet, they were not included in the measurement of responsibility change. The last item requested participants' e-mail addresses to merge the data of the first survey with the second survey.

2nd survey (post-game) The second survey consisted of 57 items, of which 34 were used for this study. Again, like the pre-game survey, the second survey measured participants' responsibility toward a vegan diet with the same ten items. Also, participants' general game experience was measured with 11 of the 14 statements

from the In-Game items of the *Game Experience Questionnaire* (GEQ) (IJsselsteijn et al., 2013), with a 7-point Likert scale. Three items were not chosen because, according to the researchers, they did not sufficiently reflect the type of game that *Promise Me* is. Also, one item was changed: instead of *I found it impressive* the researchers chose to use the statement *I found it inspiring*.

Through an open question, players could share anything regarding their experience with *Promise Me*. Participants were also asked about the location of the game session they attended. The last item again requested participants' e-mail addresses to merge data from the second survey with the first survey.

3rd survey (post-game) The third and final survey consisted of 12 items, of which six were used for this study. The items measured to what extent participants remembered the promise from the chosen Promise Card, what they did with the Promise Card and the little pig they chose after the game, to what extent participants kept their promise or not, and why they kept it or not. At the end of this last survey, the player was presented with an open question for sharing anything regarding the Promise Cards or their general game experience.

The attached Appendix 4.B shows all pre-and post-game survey items, as used for the quasi-experimental case study with *Promise Me*.

4.3.2.2 Observations

Besides the pre-and post-game surveys, observations were made of the gameplay and players' reactions during the game. These observations focused on the selection and use of the Promise Cards, discussions among players concerning veganism, and possibly other matters that stood out. The observing researcher took notes of these observations.

4.3.3 Procedure

The case study with *Promise Me* was set up as a quasi-experiment. All participants belonged to the same homogeneous group. Distributed over eight game sessions and two settings, the participants went through the same type of sessions with the same facilitator and observer. All participants completed the same surveys before and after the game sessions. Participants' individual differences in survey scores before and after the game were analyzed to examine the game's effects.

4.3.3.1 Data collection method

All 30 recruited participants received an online link to the first survey (10 minutes, including informed consent) the week before the game session they participated in. On the day of their game sessions, the facilitator briefly explained what the game session would entail and double-checked that all participants had completed the first survey. It was emphasized that the survey data would be anonymized after analysis and safely stored. After a brief explanation of the game rules, the game sessions began. During the game, players could ask for

clarification from the facilitator, and the observing researcher took notes. After the game, a short debrief was held, and there was room for questions about the research or further discussion on the game topic. The entire game session lasted about an hour. Shortly after the game session, participants received the link to the online second survey (10 minutes) and, one week after, the link to the third survey (five minutes).

4.3.3.2 Data analysis strategy

Quantitative analyses were performed using SPSS™. First, the mean scores and standard deviations of the participant's scores on the GEQ items were analyzed to assess the general game experience A Pearson's Chi-squared test was used to determine any significant differences between groups (age, setting, diet, prior game experience) concerning a kept promise or not. Next, a correlation check with a Spearman's Rank Correlation test was conducted between (not) keeping the promise and players' game experience. After recoding the negatively formulated items of the measuring scale 'responsibility toward a vegan diet', a Confirming Factor Analysis was conducted to verify the expected components of the construct. Due to the small number of participants, a Wilcoxon Signed-Rank test was performed to discover significant differences in players' pre-game and post-game scores concerning their responsibility toward a vegan diet (item level). Next, to explore differences in those pre- and post-game scores between groups, Mann-Whitney tests were conducted (for gender and age), and next, a Kruskal-Wallis test (for current diet). A correlation check with a Spearman's Rank Correlation test was applied between items in which the responsibility had increased significantly and the kept promise of the Promise Card (or not).

The qualitative data gathered by observing the game sessions (including the debrief) was analyzed as follows: after transcribing the notes, the data was coded based on the different themes of the gameplay and the content of players' reactions. The results from the qualitative data from the open survey items (post-game) were also coded based on overlapping content.

4.4 Results

All 30 participants completed the first and second surveys. 29 participants filled in the third survey. Almost half of the participants, 14 players, were meat and fish eaters (46,7%), 11 were flexitarians (no meat or fish at least once a week), two were vegetarian, and three were vegan. 80% of the participants reported playing non-digital games (such as board games) a few times a month (43,3%) or a few times a year (36,7 %). Only one player indicated never to play non-digital games.

4.4.1 General game experience of *Promise Me*

Table 4.1 shows how participants generally perceived the board game. First, it is noticeable that, on average, the game's topic had the interest of the players, and the game was perceived as somewhat inspiring. Second, the component of Positive affect was above neutral, and the component Negative affect was well

Component (N = 30)	Item	M	SD
Positive affect	I felt content.	4.93	1.081
	I felt good.	5.23	.898
Negative affect	I felt bored.	2.27	1.230
	I found it tiresome.	1.77	.817
Tension	I felt frustrated.	2.60	1.221
	I felt irritable.	1.80	.714
Sensory and imaginative immersion	I was interested in the game's story.	5.87	.937
	I found it inspiring.	5.13	1.106
Challenge	I felt challenged.	4.53	1.525
	I had to put a lot of effort into it.	3.17	1.599
Competence	I felt successful.	5.27	1.048

Table 4.1
Means and standard deviations of GEQ items (7-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (7))

below neutral. Participants were not bored during *Promise Me* and did not find the game tiresome at all. Also, on average, no tensions were experienced during the game. Finally, it is notable that it varied fairly among participants to what extent they felt challenged. It was probably less challenging for vegans anyway, and how people think about the game's topic can vary from person to person. For example, the Promise Cards may have been much more challenging for some than for others.

4.4.2 Implementation of the Promise Cards

To answer the first research question, *How can promises effectively be implemented in the design of a game for sustainability?* the use of the Promise Cards and players' suggestions for improvement were analyzed. The results were based on the qualitative data from the observations during the game sessions and the open questions of the post-game surveys.

4.4.2.1 Selecting the Promise Cards

Based on the observations during the game sessions, it was noticed that most players read the promises of the cards from their deck with full attention. Sometimes, a discussion about the feasibility of the promises arose among players. Only one player did not look at all to the promises. The debrief revealed that most players selected their Promise Cards based on how easy and realistic they seemed. For example, it seemed difficult for many participants not to eat cheese. In contrast, some players chose promises that seemed challenging to them. The portraits of the pigs on the back of the cards also appeared to play a role in the selection for some players.

4.4.2.2 Placing the Promise Cards

After the selection, the way players placed their Promise Cards on their side of the board differed. This was done both with promises or pig portraits facing up. Most players indicated that they quite randomly played a Promise Card because, content-wise, there were no major differences between the cards after their initial conscious selection. Still, it was observed that the magnitude of the promises increased the game's dynamics because it influenced how seriously players thought about the promises and the choices they made during the game.

4.4.2.3 Selecting a final Promise Card

Players based their selection of the final Promise Card to take home on the type of promise and/or the portrait of the pig. In line with the aforementioned selection criteria of easy and realistic versus challenging, hardly any mid-level promises were chosen. So, it was primarily either a promise like *I promise I will try vegan milk* or a promise like *I promise I will not eat meat for a week*. Also, vegan diet options and recommendations were sometimes shared when players chose their Promise Card to take home (like coconut yogurt as a dairy-free alternative or the name of a good vegan hamburger restaurant).

4.4.2.4 Suggestions for improvement

Results from the open questions in the second and third surveys mainly showed players' suggestions for improvement of the Promise Cards. For example, additions to the card, like:

- *"Include links to product suggestions."*
- *"Integrate effects on animals, emissions, etc. … of doing the action of the Promise Card."*
- *"Include the opportunity to write our own card if we like"*.

Or changing the format or size of the card to take home, like:

- *"If the size and feel of the Promise Card can be of a credit card, it might end up in people's wallets. Then the card is viewed repeatedly without an effort, which might impact later decision making for people who find that decision hard to remember."*

Although others would disagree with these suggestions:

- *"No way! They're beautiful! We have our cards in the kitchen at eye level next to the refrigerator."*

Also, suggestions were made on the use of the Promise Cards during a game session, like:

- *"Maybe give a card to other players for them to keep a promise."*
- *"Use them during the debrief to talk about positive outcomes if you keep the promise".*

4.4.3 Behavioral effect of the Promise Cards

When players chose one Promise Card at the end of the game, it was deliberately left up to the players what they wanted to do with their card. It was never said that players had to keep the promise of the card. Surprisingly, nobody threw away the card after the game; 22 players (75,9%) reported keeping it as a souvenir, and four players as a reminder of their promise. The rest did not take a card home. As for the pigs that players were invited to take home, only one person did not take one. 24 players (82,7%) kept it as a souvenir, and again, four players kept it as a reminder of their promise. Apart from being cute it also seemed a tangible memory of the game session:

- *"It reminds me about the emotions and experience I had during the game."*

To answer the second research question, *What is the effect of including promises in a game for sustainability on the desired post-game behavior?* it was evaluated if players had kept the promise from their chosen Promise Card and changed their eating behavior concerning vegan options in the week after the game session. 18 players (62%) remembered the promise from their chosen Promise Card one week after the game. 19 players (65,5%) kept the promise from their Promise Card entirely (55,2%) or partly (10,3%). Players who partly kept their promise reported, for example:

- *"I still ate a few eggs and one meal with cheese that week, but this was an improvement."*
- *"I bought vegan groceries for the entire week but ended up eating meat on one day."*

Also, one player eventually made and kept a different promise than the original one because that one was partially forgotten, and one player got so inspired that he even did something more than just keeping the promise:

- *"I feel it is crucial to increase consciousness regarding alternatives for meat and dairy products. That is why I organized a vegan BBQ for my friends, just to show that it is possible. Everyone loved it; thank you for inspiring me to do so!"*

No significant differences were found between keeping a promise or not and gender, age, the setting of the game, players' diet, or players' prior game experience. Also, no significant correlation was found between keeping their promise and how players experienced *Promise Me* as a game.

4.4.4 Responsibility toward a vegan diet and kept promises

To answer the third research question, *What is the relation between implemented promises in a game for sustainability and players' responsibility toward the game's topic?* the reliability of the measurement for the construct 'responsibility toward a vegan diet' was first determined. A Confirming Factor Analysis identified four distinctive factors of 'responsibility toward a vegan diet' in the players' pre-game scores and five factors in their post-game scores. Most of these factors consisted of a different set of items than previously expected from theory (see 4.3.2.1). Besides, the factors identified in the pre-game scores differed from the factors found in the post-game scores. For these two reasons, it was decided to conduct further analyses concerning 'responsibility toward a vegan diet' on the item level only. To discover if playing *Promise Me* resulted in any significant increase in players' responsibility toward a vegan diet, a Wilcoxon Signed-Rank test was performed for each scale item (see Table 4.1). Because there were three vegans among the participants (who did not receive the questions about responsibility), the sample became 27 and thus became smaller than 30.

Table 4.2 shows that for items 1, 3, 4, 5, 6, and 7, the medians of the pre-game scores equal the medians of the post-game scores. Item 2 decreased slightly in the post-game survey (Mdn = 3) when compared to the pre-game survey (Mdn = 4) but not significantly at the 0.05 level.

For item 8, the Wilcoxon Signed-Rank test indicated that the post-game median, Mdn = 3, was significantly higher than the pre-game median, Mdn = 2, $Z = -2.559$, $p = .010$. Contrary to expectations, players indicated feeling less responsible after the game in terms of 'the awareness of and concern for the impact of their behavior on others.' After the game, players still disagreed with the item (reflecting responsibility), but significantly less than before the game. This result is remarkable, as it seems contradictory to the qualitative results.

The qualitative results suggest that, at least during the game, players portrayed awareness of and concern about the effects of their eating behavior on others. During the game, for example, players wanted to push a pig as far away as possible inside the Slaughterhouse: *"So we don't have to be confronted with the slaughtered pig"*. Also, several times, players told each other *"Please, don't let them die!"* and a player who tried to save a pig mentioned *"I feel morally responsible"*. In addition, the awareness of and concern for the impact of players' behavior on others was noticeable during the discussions among players about veganism and factory farming that arose in response to the game (during the game and debrief). It could be that this awareness and concern decreased after the game, but we suspect that this item may have been misinterpreted since it was negatively phrased. Players may have different interpretations of the wording of the item *The consequences are only for me when I consume meat or dairy products*, where some might have taken a holistic view and indicated it is not 'only me,' and others might have taken the view that it is 'only me' who is to be blamed for consuming meat or dairy products. The qualitative results are also considered to be of importance here since the group size was relatively small.

N = 27	Mdn pre-game	Mdn post-game	Z	p
Item 1 When I think of veganism, certain emotions come to mind.	5	5	–1.000	.317
Item 2 The topic of veganism does not evoke specific feelings in me.	4	3	–.478	.633
Item 3 The motto 'think first, then act' relates to me.	5	5	–.264	.792
Item 4 When I buy meat or dairy products, I do not think about the possible consequences for the environment and/or animal welfare.	3	3	–.366	.714
Item 5 When I consume meat or dairy products, I take responsibility for the negative outcomes for the environment and/or animal welfare.	4	4	.000	1.000
Item 6 I accept the possible consequences for the environment and/or animal welfare when I consume meat or dairy products.	5	5	–.453	.651
Item 7 I do not care that I contribute to the existence of factory farming, when I buy meat or dairy products.	3	3	–.036	.972
Item 8 The consequences are only for me when I consume meat or dairy products.	2	3	–2.559	**.010**
Item 9 I am motivated to read information about vegan products.	5	6	–2.144	**.032**
Item 10 I find it interesting to learn more about plant-based alternatives to meat or dairy products.	5	6	–.905	.366

Table 4.2
Results of a Wilcoxon Signed Rank test for items measuring 'responsibility toward a vegan diet' (7-point Likert scale varying from *totally disagree* (1) to *totally agree* (7))

For item 9 also, a significant result was found: Z = –2.144, p = .032. The post-game median, Mdn = 6, was higher than the pre-game median, Mdn = 5. After the game, players were significantly more motivated to read information about vegan products. This means that players indicated feeling more responsible after the game in terms of 'motivation to process information attentively'. This outcome is in line with the qualitative results of the case study. In particular, during the discussions among players that arose in response to the game, non-vegan players were open to vegan product suggestions. Also, one player suggested to include links to product suggestions on the Promise Cards. Finally, item 10 increased from Mdn = 5 (pre-game) to Mdn = 6 (post-game), but not significantly at the 0.05 level.

No significant differences were found between players' pre-and post-game scores on item 9 and gender, age (17–31 and 32–58), or players' diet. Lastly, no significant correlation was found between players ' difference in pre-and post-game scores on item 9 and keeping their promise (or not).

4.5 Discussion

The quasi-experimental case study with *Promise Me* aimed to contribute to improving games for sustainability by exploring the added value of promises as a game design element. Despite the preliminary nature of this study, its initial results provide new insights into using promises to bridge the common gap between the game world and the real world. In this section, the main results and the limitations of the case study are discussed, and suggestions for future work are provided.

4.5.1 Implementation of promises as a game design element

Promises were implemented as a game design element with the use of game cards (Promise Cards) that described vegan eating behavior. Participants were invited to select and take home one such Promise Card, thus promising to try out the behavior on the card after the game.

The results of the evaluation show that Promise Cards seem to be a viable way to implement promises about sustainable behavior in a game. After the game, by selecting a played Promise Card, players consciously thought about applying (or not applying) the described sustainable behavior of the promises in daily life. In addition, players already had to relate to the promises during the game by selecting their cards and by playing the cards. As a result, the link to the real world was established much earlier in the game session. Perhaps a little less direct or even unconscious, but it could have enhanced the overall impact of the final chosen Promise Card. This way, the 'bridging moment' from the game to reality did not appear abruptly at the end of the game but already started from the moment the game started. Implementing the Promise Cards as a prominent and recurring game element stimulated the players to deliberately evaluate how they related to the game's topic and the related sustainable behavior as written on the Promise Cards. The observed discussions that additionally arose among players in response to the cards reinforced this.

The different orders of magnitude of the promises on the Promise Cards (see Table 4.A.1 in Appendix 4.A) on the Promise Cards also contributed to stimulating players' evaluation of the promises. It positively influenced how seriously players thought about the promises and their choices during and after the game. It was found that players differed in what type of promise appealed to them. Therefore, it is important to enable different types of players to make a promise that motivates them to keep it. Providing a wide range of promises clearly supports this requirement. A possible enhancement could be to add an open card for players to formulate their own promise.

4.5.2 Reducing the attitude-behavior gap

One week after the game session, the effect of players' promises on the desired sustainable post-game behavior was measured. It was hypothesized that playing *Promise Me* would lead to stimulating vegan eating behavior due to the implementation of the Promise Cards in the game. More than half of the players (65.5%)

kept the promise from their chosen Promise Card entirely or partly. This ranged from trying a vegan fish stick to not eating cheese for one week. Statistical analysis showed that gender, age, game setting, diet, or prior game experience did not seem to influence keeping the promise (or not).

4.5.3 Strengthening players' responsibility toward sustainable behavior

It was hypothesized that playing *Promise Me* would lead to an increased responsibility toward a vegan diet due to implementing promises in the game. This hypothesis is not confirmed by this research. First, overall, no significant change in players' 'responsibility toward a vegan diet' was found after the game. Second, even on item level, no correlation was found between an increased responsibility toward a vegan diet and keeping the promise of the chosen Promise Card (or not).

However, players did seem significantly more motivated after the game to process information about a vegan diet attentively. More specifically, after the game, players were more motivated to read about vegan products. What this motivation means in practice can not be stated with certainty, but it possibly contributes to more sustainable eating behavior. If players will indeed read more about vegan products, it may increase the likelihood of the purchase and use of the products (and thereby decrease players' consumption of meat and dairy products).

4.5.4 Research limitations

Some limitations of this research should be mentioned. Firstly, in this quasi-experiment with *Promise Me*, only one possible way of implementing promises in games for sustainability was explored. It should be mentioned, of course, that there are many other ways of doing this. However, for this study, the focus lay on implementing promises through Promise Cards. They existed in the original design (Viezzer, 2019), and their content could easily be changed and used to fit the research requirements. Moreover, Promise Cards are applicable in different types of games (analog and digital, multiplayer and single-player, card games, and board games) and can promote all sorts of sustainable behavior.

A second limitation concerns possible social desirability. To stimulate players' intrinsic motivation to keep their promises, they were both accountability givers and takers simultaneously. It was never mentioned that players had to keep their promise, nor that it would be varified later. However, it can not be excluded that players felt they had to keep the promise because of social desirability. Thirdly, another important issue is that it can not be directly proven that players only performed the desired sustainable post-game behavior because of implementing the Promise Cards in the game. Players may have exhibited the behavior even if no promises were made in the game. The discussions about sustainability and animal welfare that emerged during the game and debrief and filling out the pre-game survey might have influenced this as well. Still, the fact that a majority of the players implemented the precise promise of their Promise Card indicates that the Promise Cards did play an important role in establishing the behavioral effect of the game.

Lastly, the measuring scale for 'responsibility toward a vegan diet' proved insufficiently reliable to measure the construct. Responsibility seems difficult to make measurable, as reflected in the low number of existing validated surveys available. A more comprehensive theoretical basis, with more emphasis on vegan eating behavior as well, could sharpen the content of the used measuring scale. Also, more items per subdimension could be included, and the negatively formulated items should be formulated less ambiguously or positively worded like the other items to avoid misinterpretations. Nevertheless, combined with the qualitative research findings, it was possible to gain insight into the effect of the game on the players.

4.5.5 Suggestions for future work

Future work could focus on the following suggestions. First of all, similar game studies can be conducted for other sustainability topics. The results of the experiment with *Promise Me* indicate that designers do not have to take excessive account of variables like gender, age, or setting when it comes to keeping promises about sustainable behavior. This helps the already easy and flexible implementation of promises into games. Secondly, variations in content (including a blank card), size or format, and other uses of the Promise Cards can be explored. Thirdly, other ways of implementing promises in games for sustainability can be investigated. Lastly, other issues that could be addressed in future work are working with a larger sample size, adding a control group (playing a game with and without promises), and using an improved measuring scale for 'responsibility toward a vegan diet'.

4.6 Conclusion

A quasi-experimental case study with a mixed-methods pre-test/post-test research design was conducted with the board game *Promise Me* (Viezzer, 2019) to explore the use of promises in games for sustainability. Using promises as a game design element clearly has potential because promises can provide a welcome action perspective and enhance players' responsibility toward the game's topic, thus reducing the attitude-behavior gap that often occurs within sustainability issues.

Based on the findings of this research, it can be concluded that Promise Cards are a viable way to implement promises in a game for sustainability. Such cards can stimulate players to deliberately evaluate how they relate to the game's topic and the related sustainable behavior as written on the Promise Cards. The discussions that additionally arise among players in response to the cards can reinforce this. Moreover, Promise Cards are easy to implement in various games for sustainability (regardless of the type of game or topic), and are also sufficiently flexible to adjust according to other preferences. Next, the case study showed that the effect of including promises in a game for sustainability on the desired post-game behavior can be surprising. The behavioral effect of the game was that more than half of the participants (partly) showed the desired sustainable behavior one week

after the game. The behavior ranged from relatively easy behavior, such as trying vegan products, to more challenging behavior, such as not consuming meat or dairy products for one week. To measure participants' responsibility toward vegan eating behavior appeared to be more complex than expected. No correlation was found between the implemented promises and players' responsibility toward the game's topic. Still, after playing the game, players were more motivated to process information concerning veganism attentively. This increased motivation seems a positive contribution to reducing the issue of the attitude-behavior gap.

Aside from the inevitable limitations, the case study with *Promise Me* provides insights into the added value of promises as a game design element. To support the implementation of promises by the players, it was shown that a wide range of promises is helpful. Also, already interacting with the promises during the game proved to be helpful. This study encourages game designers and researchers to further investigate the implementation of promises as a game design element, as well as its influence on players' post-game behavior and their responsibility to perform that behavior.

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Appendix 4.A
Content of Promise Cards deck

Table 4.A.1 shows the variety of promises as written on each Promise Card from the personal deck of cards that each player receives at the beginning of the game *Promise Me*. From this, the players select eight cards that they decide to play with during the game.

LIGHT promises	I promise you I will try a vegan hamburger I promise you I will try a vegan sausage I promise you I will try a vegan drink I promise you I will try a plant-based milk I promise you I will try a plant-based cheese
MEDIUM promises	I promise you I will eat vegan for one day I promise you I will not eat meat for one day I promise you I will not eat cheese for one day I promise you I will not eat fish for one day I promise you I will not drink milk for one day I promise you I will not have dairy for one day
HEAVY promises	I promise you I will eat vegan for one week I promise you I will not eat meat for one week I promise you I will not eat cheese for one week I promise you I will not eat fish for one week I promise you I will not drink milk for one week I promise you I will not have dairy for one week

Table 4.A.1
Light, medium, and heavy promises as written on the Promise Cards of *Promise Me*

Appendix 4.B
Pre- and post-game survey items

1st survey (pre-game)

1. **Please indicate for each of the following statements to what extent you either agree or disagree.**

NB: 7-point Likert scale, ranging from *totally disagree* (1) to *totally agree* (7)

[*Responsibility*-items, based on earlier work of Mergler & Shield (2016)]

[subdimension *Awareness of and control over own thoughts and feelings*]

- When I think of veganism, certain emotions come to mind. [Q25]
- The topic of veganism does not evoke specific feelings in me. [Q26]

[subdimension *Awareness of and control over the choices made with respect to behavior*]

- The motto *"think first then act"* relates to me. [Q27]
- When I buy meat or dairy products, I do not think about the possible consequences for the environment and/or animal welfare. [Q28]

[subdimension *Willingness to be accountable for the behavior performed and its consequence*]

- When I consume meat or dairy products, I take responsibility for the negative outcomes for the environment and/or animal welfare. [Q29]
- I accept the possible consequences for the environment and/or animal welfare when I consume meat or dairy products. [Q30]

[subdimension *Awareness of and concern for the impact of own behavior on others*]

- I do not care that I contribute to the existence of factory farming, when I buy meat or dairy products. [Q31]
- The consequences are only for me when I consume meat or dairy products. [Q32]

[subdimension *Motivation to process information attentively*]

- I am motivated to read information about vegan products. [Q33]
- I find it interesting to learn more about plant-based alternatives to meat or dairy products. [Q34]

2. **What is your current diet?** [Q35]

I am a ...

☐ meat and fish eater
☐ flexitarian (I do not eat meat or fish at least once a week)
☐ vegetarian
☐ vegan
☐ other: .....

3. **We would like to know how often you play games. On average, how often do you play digital games*?** [Q36]

* We do not just mean big games like Call of Duty, but also simpler (online) games like Wordfeud or Candycrush

☐ never
☐ a few times a year
☐ a few times a month
☐ a few times a week
☐ everyday

On average, how often do you play non-digital games*? [Q37]

* we do not mean sports here, but card games, board games etc.

☐ never
☐ a few times a year
☐ a few times a month
☐ a few times a week
☐ everyday

4. **What is your age?** [Q38]

.....

5. **What is your gender?** [Q39]

- ☐ man
- ☐ woman
- ☐ other

6. **What is your e-mail address?** [Q40]

.....

2nd survey (post-game)

Most of the survey items from the first survey were again presented in the second survey (see 1 and 6 of pre-game survey items). In addition, the following items included the second survey:

1. **For each statement, please indicate the extent to which you agree or disagree.**

NB: 7-point Likert scale, ranging from *totally disagree* (1) to *totally agree* (7)

[In-Game items derived from and based on the *Game Experience Questionnaire* – IJsselsteijn et al., 2013]

[Positive affect]
- I felt content. [Q49]
- I felt good. [Q52]

[Negative affect]
- I felt bored. [Q44]
- I found it tiresome. [Q47]

[Tension]
- I felt frustrated. [Q46]
- I felt irritable. [Q48]

[Sensory and imaginative immersion]
- I was interested in the game's story. [Q42]
- I found it inspiring. [Q45]

[Challenge]
- I felt challenged. [Q50]
- I had to put a lot of effort into it. [Q51]

[Competence]
- I felt successful. [Q43]

2. **What did *Promise Me* do to you?** [Q53]
Please tick all the boxes that apply to you.

- ☐ it made me reflect upon my own eating habits
- ☐ it made me think about my part in the continuation of factory farming
- ☐ it made me aware of my own responsibility for a sustainable society
- ☐ it made me think about animal welfare
- ☐ it did not do much with me
- ☐ other: .....

3. **Anything else you would like to share with us concerning your experience with *Promise Me*?** [Q56]

.....

4. **Where did you play *Promise Me*?** [Q41]

- ☐ The Delft University of Technology
- ☐ art gallery 38CC
- ☐ café in Amsterdam

3rd survey (post-game)

1. **Do you remember what promise was written on the Promise Card that you chose after the game?** [Q35]

- ☐ yes, namely: .....
- ☐ yes, partly: .....
- ☐ no, I do not remember

2. **What did you do with the Promise Card that you chose after the game?** [Q33]

- ☐ I threw it away
- ☐ I kept it as a souvenir
- ☐ I kept it as a reminder of my promise
- ☐ I do not remember
- ☐ other: .....

3. **What did you do with the little pig that you chose after the game?** [Q15]

- ☐ I threw it away
- ☐ I kept it as a souvenir
- ☐ I kept it as a reminder of my promise
- ☐ I do not remember
- ☐ other: .....

4. **Have you carried out the promise that was written on the Promise Card that you chose?** [Q34]

- ☐ yes, I did!
- ☐ yes, partly: .....
- ☐ no, I did not

Why did you keep the promise from the Promise Card you chose? [Q50]
or:
Why did you not keep the promise from the Promise Card you chose? [Q51]

.....

5. **Anything else you would like to share with us concerning the Promise Cards or the game in general?** [Q36]

.....

5. Discussion

"Learning is not doing; it is reflecting on doing."

Henry Mintzberg
Management scientist

Chapter 1 presented this dissertation's main overarching research question about improving the behavioral impact of persuasive games that promote a sustainable society, including its three sub-research questions. Next, Chapters 2, 3, and 4 described the three case studies that were conducted related to each of these subquestions. All three studies evaluated specific games about specific behavior and were played by a specific group of players in a specific setting. Nevertheless, these studies can be generalized to some extent to provide answers to the more generally formulated subquestions and the main research question.

This chapter discusses the results and limitations of the case studies before the findings are generalized. First, each study is discussed separately and then the implications of the three studies together are discussed. Next, suggestions for future research are made. The discussion of this chapter eventually allows for the conclusion of this dissertation in Chapter 6 by answering the subquestions and the main research question.

5.1 Case study 1 Making players aware of their incapabilities

Case study 1, involving the evaluation of the digital listening game *Free the Listening Mutant!*, aimed to answer the first subquestion to the main research question: *To what extent can a persuasive game make players aware of their incapabilities?* The study addressed incapabilities in active listening.

Active listening is an essential prerequisite for a sustainable society. If we do not listen to understand each other, the collective action needed to tackle global crises has no chance of success. Despite the importance of active listening, higher education underestimates listening as a distinct communication skill. However, listening is a complex skill that requires training and development. Students generally acknowledge the importance of listening but tend to overestimate their listening skills. The first case study, therefore, evaluated the game *Free the Listening Mutant!* to make first-year university students aware of their listening incapabilities as a first step of listening instructions to increase the likelihood that they will listen more actively to others.

5.1.1 Results of case study 1

Contrary to expectation, the results of the mixed-methods quasi-experimental case study with the game *Free the Listening Mutant!* showed that participating students hardly became aware of their listening incapabilities by playing the game. Before and after the game, the students rated their listening skills as *more than sufficient*. Acknowledging others' poor listening habits turned out to be easier for them. Still, some increased personal awareness was found for elements of passive listening that were directly included in the game content.

The exploration of attitudinal game effects confirmed that the students had a positive listening attitude before the game. Still, the game was able to strengthen students' listening attitude somewhat, and a majority of the students felt more responsible for listening actively after the game. Their expressed valuation of listening made it perhaps uncomfortable to admit they are not very good at it, explaining why the students barely reported any awareness of their listening incapabilities. Lastly, the exploration of behavioral game effects showed very small behavioral changes to have occurred. Still, the strengthened listening attitude of the students could increase the likelihood of improved future listening behavior.

5.1.2 Research limitations of case study 1

The measurement of players' awareness of their listening incapabilities might have partly affected the results. The survey items measuring students' perception of their listening skills did not match one-to-one with the students' direct experiences during the game. Some statements in the survey described listening behavior that only subtly appeared in the game. This may be why not much awareness of listening incapabilities was reported by the players after the game. Also, the research design did not include a second post-game measurement after the collective debrief, where players who had not understood the game's message could find it out after all. An additional measurement might have revealed more awareness of players' incapabilities, as the debrief gave room for a type of reflection that was impossible during the game.

Social desirability may also explain why little awareness of listening incapabilities was found. Although it was emphasized that participants' answers were

only accessed by the researchers and there was no 'good or bad' answer, it could be that the students felt it was undesirable to admit their listening incapabilities. A potential weakness in gathering the qualitative results was that the semi-structured interviews were conducted by the researchers themselves, which can not rule out a possible researcher bias. A final limitation to consider is that the students were obliged to participate in the experiment, so they may not have been entirely motivated to participate seriously and, as a result, did not fill out the surveys with full attention.

5.1.3 Generalizing the findings of case study 1

The case study with the digital listening game *Free the Listening Mutant!* showed that making people aware of their incapabilities with a persuasive game can be challenging. The players' perception of their behavior can be persistent and does not seem to be easily altered with the one-time play of a persuasive game. Potentially, this can occur especially if this game is designed with the premise of 'persuasion 2.0', in which the persuasive message of the game is interwoven within the game's content. Not all players can equally easily discover a 'hidden' message that is not immediately visible in the game. Even an in-game debrief can not solve this at once. Therefore, a separate debrief after the game is recommended to increase the likelihood of players' reflection concerning their incapabilities.

Especially when players' attitude toward certain behavior is considerably positive, admitting not to be very good at it does not seem easy. Still, in that case, a persuasive game can make players aware of some of their incapabilities by directly addressing players' behavior in the game and creating interactions whereby they can experience the consequences of that behavior. It seems additionally important that the game content is recognizable for the players so that the game and reality are reasonably close. Other kinds of behavior related to the game's behavioral topic but not explicitly addressed in the game might be too subtle for players to notice and thus reflect on.

5.2 **Case study 2** Increasing players' knowledge, attitude, subjective norm, perceived control, and responsibility

Case study 2, involving the evaluation of the cybersecurity training game *The Human Firewall*, aimed to answer the second subquestion to the main research question: *To what extent can a persuasive game increase players' knowledge, attitude, subjective norm, perceived control, and responsibility concerning specific behavior, and how does this relate to the potential behavioral change of players after the game?* The study addressed secure information handling.

Society has become highly dependent on information technology, resulting in the constant threat of cyber attacks and their potentially catastrophic consequences. Secure information handling contributes to minimizing these ongoing threats that undermine the creation of a sustainable society. Despite the attention and acceptance of cybersecurity, gaps and weaknesses remain. Security and risk

management leaders face technological, organizational, and human malfunctions. Significant security incidents and data breaches are, therefore, still prevalent. Human factors are considered one of the main causes of vulnerabilities in an organization's information security. The second case study, therefore, evaluated the game *The Human Firewall*, actively targeting behavioral predictors to increase the likelihood that employees will handle information more securely in their workplace.

5.2.1 Results of case study 2

As expected, the results of the mixed-methods experimental case study with the game *The Human Firewall* showed that the game was able to increase participating secretaries' knowledge, attitude, subjective norm, perceived control, and responsibility concerning secure information handling. These increases occurred mainly on the issues where there was still room for improvement. Additionally, secretaries improved their secure information handling after the game with small but key behavioral changes, and correlations were found between increased behavioral predictors and increased secure information handling.

The included preliminary exploration of how players' responsibility could be increased by playing a game showed that modified text elements conveying a more personal approach, the urgency of the behavioral change, and players' responsibility for this proved to be too subtle to further reinforce players' responsibility.

5.2.2 Research limitations of case study 2

The group of participants included employees who considered the game's topic so important that they voluntarily participated because they wanted to learn more about it. Another group of employees indicated that they value secure information handling, too, but eventually did not sign up for the experiment because of their high workload and lack of time. It would have been more representative if this last group also had participated because it might be that employees who have high workloads are more likely to make errors, possibly with information security consequences. Also, ideally, the distribution of enrolled participants between the two experimental groups would have been more random.

The surveys were about employees' behavior while at work. Despite stressing that the research data was kept strictly confidential, the social desirability in completing the surveys can not be ruled out. Also, the researcher conducted the semi-structured interviews, which can not rule out a possible researcher bias. Lastly, a limitation to note is that the first survey was conducted one day before participants started to play the game. Ideally, there would have been more time between this survey and the game, so the content of the survey items would be less likely to affect the game experience, which could, in turn, influence the results of the second and third surveys.

5.2.3 Generalizing the findings of case study 2

The case study with the cybersecurity training game *The Human Firewall* showed that a persuasive game can increase players' knowledge, attitude, subjective norm, perceived control, and responsibility concerning specific behavior with a one-time play, mostly when there is clearly room for improvement. This is particularly the case when the behavioral predictors are related to specific behaviors that a person does not experience daily.

To increase players' subjective norm, the game content must be well aligned with the player's reality, and offering the game in stages can be conducive. If a person has a lot of (increased) knowledge about certain behavior, the role of the subjective norm seems less substantial. Also, a storyline emphasizing personal responsibility in the context of a larger collective system can contribute to increasing players' responsibility.

Subsequently, besides raising awareness, the same game can lead to small, concrete, positive changes in players' behaviors in their daily practice. In some cases, an increase in one of the behavioral predictors also leads to increases in certain related behaviors. In particular, an increase in players' perceived control may correlate strongly with an increase in players' behavior after the game.

5.3 **Case study 3** Including a game design element for responsibility

Case study 3, involving the evaluation of the board game *Promise Me*, aimed to answer the third subquestion to the main research question: *What is the effect of explicitly including a game design element for responsibility in a persuasive game on increasing players' post-game behavior?* The study addressed vegan eating behavior.

Factory farming has been found to contribute to the environment negatively, and these negative effects can be countered by reductions in consumption or replacement of products, like vegan or vegetarian alternatives. In the Netherlands, where the case experiment was conducted, only 0.4 % of the population is vegan, 5% is vegetarian, and 45% of the Dutch are flexitarian, meaning that they eat meat maximally four days a week. This means that almost 50% of the Dutch eat meat at least five days a week. The case study, therefore, evaluated the game *Promise Me*, presenting a simplified simulation of factory farming and its consequences and aiming to trigger players' responsibility whenever they consume meat and dairy products.

5.3.1 Results of case study 3

As expected, the results of the mixed-methods quasi-experimental case study with the game *Promise Me* showed that including promises in a persuasive game can increase players' post-game behavior to a certain extent. Over half of the players (65.5%) kept a promise about vegan eating behavior, entirely or partly, one week after playing the game. That way, the promises seemed to bridge the gap between the game world and the real world.

The use of Promise Cards turned out to be a viable way to implement the promises. As a prominent and recurring game element, these cards stimulated the players to deliberately evaluate how they related to the game's topic and the related promises written on the cards. The observed discussions arising among players in response to the cards reinforced this. Also, enabling different players to make a promise that motivates them to keep it appears essential. Providing a wide range of promises supports this requirement.

However, contrary to expectations, no correlation was found between keeping a promise and an increased sense of responsibility toward a vegan diet after the game. So, to what extent promises can be seen as a game design element for responsibility can not be determined based on the case study with *Promise Me*. Hardly any increase in player's responsibility was found after the game. Still, players were significantly more motivated to read about vegan products after playing the game. This may increase the likelihood of purchasing and using vegan products at a later stage.

5.3.2 Research limitations of case study 3

As for this dissertation's first two case studies, the third case study had several limitations. Firstly, it can not be directly proven that players only performed the desired sustainable post-game behavior because of the Promise Cards in the game. Players may have exhibited the behavior even if no promises were made. The discussions about sustainability that emerged during the game, the debrief, and filling out the first two surveys might have also influenced this. Secondly, as for the other two case studies, it can not be ruled out that players felt they had to keep the promise because of social desirability. After all, the players knew another measuring moment a week after the game might ask them about their promise. Thirdly, the measuring scale for 'responsibility toward a vegan diet' proved insufficiently reliable for measuring the construct. A more comprehensive theoretical basis, with more emphasis on vegan eating behavior as well, could sharpen the content of the used measuring scale and thus the surveys' validity. Also, more items per component could be included, and the negatively formulated items should be formulated less ambiguously or positively worded like the other items to avoid misinterpretations.

5.3.3 Generalizing the findings of case study 3

Including promises in a persuasive game can increase players' post-game sustainable behavior to a certain extent and motivate players to process information about the game's topic attentively after the game. Players' positive behavioral change mainly concerns small and concrete behaviors closely linked to the game content. The extent to which these behaviors persist and give rise to other positive behavioral changes is unknown. Increased motivation after the game to read more about the game's topic may increase the likelihood of related sustainable behavior.

Promise Cards, as a prominent and recurring part of the gameplay, can be a viable way to implement promises of sustainable behavior in a persuasive game.

It is essential in this respect to enable players to make a promise that motivates them to keep it. Providing a wide range of promises from which players can choose supports this requirement. Additionally, it is essential to anticipate the players' intrinsic motivation, leaving it open to them to make a promise and to whom the promise is made.

5.4 Learnings from the three case studies

All three case studies that were conducted for this dissertation evaluated games that aimed to positively influence players' post-game behavior. Each game used a different way to help accomplish this. The first game was aimed at the first stage in behavioral change: becoming aware of possible personal incapabilities, in this case regarding listening skills, and opening the mindset of the players to develop new capabilities after the game. The second game was aimed at stimulating post-game behavior in a more direct way, intentionally targeting behavioral predictors. Players were given suggestions for secure information handling to apply in their regular workplace. The game was customized in several ways to best reflect the organization the players worked for. The third game introduced a new game design element to stimulate players' responsibility. These so-called Promise Cards explicitly helped with the transition between the game world and the real world. All three ways can help increase the likelihood that players will positively change their behavior after the game to some extent. The following subsections will address some general findings when studying the three case studies in combination.

5.4.1 Indirectly and directly influencing players' post-game behavior

All three studies showed that playing a persuasive game that promotes a sustainable society can positively contribute to players' post-game behavior, even after a one-time play. It is noticeable that players' post-game behavior involved relatively small and concrete actions closely related to the game content and ones that players could perform without too much effort.

Case study 1 showed that it is challenging to increase players' *Capability* by making players aware of their incapabilities, especially when their attitude

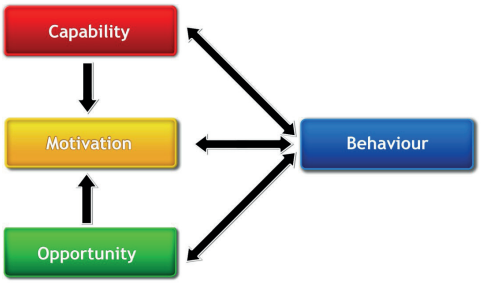

Figure 5.1
Relations between components of the COM-B model (Michie et al., 2011)

is already positive; still, players' *Motivation* was strengthened by the game (see Figure 5.1). Next, case study 2 showed that targeting behavioral predictors can increase players' *Motivation* and related *Behaviour*. Additionally, case study 3 confirmed the direct behavioral impact persuasive games for sustainability can make.

The COM-B model is a valuable framework when developing serious games for behavioral change. The empirical results of the case studies show that explicitly considering *Capability* and *Motivation* in the design of the game is key when the game intends to reduce the attitude-behavior gap. To stimulate *Motivation*, the Theory of Planned Behavior appeared to be useful and relevant.

5.4.2 Persuasive Game Design 2.0 and the value of a debrief

All three case studies evaluated games that used the principle of 'persuasion 2.0', in which the game's message is interwoven within the game's content. The players' post-game behaviors were, therefore, probably driven by self-persuasion, which can have an enormous power to affect long-term changes in attitudes and behavior (Aronson, 1999). However, the extent to which players will perpetuate their post-game behaviors in their daily lives can not be concluded from the studies. Still, the games do seem to have 'planted a seed' in a significant proportion of players.

The role of a debrief where there is room after the game for discussion, to explicitly link the game world and the real world, should not be underestimated. A debrief creates a type of reflection that is often impossible to achieve during the game. Particularly in the case of games promoting a sustainable society, collective debriefing seems valuable. Interestingly, in case study 2, where no separate debrief was offered to the players after the game, players themselves even expressed a need for it.

5.4.3 Difficulties addressing players' responsibility using a game intervention

As described in the introduction of this dissertation, the attitude-behavior gap applies to many behaviors essential for a sustainable society, and given the high priority of behavioral change on the policy agenda, it seems critical to deploy interventions (including the use of persuasive games) that try to reduce the attitude-behavior gap. As strong behavioral intentions can reduce the attitude-behavior gap, case study 2 therefore focused on the evaluation of actively targeting behavioral predictors that are supposed to strengthen one's behavioral intentions. Additionally, the same study included a preliminary exploration of how players' responsibility toward behavior could be strengthened, as this could also increase the likelihood that someone puts their intended behavior into practice. It can be concluded that the approach to strengthen the player's responsibility proved to be too subtle in case study 2 to achieve the intended outcome. The results of including text elements conveying a personal approach, emphasizing the urgency of the behavioral change, and the players' responsibility for this were very limited.

Case study 3 further explored how a persuasive game can strengthen players' responsibility in a less subtle way. In this case, a game design element was implemented and evaluated: making a promise for behavior after the game. Using promises in a persuasive game's design proved effective and yielded surprising results beyond expectations. Many players did not throw away their Promise Card after the game but took it home and even took action on it the week after the game. Even though it could not be determined to what extent promises can be seen as a game design element for responsibility, it can be concluded that making promises for sure created a connection between the game world and the real world.

5.4.4 Enhancing the validity of survey items

Some overlapping research limitations between the case studies were found, which may have influenced the results. The studies showed that measuring a construct like 'responsibility' adequately regarding reliability and validity can be complex. In addition to limiting the familiar factors such as social desirability and the researcher bias concerning reliability, it can be concluded that the research validity of game evaluation studies such as the conducted studies could be increased when statements in survey items directly match the game content and players' experience as much as possible. The surveys of the studies conducted sometimes asked about behaviors that did not occur or occurred very indirectly in the game. In such a case, it does not seem surprising if no effect of the game is found concerning that behavior. This is consistent with an earlier theoretical exploration that emphasized the aligned degree of specification of the game's message and the desired post-game behavior (Erdbrink et al., 2019).

5.5 Suggestions for future work

Several suggestions for future work can be given based on the findings of the three case studies. The findings of this dissertation would be strengthened if future studies would conduct additional similar case studies with games for sustainability. The same research questions could be maintained, but the games would have to involve topics other than active listening, secure information handling, and vegan eating behavior. Should similar results be found, the generalization of the results will be more substantial, for example, the effect of the Promise Cards.

Ideally, this type of future studies also involves a larger sample of representative participants, possible control groups, and a more random distribution of participants across the experimental conditions. The games being evaluated should include simulations of behavior that are realistic and relevant to the players and include a collective debrief session. If necessary, the target group can help to develop the game through co-creation. Also, measuring scales used to evaluate the games should directly match the game content and players' experience as much as possible. Behavioral measurements after the game should be done not only after one or two weeks but also later to discover more about the long-term effects of games for sustainability. Future studies should also enrich the qualitative findings by examining the specific elements or features within the games that

contribute to player's experiences. Also, the cultural and demographic factors that might influence the effectiveness of persuasive games across different populations could be further explored. Additionally, it would be interesting to examine the behavioral impact of games for a sustainable society when they function as a starting point in larger and longer interventions where other intervention tools are used alongside games.

Of all measured behavioral predictors, players' increased perceived control was found to positively correlate most with participants' increased behavior after playing a game promoting a sustainable society. This suggests that it can be helpful to emphasize players' perceived control in games that aim to change behavior. Future studies can be developed to explore how players' perceived control can be addressed and strengthened in games for a sustainable society. Lastly, more research is needed to further explore how players' responsibility toward behavior can be strengthened.

Despite the shortcomings of the conducted studies, it can be concluded that they have provided promising insights that contribute to the issue within game studies about games as a persuasive medium. As stated above, much research remains to be done. Still, it is hopeful to have discovered that persuasive games that promote a sustainable society can positively contribute to behavioral change at an individual level.

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6. Conclusions

"Vision without action is a daydream. Action without vision is a nightmare."

Japanese proverb

Chapter 5 discussed the main results and limitations of the three case studies that were conducted with the persuasive games *Free the Listening Mutant!*, *The Human Firewall* and *Promise Me*, aiming to positively influence players' post-game behaviors that are desirable in a sustainable society. Each game used a different way to help accomplish this. Despite the diversity of the three studies, their results showed that all three ways can help to increase the likelihood that players will positively change their behavior after the game to some extent.

This last short chapter briefly recaps the motivation and approach of this dissertation before presenting the final conclusions that answer the main research question as introduced in the introduction of this thesis.

6.1 Game design for a sustainable society?

To establish a sustainable society of ecological, social, and economic stability far into the future, collective action on all levels is required to tackle urgent global challenges in energy and climate, biodiversity and food, and peace and security. One key psychological component of such complex societal problems is the often needed behavioral change on multiple levels (government, companies, and individuals). Behavioral interventions can stimulate such change, ideally changing behavior simultaneously and consistently on population, community, and individual levels. Psychological frameworks can be of great use for the content development of those interventions. Subsequently, persuasive games are a promising

intervention tool for successfully conveying that content on an individual level but to a broad audience. However, there is still a long way to go before the viability of games as a persuasive medium can be firmly determined.

This dissertation, therefore, attempted to contribute positively to improving the behavioral impact of persuasive games that promote a sustainable society. After conducting three mixed-methods (quasi) experimental case studies with games that involved themes that belong within a sustainable society, the answer to the main research question can be provided.

6.2 Answer to the main research question

As introduced in Chapter 1, the introduction of this dissertation, the main research question that guided the conducted case studies was the following:

How can persuasive games that promote a sustainable society be designed so that playing the game has a positive effect on players' post-game behavior?

The answer to this research question can be concluded as follows.

A persuasive game that promotes a sustainable society can have a positive effect on players' post-game behavior if the following is taken into account when designing the game:

- Players can not improve their behavior if they are not first aware of possible incapabilities. As Chapter 2 showed, persuasive games can make players somewhat aware of their incapabilities when the behavioral situations are directly addressed and recognizable to players. A prerequisite for this awareness is that the players understand the game's message. If the game fails to do that, a debrief can still stimulate players' awareness of their incapabilities. Still, players' perceptions of their behavior can be persistent and do not seem to be easily altered with the one-time play of a persuasive game.

- Chapter 3 addressed the active targeting of players' knowledge, attitude, subjective norm, perceived control, and responsibility concerning specific behavior to increase these behavioral predictors. This increase mostly appears when there is room for improvement, often concerning behaviors that a person does not experience daily. Next to strengthening players' behavioral intentions, the same game can lead to small, concrete, positive changes in players' behaviors in their daily practice. An increase in perceived control can correlate strongly with a positive increase in post-game behavior

- Chapter 4 showed that explicitly including a game design element for responsibility, such as promises, can lead to players' positive behavioral change, mainly concerning small and concrete behaviors closely linked to the game content. It

is important that the element can effectively link the game world with the real world by still being relevant to the player even after the game is over. Additionally, the same game can motivate players to process information about the game's topic attentively after the game, possibly increasing the likelihood of related sustainable behavior.

Persuasive games that promote a sustainable society should never be designed with the idea that they can cause a complete change in someone's behavior. That is not realistic. However, this dissertation shows investing in small, concrete changes does have a chance of success. This way, such games could be a strong starting point for more significant, longer interventions where other intervention tools are used alongside games. As input to a general design guideline for such games, it was determined that multiple levels of consideration must be taken to see how the gap between attitude and behavior can be narrowed; both in terms of design strategies and more specific design elements.

The outcome of this dissertation forms a modest but positive contribution to improving the behavioral impact of persuasive games that promote a sustainable society. Future research is needed to further validate the results of the conducted case studies. Still, this dissertation could inspire policymakers and game designers who are motivated to successfully deploy persuasive games in realizing a sustainable society. May the implementation of the suggested design recommendations increase the likelihood of future players making small but concrete positive behavioral changes in their and our daily lives. Let's take collective action to bring persuasive games to their next level!

Acknowledgments

"Doing a PhD research is basically one big Montessori task", a friend told me as she had just completed her doctoral research, and I was about to start mine. Her comment caused me both hope and despair. As a former student of that independent form of education, I knew all too well the benefits and pitfalls of the freedom you were given to complete your schoolwork. Despite my tendency to procrastinate, I always met deadlines perfectly on time until then, but I wondered how it would go when there was only one big deadline of four years ...

As it turned out, I was indeed unable to meet that official deadline. From the original GAMPSISS project (with even a performance at the Holland Festival) to the additional case studies (one of which arose from a found wallet), there was so much of my interest to explore. This variety has led to a truly memorable period. Naturally, the people I worked with over the past few years played an essential part in that.

I want to express great gratitude to my excellent supervisors, Alexander Verbraeck and Rens Kortmann, who convincingly carried the Montessori motto *Teach me to do it myself*. I am grateful for their enthusiasm, constructive feedback, and angelic patience. Thanks to them, I could work at my own level and pace, and I greatly appreciate that. I always found working together enjoyable, and I loved that they also empathized with situations in my personal life. Also, I would like to emphasize the uniqueness of the NWO-funded GAMPSISS project and its wonderful team members, Janna Michael and Arlon Luijten, under the pas-

sionate leadership of creative initiator Micha Hamel. What we proclaimed back then is now mentioned daily in the media: we must learn to listen better. What a pleasure to explore this relevant topic together. It was an enriching experience to bridge our perspectives and find each other in the shared love of art and culture. Also, many thanks to Manuela Viezzer and Sophie Jellema for the inspiring collaborations. Next, I thank the committee members immensely for their time and attention in reviewing my dissertation with their expert eye. Finally, I honor my dear paranymphs Anastasia Roukouni and Amir Ebrahimi Fard for our natural friendship since we first met at the Delft University of Technology.

CV & publications

2024	Cultural policy advisor *Municipality of Baarn*
2017–2025	PhD research in Persuasive Game Design *Delft University of Technology* Multi Actor Systems – Policy Analysis *Faculty of Technology, Policy and Management*
2017–2018	Research and concept – interactive socio-cultural projects *Freelance*
2015–2016	MSc Information Studies, track Game Studies *University of Amsterdam*
2009–2017	Public Program *Hermitage Amsterdam	De Nieuwe Kerk*
2003–2008	BSc and MSc Psychology, track Social Psychology *University of Amsterdam*
1995–2002	VWO – Gymnasium, track Culture and Society *Gymnasium Haganum, The Hague*

Published

Erdbrink, A., Michael, J., Kortmann, R., Hamel, M., van Eijck, K., & Verbraeck, A. (2021). Listening Space: an exploratory case study on a persuasive game designed to enrich the experience of classical music concerts. *Journal on Computing and Cultural Heritage*, *14* (4), 1–20. doi:10.1145/3458677

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Under review

Erdbrink, A., Kortmann, R., & Verbraeck, A.
Using promises as a game design element to improve the behavioral impact of games for sustainability.

Erdbrink, A., Kortmann, R., & Verbraeck, A.
The Human Firewall: a training game to enhance secure information handling.

Co-authored

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GAMPSISS project

The abbreviation GAMPSISS stands for GAmeful Music Performances for Smart, Inclusive and Sustainable Societies. This four-year project was funded by The Dutch Research Council (NWO) and was part of its Smart Culture program. In the GAMPSISS project, research on the impact of 'gameful music performances' was integrated with research about listening to classical music and (others in) society. The aim was to eventually provide the classical music sector with tools to establish contemporary societal relevance, resulting in engaging new and inclusive audiences. Four research institutions participated in the project: Codarts University for the Arts, Rotterdam; Erasmus University, Rotterdam; Delft University of Technology; and the Willem de Kooning Academy, Rotterdam.

In year 1, our research on listening and persuasive games aligned with the cultural and sociological perspective on concert audiences and concert experience. In year 2, based on the knowledge gained, we jointly built and evaluated a prototype of a game called *Listening Space*. This mobile game is played before a (classical) music concert to train listening skills through awareness and playful practice of different listening modes. In year 3, we designed and evaluated an interdisciplinary gamified performance called *Listening Mutant 2021*. The audience worked through a wide range of listening games and training. This time, the games were about listening to music and listening to others (social listening). The performance was played for a specially recruited diverse audience. It included orchestral music, theatrical scenes, audience participation, a quiz, a

debate, a newly designed mobile game, and an audio story, all integrated into a total experience with a festival atmosphere. Due to COVID-19, it was not produced (in a modified version) until year 4 and for a smaller audience than we originally envisioned. In year 4, we then finished analyzing, writing, and reflecting.

At the Willem de Kooning Academy, we set up a GAMPSISS course that all researchers taught. Students were asked to design listening games. Some of these served as inspiration for *Listening Mutant 2021*. Two substudies were also conducted under the accolade of GAMPSISS, namely a study on what happens when people listen to a piece of music repeatedly and a combination of empirical research and extensive desk research on listening from a predominantly philosophical perspective, resulting in the paper *A concise theory of listening*, that can be used in conservatories and music practices. Finally, the PhD candidate conducted several more studies on other persuasive games, as described in this dissertation.

Micha Hamel
Initiator, project leader and artistic researcher of the GAMPSISS project