The Naze - Exploration of Olfaction within immersive storytelling games

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0. ABSTRACT

This project explores how the integration of olfaction in digital games may help storytellers evoke emotions and improve immersion. We do so by creating an immersive storytelling gameplay experience by developing an olfactory display responsive to feedback provided by the virtual world of Minecraft, aiming to explore whether we can indeed use olfaction to evoke emotions and guide players through a story.

CCS CONCEPTS • Human-centered computing • Human Computer Interaction (HCI) • Interaction devices • Displays and imagers

Additional Keywords and Phrases: olfaction, olfactory display, immersion, storytelling, game development, video calibration, smell in video games, smell games, Minecraft, Minecraft modding, smell-interaction, interactive scent

1. INTRODUCTION

Human beings use five different senses to interpret the world around them. These senses are sight, hearing, touch, smell and taste. However, video games are primarily based around two senses: audio, visual. Recently there has been an increasing amount of interest in incorporating the sense of smell through use of olfactory displays. Yanagida(2012) describes olfactory displays as devices that generate scents with the intended component and concentration of odour material and provide it to the human olfactory organ. Many people have lost their sense of smell because of the recent covid-19 outbreak, which has further highlighted the importance of the sense of smell and our subconscious reliance on it.

Our research and discoveries are based on the existing theory around olfactory displays, smells, emotion and immersion touching on multiple fields from Neuroscience, Game Design to Interaction Design. How can olfaction aid storytelling in evoking emotions within videogames? Our research provides a method of

implementation of Olfaction within Minecraft to use as a tool in game development to induce further immersive outcomes.The prototypes were a means to explore the emotional experience players could potentially feel as they play a story based game with smells to trigger these emotions. If proven possible this opens up creative opportunities for both Interaction designers, game designers and also other fields in media & entertainment.

This is not a design proposal for an at-home game device. Instead, the project solely aims to explore the potential of utilizing the sensation of olfaction to create more dynamic and immersive storytelling in gaming.

2. RELATED WORK

2.1 Design cases

Taking inspiration from Jacob Hylén's Nosy Nazo (2020) olfactory build which used vaporizers and water based scents, we created our own for our testing purposes. Very similar to our tests, Hylén et al (2020) use their display in a puzzle based game to also explore an increased immersion.

Additionally, we drew inspiration from Tim Johansson-Hugg's (2014) thesis *A cautionary odour*. Johansson-Hugg's thesis examines the relationship between smells and digital games, with an emphasis on how smells may affect player behaviour and how they interact with and respond to a digital game with smells. Furthermore, Johansson-Hugg (2014) discussed how he went about incorporating smells into games and how user tests were conducted, along with how the findings of those tests affected his project.

Jesper van Laar et al's (2019) *Tangible and Embodied data: Using Minecraft as a tool to make virtual information tangible through a multimodal interface* proposes the idea of using the video game Minecraft as a platform for concept creation and integrating smell emitting hardware through hardware devices such as Arduino. Therefore, this project opened up our eyes to using Minecraft and its modification possibilities for our project.

2.2 Research

Newman J (2004) in his Video Games research paper argues that overall quality of outputs contribute to the sense of immersion and that it is often taken for granted that a bigger screen and a better quality of audio equals a greater sense of immersion, therefore our build consisted of: a noise cancelling headset, vision blockers to the surroundings (similar to how a VR headset works), the surroundings being us: the designers watching them. Furthermore, *Pine and Gillmore (1999),* describe that there are two different types of experiences that occur: "*participation and connection. The dimension of participation varies from active to passive participation and the dimension of connection varies from absorption to immersion*." This absorption factor is key to our definition of immersion, to lose the physical realm around you and to enter the virtual world. "*Absorption means direct attention to an experience that is brought to mind, whereas immersion means becoming physically or virtually a part of the experience itself.*"

To deepen our understanding of the methods to evoke emotions, we did some research on calibration. We explain calibration as a method that is originally inspired from Russian brainwashing tactics; where users are exposed to rapid imagery meant to inspire an emotion, in our case it is both imagery and a selected scent. The scent is then linked with the imagery essentially rewiring how users interpret the odour. Pacheco-Unguetti et al (2010) reveal results of calibration through "a case study was made where participants underwent an anxiety induction between the two odour detection runs." This research showed, "anxiety induction involved 12 anxiety-provoking images [...], depicting life-threatening emotional content (e.g., mutilation, disease, or violence). [...]" Before and after anxiety induction testes were asked about their emotional state and their vitals were monitored and resulted in an increase of stress.

Following the previous research, our goal was to use calibration and smell to evoke "fearful" emotions in players. "Emotions can usefully be defined as states elicited by stimuli that are rewards or punishers, that is which have value (Rolls, 2005). For example, the "fear" evoked by the smell of a predator is associated with actions to avoid the predator, changes in heart-rate, increased blood flow directed to skeletal muscles, adrenaline release, etc. that maximize the ability to expend energy to escape." [Kadohisa 2013]

"Although Ekman suggested that there is a set of basic emotions, fear, anger, enjoyment, sadness, disgust, and surprise (Ekman, 1992), a much larger range of emotions can be accounted for if we take into account the rewarding or punishing effects of many different types of reinforcer, such as the taste of food, pleasant touch or pain, and the sight of a beautiful person or scene. "Humans and non-human animals alike will perform actions to obtain a stimulus which is a reward, and will perform actions to avoid or escape from a punisher, and these reinforced actions are fundamental to survival and reproductive success (Rolls, 2005)." [Kadohisa 2013]

Which coincidentally is very similar to simple Game Design principles of punishment and reward.

We drew inspiration on our choice of choosing odours from a study that was conducted by Elizabeth A. Krusemark (2013), *when the Sense of Smell Meets Emotion*, the negative odorants such as: trimethylamine and valeric acid were used to create a sense of heightened stress responses and anxiety. Trimethylamine is a chemical found in rotting fish, urine, trash and if combined with a chemical smell can induce feelings of stress and even disgust. All of these odours are negative however, and when looking into smells that can inspire a sense of safety olfaction researchers from Fragrance Science (2021) have found that the feeling of "safety" in "clean" smells such as cotton, citrus, ocean spray.

3. METHODOLOGY
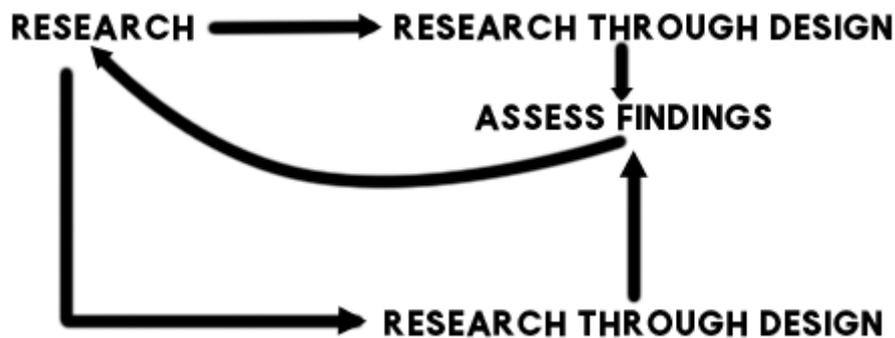
Inspired by the Double Diamond, our work strategy involved a back and forth between research and assessing user test findings. From those findings more questions would arise leading to more research in preparation for another design. Our goal was to create 3 prototypes, the 3rd being the result of both prototypes and research that came before it. However, the creation of our 2nd prototype was more time consuming than expected and unexpected problems surfaced while building our olfactory display, leading the project to end at the 2nd prototype.

4. DESIGN PROCESS

To understand how video games can inspire emotions, notably fear, we familiarised ourselves with games such as *Layers of Fear* by Bloober team that presents a gripping first person thriller/horror storyline and *Until Dawn* by Supermassive Games which offers the players to calibrate their own player experience by choosing what they are afraid of. Furthermore *Minecraft* is a strong creative tool and Arduino has worked with MCreator Link to allow for easier connections to hardware devices. Therefore we were able to digitally control the olfactory output by using player input within a custom game of our own creation.

Our first prototype used olfaction for directional cues (see figure 2) with the calibration videos, just to observe how the calibration influenced their actions within the small dark maze the users were thrown into. The first maze was built in minecraft providing us with the opportunity of creating a quick 3D game environment to test with. The fragrances were selected based on their drastically different scent notes, so the tester could differentiate them. We believed that a combination of in-game events and player experience could potentially create the emotion of fear. The player was told they needed to find a key (curiosity smell) and the end of the maze (good smell) to escape, should they choose the wrong direction (the bad smell) they were met with consequences such as in-game death.

After the success of the first prototype we moved forward towards more complex emotions and built-in smell systems. Creating new "scent" blocks, thanks to MCScript & MCreator within minecraft that automized the smell distribution instantaneously as the player navigated the space. Rooms were designed to create a specific emotion through first person audio storytelling.

4.1 Prototype 1

A maze was ideal for our first question which was influenced by Takahashi, Y(2013)'s study on rats, to see if the users could be guided with the smell, replacing the visual cues. The maze was built in Minecraft with black blocks and was in a dark environment to disorient the user, eliminating all visual aids. Throughout the maze, players experience three different smells with usage of calibration videos creating good, bad and curiosity cues (see Appendix 1,2 &3). The player then would have to navigate and find a key to escape the maze while avoiding the negative smell. Bad smells would lead to death situations such as monsters, lava and pits. Wearing a sound cancelling headset playing a horror ambient soundscape (see Appendix 4) and vision blockers.
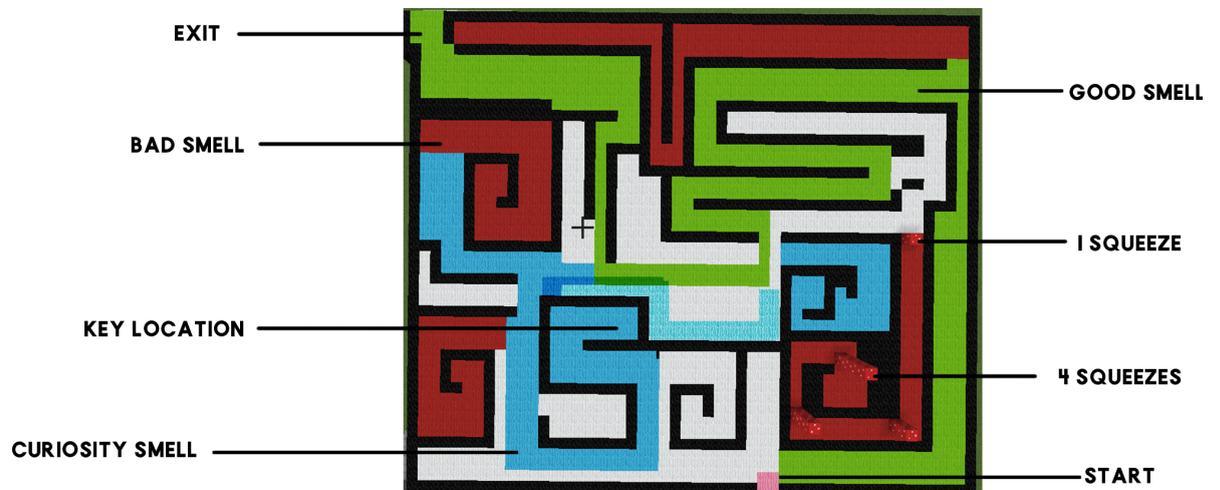
(Figure1: Minecraft initial map indicates where to distribute smell)

(figure 2: playtesting the maze and smell)

Two members of our team were tasked with keeping track of the players wearabouts and the other three output the smells manually through squeezing the coffee cups. (see Appendix 5)Those tracking the player would tell the scent distributors when to give them a certain smell and how intense (amount of squeezes).

4.1.1 User tests and findings

The first prototype did not succeed in evoking fear during the game the way we expected. Smell alone could not evoke fear due to the lack of other stimuli that fear requires such as visuals and sound. We could not provoke the emotion of fear and express it through smell to inspire the user to be cautious and scared while escaping the maze. Thereby, we shifted our interest into evoking other emotions. On the other hand, users reported that

adding smell into the gameplay was helpful in which direction they should choose within the maze to find the key and escape the maze. Demonstrating to us that directional smells paired with calibration was a success.

Table 1: present the findings from the user testing

User Categories	Definition	Findings
Gamers	users who have a gaming/Minecraft experience	Gamers were fast at unlocking the aspect of the maze. They found that the smell was useful in guiding them through and letting them know they were on the right track. users didn't know the indication of each smell but as soon as they started the game they made the association to the meaning. the users did not feel immersed.
Non-Gamers	users with no gaming/Minecraft experience	Users were overwhelmed by the game mechanics and basics of navigating. They found the smells enhanced the experience and understood the directional cues even if they had difficulties playing the game.
With calibration videos	Users are exposed to 3 calibration videos that evoke positive, negative and curious emotions.	Users' thoughts on the videos were good but they reported that the curiosity video did not inspire any emotions.
Without calibration videos	The player is thrown into the maze and tries to make connections between ingame experiences and the smell offered to them.	Users made the association to the smell and directions through experience in the game. Some reported that the smell was overwhelming and they liked the bad smell more than the good one. They also reported that the smell was helpful in guiding them but didn't make the game more immersive.

4.2 Prototype 2

Referring to our findings from the first user test, and how users did not feel fear, we changed our scope to focus on other emotions that we could inspire through smell such as anxiety, disgust and happiness (Elizabeth A. Krusemark, 2013). Again, with calibrative videos to subconsciously plant the seed of anxiety and disgust(see Appendix 6 & 7). Furthermore, we found that delivering the correct smell on time manually would lead to human error, at times distributing the fragrance too soon or too late. Running over potential solutions we encountered MCreator which led us to creating smell blocks (see figure 6). This build included directional smell to navigate players towards story elements, using the "positive" odour. Placed within specific areas, tied to the storyline, were scattered smell cues of disgust and anxiety where we desired the users to feel as such. The story element would use smell to support it's emotional impact, for example: The player through a first person character discovers they murdered a person, the room is filled with our Disgust concoction and the player is asked how they felt upon this discovery.

In order for players to feel more immersed, we created a "peer-in" box that limits players' view and to provide us with better coverage to hide the smell delivery system. Moreover, the olfactory delivery system is made from multiple humidifiers that were hooked up to the Arduino board which was coded with MCreator in Minecraft. We also created blends of extremely strong water based smells. (see Appendix 9 of Prototype 2 in action.)
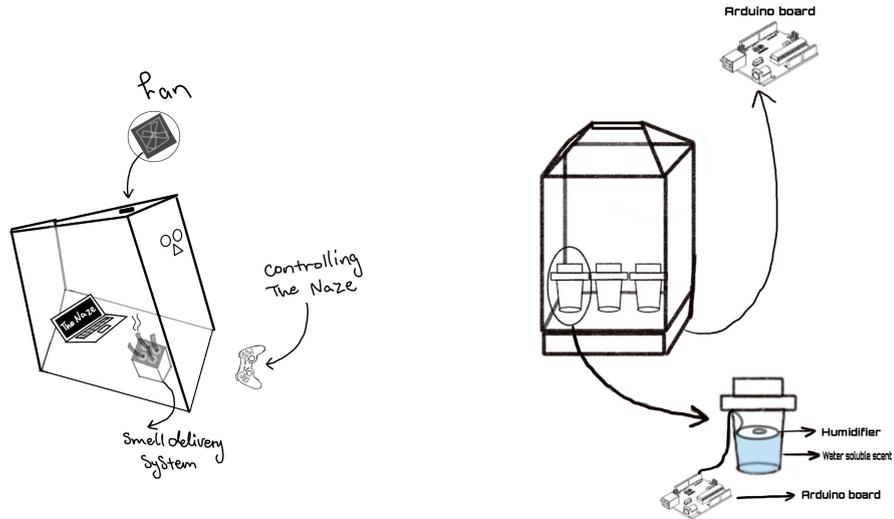
(Figure 3: sketch showing the "box" that is designed to limit users' vision)   (Figure 4:sketch showing the olfactory delivery system)

       The story used within our prototype was written keeping horror game tropes in mind and through voice acting. "*The game's sense of horror emerges from the avatar's construction as a psychologically motivated protagonist in a desperate situation within a recognisable -if supernaturally transformed- location, and the story she gradually uncovers.*" Kirkland(2009) Taking place in a hospital setting the player is thrown into an unknown situation, and much like the character do not know how or why they are there. Players discover through textual and audio means the truth behind the virus they have contracted. (See audio recordings appendix 8)
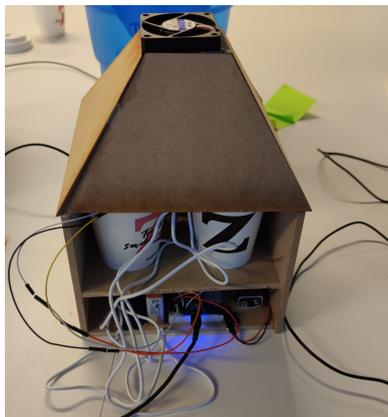
  (figure 5: olfactory delivery system)   (Figure 6 : showing Minecraft player triggering the olfactory delivery)
system)
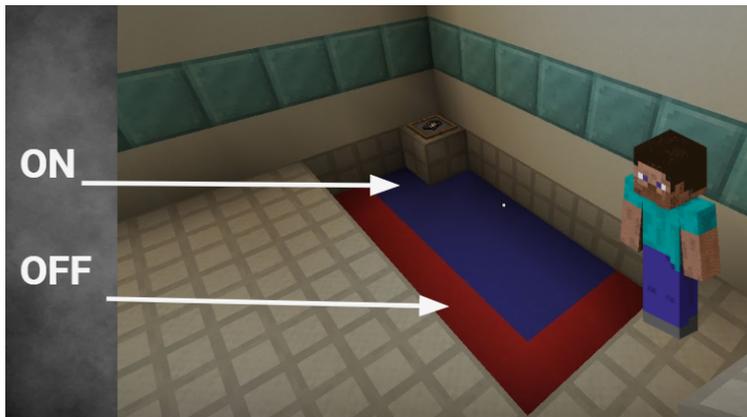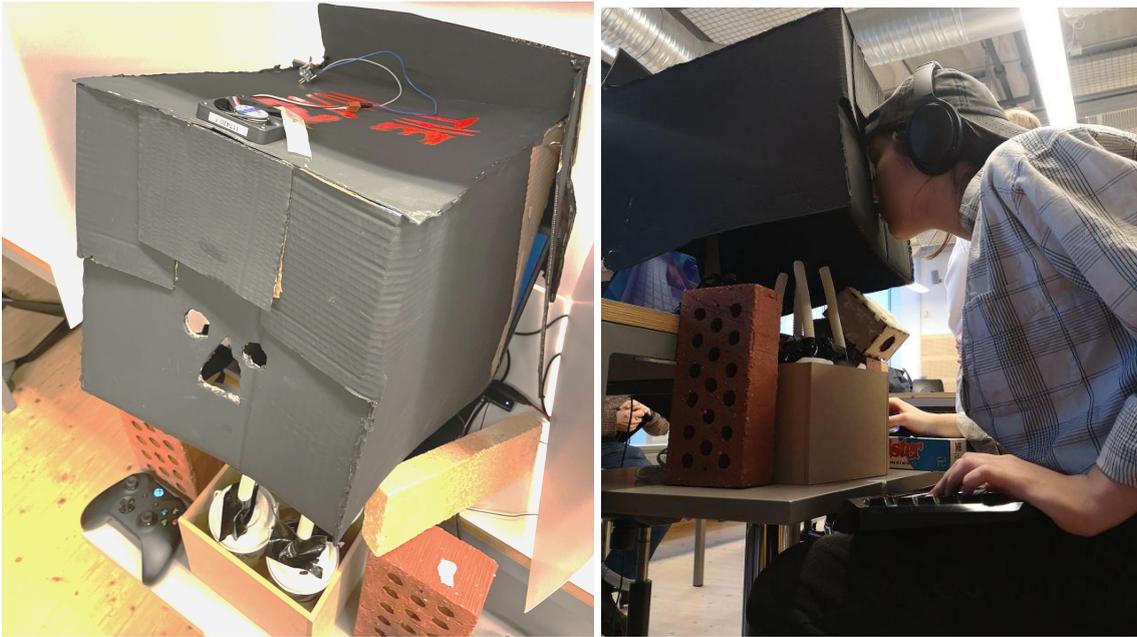
(figure 6: final prototype "the Naze")

4.2.1 User tests and findings

Table 2: Findings from the second user testing

User Categories	Definition	Findings
Gamer + calibration videos	users who have a gaming experience in Minecraft or otherwise	· The user was not using smell to navigate. We concluded that might be because she didn't pay much attention to it or the scents were not strong enough. Another reason might be that the user could not tell the difference between smells. · User suggested that the fan work in sync with the humidifiers and not through the whole game to to follow basic design haptics so the user knows when a new smell is released.

Non-gamer + The calibration videos + experienced smeller	users with no gaming experience or background in Minecraft or otherwise	- The user was intrigued and into the story. The user was paying attention to the smells. - The user could detect the different smells based on the calibration videos and understood the impact of the smell on the story and gameplay. - He didn't seem to have a lot of emotional connection to the game, it didn't seem to inspire/enhance emotions that well. However, we also need to take into account that while playing, we didn't have him play it through the box, with noise cancelling headphones and was being guided by us through the gameplay. Which means that he wasn't fully immersed in the game which altered the experience in provoking any emotions. - An intense voice acted bit of the story made the testers facial expression change to look quite focused/tense and made him say "scary", not a conclusive finding to whether he was actually scared, but he might've felt a bit of a scary environment.

5. DISCUSSION

The Naze introduces olfaction to the world of immersive storytelling games. This project aimed to investigate whether olfaction could be a useful tool for storytellers, working as a tool to lead users through a story and to increase the emotions a storyteller can evoke through their storytelling.

By aiming to make the experience as immersive as possible, we wanted to create an environment in which the storytelling, olfaction, visuals, and audio would all simultaneously contribute to evoking emotions. We define immersion as a loss of the physical space and unawareness of what is happening around you. Therefore, the peer-in box aimed to make the player feel as they're within the game, and the story. With the hope that the story would evoke emotions, and that the use of olfaction would in turn enhance those evoked emotions. Our findings indicate that olfaction wasn't as successful in evoking emotions as we would've hoped. However, we recognize that these results may have been different depending on how compelling the story was and if the experience was more immersive. Additionally, we are aware that Minecraft isn't the most visually appealing game and is quite limited in its decorative abilities without heavy modification. Therefore, the surroundings of the game might've not assisted the storytelling in highlighting the severity of the situation in the story, i.e., it might not have been "scary" enough for the user to feel frightened.

Therefore, we consider our findings regarding emotions evoked by olfaction to be inconclusive, and we acknowledge that there needs to be more research conducted regarding if storytelling video games and olfaction can cooperatively evoke emotions meaningfully.

During our design process, the notion of directionality and guiding users through the gameplay with smells was explored through both our prototypes. Both prototypes feature little to no visual cues that would force the users to pay attention to their olfactory senses if they wished to progress further in the story and ultimately finish the game. From our user tests we learned that using olfaction as a tool for guiding users through a game or story worked successfully, thereby it can be a useful tool for storytellers.

There is also an ethical question to be considered; We used video calibration to make people associate different smells with different emotions. There might be questions regarding if this association will evoke the same emotion when it is presented outside of the game, and if Decalibration videos are necessary to the design to deprogram players before they end the game.

Our method of scent delivery had several issues with the humidifiers used:

Firstly, our intended smells backed by research to help enhance certain emotional states were oil-based fragrances. Unfortunately, after a while of usage, the oil-based fragrances caused our humidifiers to clog, and stop emitting vaporised water. Since this occurred relatively late in the design process, we were forced to create our water-soluble fragrances by mixing what we had available. As a result, we didn't have enough time to gather the resources needed to make water-soluble fragrances that would match the ideal fragrances we had discovered through research. Thus, this could have affected how successful our prototype was at triggering emotions.

Secondly, the humidifiers tended to overfill with water, causing them to stop working until they were emptied. There was either an overfilling of the cups with water or vaporised water condensing inside of the tubes, thereby causing liquid water to form in the tubes and go down to the humidifier, preventing it from functioning properly.

Smell contamination is a crucial aspect of olfactory displays, and in our case, we tried to manage this by adding a fan on top of the box that would remove the scent-filled air. Although this solution worked in part, it wasn't enough to ensure the box remained odour-free. Consequently, this can confuse the players, as they may believe that a scent is being emitted when in fact, there is none. Thereby, players may be misled during gameplay. Due to the presence of so many strong scents, it may also result in an overwhelming smell experience. This was something several of our testers reported.

6. CONCLUSION

Throughout our research, we found that humans, like rats, can be retrained to interpret smells and use those interpretations as a subconscious guide throughout their gameplay. We also found that for Olfaction to be used within a story game context, the story must revolve around the smells themselves, or at least be introduced to the player as a game mechanic in order for the users to properly use their noses. Our findings on if emotions could be provoked on demand or not, were inconclusive due to our limitations in acquiring the odours from our research. As of now, Olfaction can be used as a creative tool in creating directional cues for players, however further testing would be required to determine if olfaction can be used to force a certain emotion on cue.

References

1. De Groot, J. H., Semin, G. R., & Smeets, M. A. (2014). I can see, hear, and smell your fear: comparing olfactory and audiovisual media in fear communication. Journal of Experimental Psychology: General, 143(2), 825.
2. Takahashi, Y., Kiyokawa, Y., Kodama, Y., Arata, S., Takeuchi, Y., & Mori, Y. (2013). Olfactory signals mediate social buffering of conditioned fear responses in male rats. Behavioural brain research, 240, 46-51.
3. Ehrlichman, H., & Bastone, L. (1992). Olfaction and emotion. In Science of olfaction (pp. 410-438). Springer, New York, NY.
4. Wu, Y., Chen, K., Ye, Y., Zhang, T., & Zhou, W. (2020). Humans navigate with stereo olfaction. Proceedings of the National Academy of Sciences, 117(27), 16065-16071.
5. Rosen, J. B., Asok, A., & Chakraborty, T. (2015). The smell of fear: innate threat of 2, 5-dihydro-2, 4, 5-trimethylthiazoline, a single molecule component of a predator odour. Frontiers in neuroscience, 9, 292.
6. Pine, B. J., Pine, J., & Gilmore, J. H. (1999). *The experience economy: work is theatre & every business a stage*. Harvard Business Press.
7. Niedenthal, S., Lundén, P., Ehrndal, M., & Olofsson, J. K. (2019, May). A handheld olfactory display for smell-enabled VR games. In 2019 IEEE International Symposium on Olfaction and Electronic Nose (ISOEN) (pp. 1-4). IEEE.
8. Yanagida, Y. (2012, October). A survey of olfactory displays: Making and delivering scents. In *SENSORS, 2012 IEEE* (pp. 1-4). IEEE.
9. Fragrance Science(n.d.). Fragrances that smell like "safe" [Web log post]. Retrieved from https://www.fragrancescience.com/fragrances-that-smell-like-safe/
10. Siebeneicher, H.S. (n.d.). *Nosy Nazo Introducing smell as a new dimension.* Siebeneicher Design. https://www.siebeneicher.design/work/project-1
11. van Laar, J., Sanders, R., Thapphasut, T., & Wibom, M. Tangible and Embodied data: using Minecraft as a tool to make virtual information tangible through a multimodal interface. https://www.jespervanlaar.nl/wp-content/uploads/TEI_Paper.pdf
12. Kirkland, E. (2004). Survival Horrality: Analysis of a Video Game Genre . *Computer*, *44*(3), 118-130. https://irishgothichorror.files.wordpress.com/2018/03/ewanc2a0kirkland.pdf

Appendix

1. Good smell calibration video: https://drive.google.com/file/d/1adJy7_g6KeiDSGlbdfXPZFHvTTWRG26z/view?usp=sharing
2. Curiosity smell calibration video: https://streamable.com/vzvetx
3. Negative smell calibration video: https://streamable.com/59qgk6
4. Creepy background noise: https://www.youtube.com/watch?v=lnJNkjORboc
5. Cup scent delivery: https://streamable.com/89jfr3Positive smell calibration video: https://streamable.com/3uzx6v
6. Anxiety smell calibration video: https://drive.google.com/file/d/1bPfvjqmAu8YFZbJt1jxViDXMXn2QgusP/view?usp=sharing
7. Disgust smell calibration video: https://drive.google.com/file/d/1cLb1ei0tLovAhVugpYj_dHA96Xla5LZQ/view?usp=sharing
8. Cassette tape recordings: https://drive.google.com/drive/folders/1_n1KRXs8BWR51AdCFtjeyQrkCKTI2Y1q?usp=sharing
9. 2nd Prototype working: https://drive.google.com/file/d/1dvW87e8ywSbstUCS5L4ABkhjuFWZQTLc/view?usp=sharing