

ASSESSING THE EFFECTS OF OLFACTION ON THE SENSE OF EMBODIMENT IN VIRTUAL REALITY

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The Sense of Embodiment and Olfaction

Virtual Reality Research has largely focused on the visual and auditory aspects of both experiences and of the technology used to distribute them. What has largely been ignored, however, is the relationship between VR technology and the other senses. While there have been experiences that explore olfaction and touch in VR, a wholly ignored section regards olfaction and the Sense of Embodiment in VR [1]. The olfactory system plays a significant role in our daily lives, contributing to our ability to detect and discriminate a wide range of scents. Smell can evoke strong emotional responses, trigger memories, and shape our perceptions of the world around us [3].

Sense of Embodiment is split into three main components; the Senses of Agency, Body-Ownership, and Self-Location [2]. Agency regards the ability of the user to believe that they are "present in active movements" [2]. This means that they are able to control the limbs they percieve in such a way that is believable, smooth, and controllable. Disruption of Agency occurs when a user wishes to move, and believes they are, but the actions they see do not match that. Body-Ownership regards the user's belief that the body they see around them is their own. This means that the body they see is the source of the sensations they are feeling. Self-Location refers to "one's spatial experience of being inside a body and it does not refer to the spatial experience of being inside a world" [2]. This refers soley to the body that the user percieves as their own: is it their's or someone else's when they look down.

SoE largely relies on visual perception, but there is a strong link between olfaction and vision [3] As such, the researchers set out to see if SoE could be hindered and improved when mismatching and matching olfactory sensations to the VR experience.

Waddle: A Penguin's Tale

The study was conducted using an Oculus Quest 2 with Waddle: A Penguins Tale(<https://github.com/fielddaylab/penguinsVR>). The experience prompted a user to use their hands/flippers, waddle like a penguin, and pick up things with their head/beak. The experience had two climatic points; a 'mating' experience in which the player 'danced' with another penguin. The other had the user fight off Skua birds using the controls aquired throughout the game. The experience takes 10 minutes to complete.



Research Objectives

Following are our research objectives for this work:

- O1:** To examine whether adding a scent not associated with the present experience resulted in a lower experience of Embodiment for the participant.
- O2:** To examine whether adding a scent associated with the present experience resulted in a higher experience of Embodiment for the participant.

Experiment Setup

Participants in the study were split into three groups, Group A (Negative Smell) being exposed to a smell opposite the experience. Peppermint was introduced to this group as they worked through the experience. Group B (Positive Smell) was exposed to a smell that would match the experience. The smell of mackerel will be introduced to the user when following the experience. Group C (Neutral Smell) was not introduced to any smell during the experience.

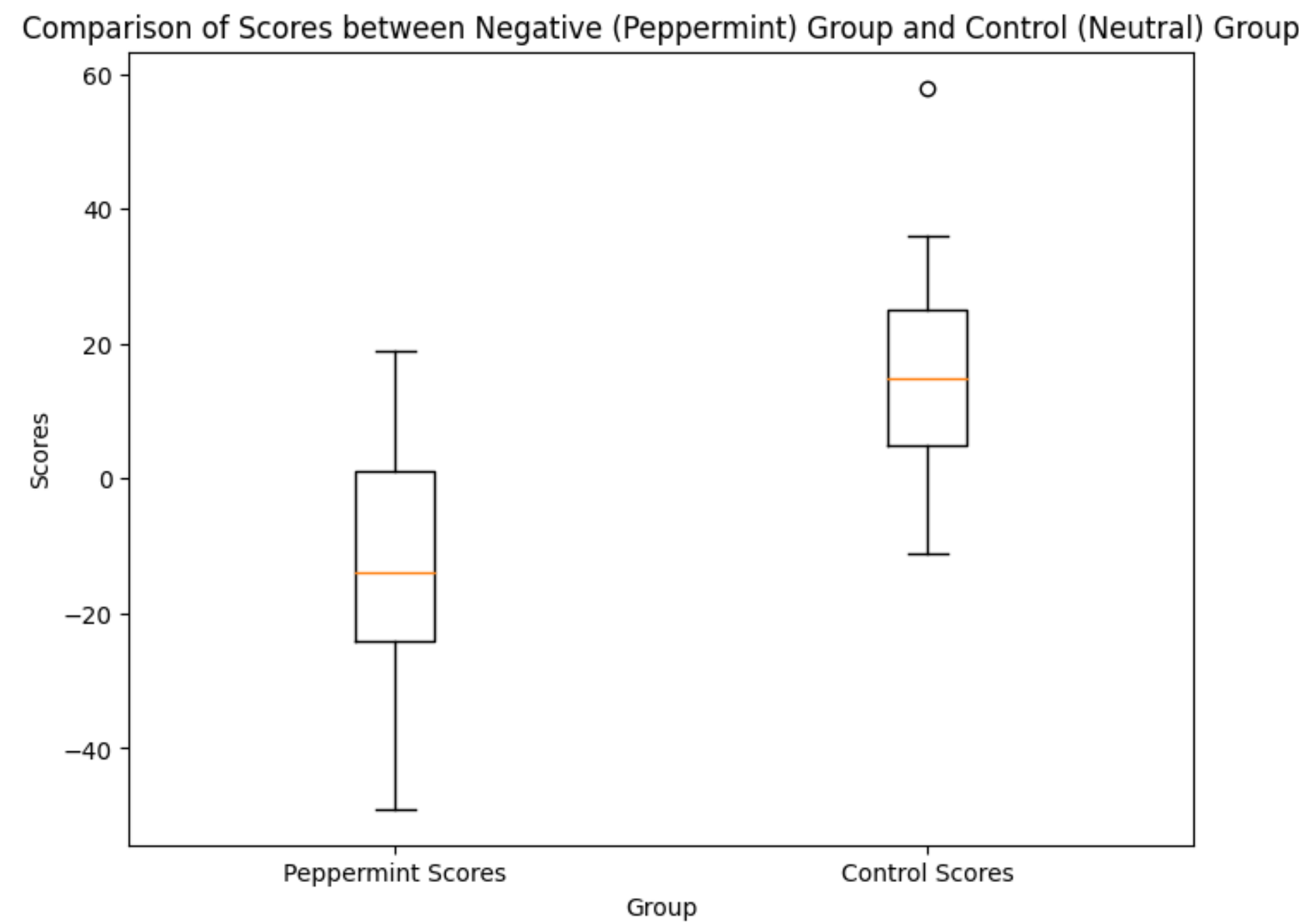
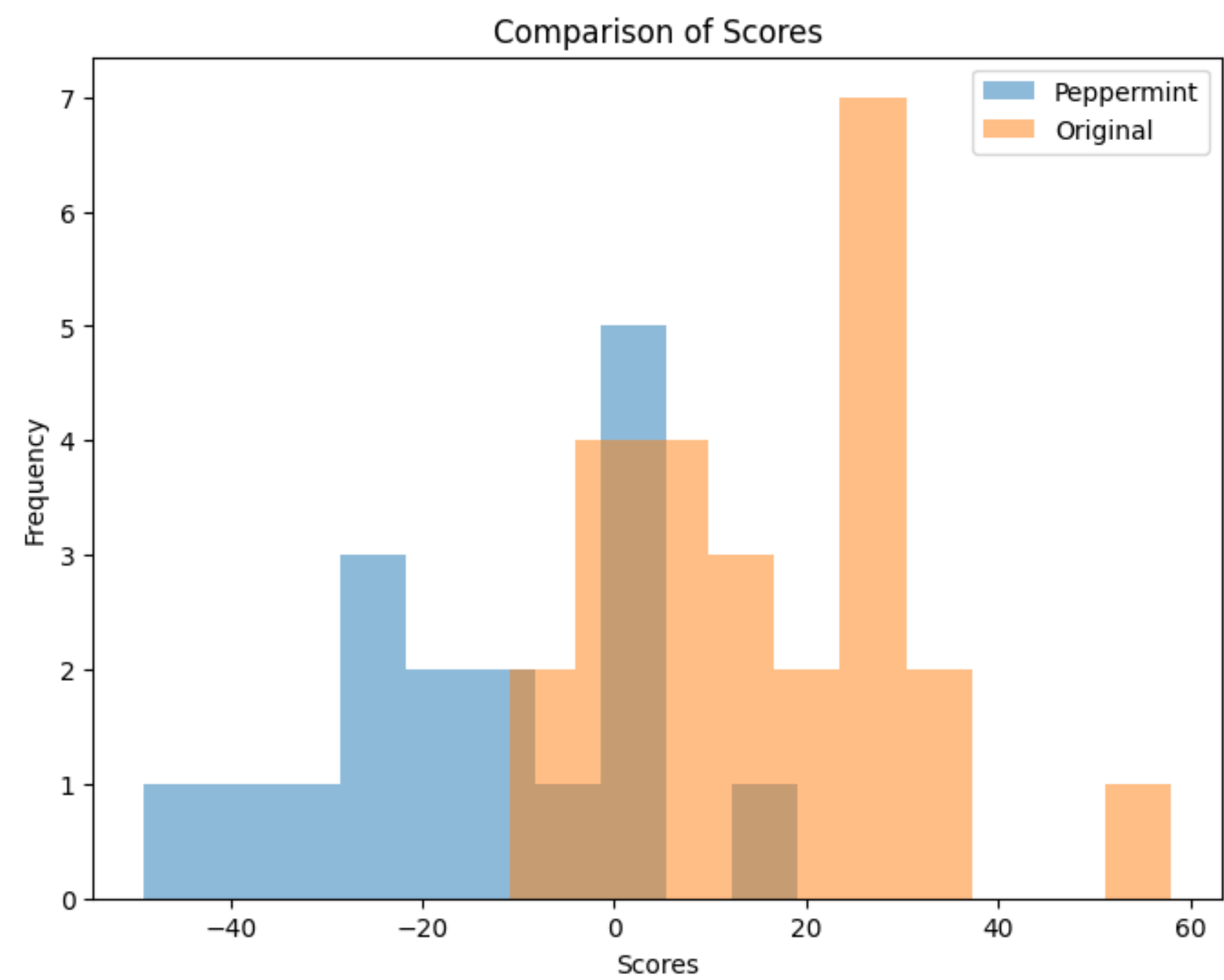
The experience took around 25 minutes total, from first explaining how to use the VR head-set, to going through the experience, to completing the 24 question survey. After going through the experience, the participants were given a survey to test the three aspects of Embodiment.

- I felt as if the virtual wing/flipper I saw when I looked down was my arm.
- It felt as if the virtual penguins I saw in the game were someone else.
- It seemed as if I might have more than one set of hands.
- I felt as if the virtual penguin body I saw when looking in the mirror was my own body.
- I felt as if the virtual penguin body I saw when looking at myself in the mirror was another being (i.e. not me).
- It felt like I could control the virtual wings/flippers as if they were my own.
- The movements of the virtual wing/flipper were caused by my movements.
- I felt as if the movements of the virtual wing/flipper were influencing my own movements.
- I felt as if the virtual wing/flipper was moving by itself.
- When collecting rocks, it seemed as if I felt the touch of the rock in the location where I saw my virtual beak touched the rock.
- It seemed as if the touch I felt was located somewhere between my face and the virtual beak of the penguin.
- It seemed as if the touch I felt was caused by the rock touching the virtual penguin beak.
- It seemed as if my face was touching the pebble.
- I felt as if my feet were located where I saw the virtual penguin feet.
- It felt as if my real body were turned into the penguin.
- At some point, it felt as if my real body was starting to take on the posture of the virtual penguin body.
- When playing the game, I felt like I left my real body behind.
- At some point, it felt that the virtual penguin face resembled my own face, in terms of shape, skin tone or other visual features.
- I felt that my own body could be affected by the skua birds that were trying to steal the egg.
- I felt a nervous sensation in my body when I saw skua bird come towards me.
- When skua bird tried to attack my nest, I felt the instinct to protect my nest and egg.
- I felt as if my hand had hit the skua bird.
- I had the feeling that my egg might be harmed by the skua bird.
- I was fully able to engage in the game; I was not distracted by things outside the game.

The survey questions were answered on a Likert scale, from Strongly Disagree to Strongly Agree, with 7 possible responses total. Each score was converted into a numerical value from -3 to 3, and then each participant was given a Sense of Embodiment Score, with the higher scores indicating higher levels of embodiment. The scores were then normalized to perform more tests on them.

Comparison

After normalizing the scores, it was found that there was significant difference between the normalized scores for the Negative Smell (Peppermint) Group and the Control (Neutral) Group. T-statistic: 5.529474350358833 P-Value: 4.794476876422719e-6 We therefore reject the null hypothesis for these groups.



Remarks and Future Work

Currently we are recruiting for the Positive Smell Group. Based on the findings of the negative smell group, we expect a high SoE to be observed here. We are aiming for 20 participants in this group, with the same survey and analysis done.

References

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