Soma design to enhance aircraft passenger comfort

Mahnaz Sharafkhani[1], Paul Tennent[2], Elizabeth Argyle[3] & Sue Cobb[3]

[1]Instutitute for Aerospace Technology, Human Factors Research Group, University of Nottingham, Nottingham, United Kingdom, [2]Mixed Reality Lab, University of Nottingham, Nottingham, United Kingdom, [3]Human Factors Research Group, University of Nottingham, Nottingham, United Kingdom.

ABSTRACT

Aircraft passengers can become uncomfortable while seated because of the restricted physical space. This work aims to investigate a new strategy for designing interventions that can be used to encourage aircraft passengers to move more while seated and thus to improve their perceived level of comfort. We discuss the utility of applying the 'soma design' methodology to creating these interventions, which aim to target specific body discomfort areas identified in a previous study. In this paper, we report on a series of design activities to address this challenge.

KEYWORDS

Comfort, interventions, soma design methodology

Introduction

Aircraft passenger physical movements are very limited during the flight, and this can have serious impact on their experience of comfort (Vink & Brauer, 2011). In-seat movements can lead to better comfort experiences and reduced discomfort experiences (Bouwens et al., 2018). In our previous study, we asked participants to sit in a simulated aircraft cabin for three hours and periodically report their comfort score. Their posture and movements were also video recorded. The main body areas associated with discomfort were identified as: the back of the neck, shoulders, buttocks and the lower back. In addition, participants were observed to maintain postures with their neck down and trunk backward for most of the study duration (Sharafkhani et al., 2021). In this paper, we explore the applicability of the 'soma design' methodology to aircraft passenger comfort research. The prior work provides us with a framing of our design space – the combination of the *restrictions of the seat* and the specific *bodily area of interest*. Now we examine what we might do in that design space. We report on a series of activities, which were conducted in order to explore the utility of the soma design methodology to design and evaluate interventions to be used for improving passenger awareness of posture-induced discomfort.

Soma Design

Soma design originates from the philosophy of somaesthetics based on the work of Professor Richard Shusterman (2008). Somaesthetics is the combination of Soma (body, mind, and emotion as one subjectivity) and aesthetics (the deepening of our sensory appreciation skills). Soma design is a holistic design method which encourages users to engage in a smooth and embodied interaction between their own actions and system responses (Höök et al., 2018). In other words, the aim of Somaesthetic Design is to "*design interactions that harmonize - aesthetically and somatically*" (Höök et al., 2018). Höök characterises soma design is a *"qualitative shift from a predominantly symbolic, language-oriented stance to an experiential, felt, aesthetic stance permeating the whole design and use cycle"*(Höök, 2018). This approach allows us to examine and improve on

connections between sensation, feeling, emotion, and subjective understanding and values (Khut, 2016). In practical terms, soma design is a methodology that can be used for designing experiences and products in a reflective, first person manner, with established tools for both enhancing participants' understanding of a design space, and articulating their experiences with those designs.

Ideation workshop

We conducted a workshop, implementing soma design techniques to direct participants to focus on upper body posture and ideate a range of potential movements and game interventions that could be used to reduce postural discomfort. Sixteen participants were recruited for three ideation workshops. Sampling was a combination of ten males and six females and with a mix of design and non-design backgrounds. At the beginning of each workshop, the researcher explained the purpose of the workshop and summarised the findings from the previous study (Sharafkhani et al., 2019) including the discomfort areas identified and the main restrictions while sitting in an aircraft seat (e.g. the limited physical space). The researcher also demonstrated this restriction visually making sure that the participants were fully aware of the constraints and discomfort areas. A body scan process (Varela et al., 2000) and the body maps instrument (Loke et al., 2014) were introduced briefly. The participants then read and completed the informed consent forms.

Mindfulness awareness

The first workshop activity helped participants to develop a mindful awareness of their body sensations. The purpose of this activity is to direct the focus of participants into their own bodies as part of the soma technique and thus understand whether people feel more comfortable when they are aware of their bodies and focus on their bodies. Feldenkrais is a typical bodily activity which is used in soma design (Höök et al., 2018). The Feldenkrais method is a body-oriented experience, based on the body-mechanics research of Moshé Feldenkrais (Moshe Feldenkrais, 1982) and shares some characteristics with yoga. This technique helps people to reconnect with their bodies and is often used as a sensitising activity in soma design workshops. The researchers explored, through discussion with the Feldenkrais facilitator, how to move effectively within the constraints of an aircraft seat. The focus was on movements of the neck, shoulders and sitting bones. Similar techniques have been applied in other soma design workshops (Søndergaard et al., 2021).

Idea Development

In the next activity, the researcher rearranged the seats in rows in a similar arrangement to a passenger aircraft layout to represent the physical constraints of the aircraft. The physical restriction of the space for participants aimed to help them embody their design thinking in an equivalent space. Participants were asked to perform typical in-flight posture movements such as neck rolls, shoulder rolls, forward flexes, etc. and to think about their feelings of discomfort in the specific body areas identified in our prior study, including: the back, neck, shoulders, lower back and buttocks. They were asked to think about the possible movements that they could make and the effect of the space on those movements. This included attempting to find the available range of movements, and to consider the effect these movements might have on other connected parts of their bodies. The researcher gave prompts and examples to help the participants to focus on how they could move within the space. For instance; what is the movement space? How far can we move in the aircraft seat? What kinds of movements? How do you like the movements? Do they encourage you to do more? Participants worked in breakout groups to ideate a range of games and playful interventions to encourage physical movements within the confines of the seat. During this section, the researcher observed, recorded and took notes of each group's discussion. Then, to

further seed ideas, the participants used challenge and opportunity cards from the Mixed Reality Game ideation cards (Wetzel et al., 2017). These cards are used in design exercises to support ideation, to encourage new possibilities, and to add artificial restrictions which can further drive creativity (Benford et al., 2005). Use of these cards can be seen in Figure 1a. During these ideation sessions, 50 game design ideas were generated - from whack-a-mole, to a racing game, to a dance competition. Figure 1b shows an example of one of the groups' notes.

Figure 1a: Mixed Reality Game cards.

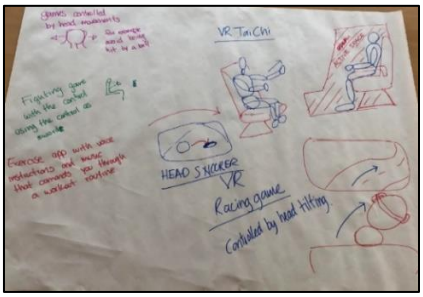

Figure 1b: Group notes from brainstorming game ideas.

Selecting an appropriate game design

Our next step was to select an appropriate example from the game ideas to take forward to prototype. We developed some criteria to help us make this selection then used these as heuristics to narrow the list of options. For example, the game should be practical for the location; the movements of the game should target the known body discomfort areas and should help to distract the passenger from the physical constraint; and it should be deliverable with relatively cheap consumer hardware. *Robot Rescue*, a puzzle computer game loosely based on Avalon Hill's *Robo Rally*[1] and controlled by gesture movements was selected and prototyped. This was then taken forward into a study to evaluate the applicability of this intervention. We created a version of the game that could be used in a virtual environment, with a view to assessing whether the embodied nature of the virtual environment would serve to focus the user on their body and help them ignore their physical environment. This also served the additional purpose of delivering a consistent visual environment as we were unable to test in the "wild' setting of a real aeroplane, or even in laboratory with real plane seats due to COVID-19 national lockdowns – instead participants would be at home.

Robot rescue game

The Robot Rescue game is an exertion game in which a series of arm-movement gestures are used to pre-program the directional movement of a robot character through a 3D virtual environment. This puzzle-based game mechanic appears in a number of existing game designs such as Robo Rally (ibid) and Space Alert[2]. Using a 'pre-programing' approach allows the movements to be slow and explicitly made, rather than performed under time pressure. The participants then viewed the character automatically moving around the environment according to the directional instructions given. This activity was presented to the players in VR. We imagine this game being played on a plane – however, rather than use a model of a plane as the background, we selected a quite serene environment, though the plane seat is still featured to help ground the player in their immediate (imagined in this case) environment. Figure 2 shows the game in play.

[1] https://avalonhill.wizards.com/games/robo-rally
[2] https://czechgames.com/en/space-alert/

Figure 2: The Robot Rescue game, looking forward, up and down and a participant playing it in VR

Study

Next, we then ran individual studies with six participants playing Robot Rescue, held online over three hours and followed this with a focus group meeting for all six participants. Participants first completed a 'sensitising' Feldenkrais exercise, as with the previous workshop, which was included to help them focus on their bodies. Figure 2 shows a participant playing the game. During the study participants were asked to complete body maps (Loke et al., 2014) and soma trajectories (Tennent et al., 2021) as non-verbal, reflective ways of articulating their felt experience. This formed part of a qualitative, soma-focussed exploration of their experience of the game. Soma design methods were used for our evaluation because of their holistic, non-dualistic focus on sense, sensation and sense-making and the richness of the descriptions provided by the participants using these methods.

The body maps and soma trajectories were used to document the body in a relatively unconstrained way before and after the activity and as articulation tools to support reflection and discussion in these sessions through a range of dimensions including – critically - discomfort. These techniques encourage creativity in articulating 'felt' experiences - albeit informed here by the focus of the study on discomfort, The soma design methodology suggests that language does not tell a true story about design (Höök, 2018). Therefore, participants were allowed to use any kind of words, shapes, figures and paintings. An example of a body map and set of soma trajectories from our study can be viewed in Figure 3a and Figure 3b respectively.

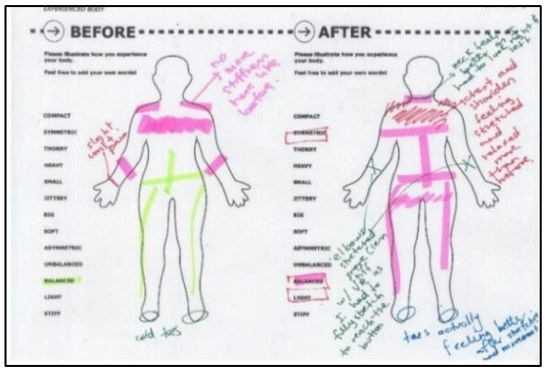

Figure 3a: An example of body map.

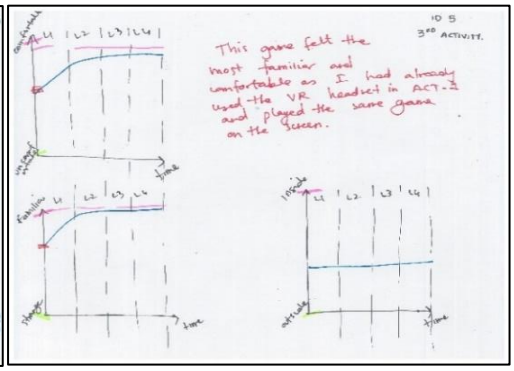

Figure 3b. An example of a set of soma trajectories.

Focus Group Meeting

As one of the key activities of the soma design methodology is to encourage discussion and articulation of the user experience, especially drawing on the immediate reflections described by the body maps and trajectories, all six participants were invited to a focus group meeting to discuss their experience of the study. Soma design focusses on the plurality of experience – how felt

experiences may be very different for individuals - and makes a virtue of this by using it as an explicit focus for discussion. The participants talked about their shared experience and the differences between them and translated their non-verbal articulations into discussions about their feelings. They started to talk about their general opinions about the game and then they explained their body maps and soma trajectories – reflecting on them and adding layers of meaning.

For example, one participant mentioned that she had a bit of stiffness in her neck, but after completing the activity, the stiffness went away and she felt more like light and bouncy, stating: *"I don't know if it's because of the increased range of motion of that activity"*. In general, she mentioned she felt more balanced with heightened awareness of her upper body and sitting bones. Another participant put a happy smiley face in her body map after doing the activity. She mentioned that she enjoyed playing the game and that the game play encouraged her to do more movements: *"You know, once I passed the levels so I felt confident and also energetic and I felt my body and my arms, especially, felt activated"*. For her comfort trajectories, she drew her comfort level increasing over the time. A third participant mentioned that she moved her entire upper body while playing the game and she added that the neck movements felt *"so good."* She also represented her comfort level as increasing. Conversely, however, another participant explained that she started being pretty much comfortable but, when describing her comfort trajectories, she stated: *"it started comfortable, but getting uncomfortable".* She mentioned the forward movements got annoying for her after doing it for more than three or four times.

Reflections on The Method

The fundamentally qualitative nature of the soma design lends itself to small sample sizes with very deep explorations of each individual's experience. It is by nature individual and recognises the plurality of experience. Using the soma design methodology provides the researchers with rich descriptive data providing deep insight into the participants' subjective experiences. In an era where interventions can be personalised though technologies like virtual reality, this pluralistic perspective can serve to deepen our understanding of users' needs and experiences. From a design perspective, using soma design techniques such as the sensitisation and bodily ideation seen in in our workshop led to a wide variety of design concepts. As a method of evaluating a prototype, the tools associated with soma design, such as body maps and soma trajectories, provide a rich set of highly descriptive data that can be used alongside existing evaluation methods to add both qualitative depth and individual experience. We found the bodily articulations to be particularly effective alongside interviews for encouraging participants to detail their experience both spatially (with body maps) and temporally (with soma trajectories).

Conclusion

This paper reflects on the application of soma design to the specific challenge of aircraft passenger discomfort research. Building on the findings of our prior work, which helped us to identify the bodily design space – that is the areas of discomfort associated with being an aircraft passenger, and by extension the associated muscle groups to target, and combining this with the physical design space – the aircraft seat and the limited space around it; we were able to apply a soma design methodology to quickly ideate a wide selection of potential interventions. Taking one of these to prototype stage and evaluating it suggested that our design strategy was a sound one, as our participants reacted mostly positively to the intervention. We therefore suggest that soma design may serve as a powerful tool for designing targeted comfort interventions as part of practical ergonomics research, especially when informed by additional constraints such as target areas of the

body, and posture/space limitations, and for gaining very rich qualitative feedback about the efficacy of those designs. We therefore argue that soma design can and should be added to the toolkit of design and evaluation methods found in modern ergonomics research.

References

Benford, S., Schnädelbach, H., Koleva, B., Anastasi, R., Greenhalgh, C., Rodden, T., … Steed, A. (2005). Expected, sensed, and desired: A framework for designing sensing-based interaction. *ACM Transactions on Computer-Human Interaction*, *12*(1), 3–30. https://doi.org/10.1145/1057237.1057239

Bouwens, J. M. A., Fasulo, L., Hiemstra-van Mastrigt, S., Schultheis, U. W., Naddeo, A., & Vink, P. (2018). Effect of in-seat exercising on comfort perception of airplane passengers. *Applied Ergonomics*, *73*(August 2017), 7–12. https://doi.org/10.1016/j.apergo.2018.05.011

Francisco J. Varela, E. R. and E. T. (2000). *The Embodied Mind Cognitive Science and Human Experience*. Cambridge, Mass: MIT Press.

Höök, K. (2018). *Designing with the Body: Somaesthetic Interaction Design*. The MIT Press (November 13, 2018).

Höök, K., Caramiaux, B., Erkut, C., Forlizzi, J., Hajinejad, N., Haller, M., … Tobiasson, H. (2018). Embracing first-person perspectives in soma-based design. *Informatics*, *5*(1), 1–26. https://doi.org/10.3390/informatics5010008

Loke, L., G. P. K. (2014). Intimate Aesthetics and Facilitated Interaction. In *Interactive Experience in the Digital Age. Springer Series on Cultural Computing* (pp. 91–108). https://doi.org/https://doi.org/10.1007/978-3-319-04510-8_7

Feldenkrais, M., (1982). *Awareness Through Movement: Health Exercises for Personal Growth*. New York: HarperCollins Publishers.

Shusterman, R., (2008). *Body Consciousness A philosophy of Mindfulness and Somaesthetics*. https://doi.org/https://doi.org/10.1017/CBO9780511802829

Sharafkhani, M., Argyle, E., Cobb, S., & Tennent, P. (2021). Posture, movement, and aircraft passengers: An investigation into factors influencing in-flight discomfort. *Work*, *68*(s1), S183–S195. https://doi.org/10.3233/WOR-208016

Sharafkhani, M., Argyle, E., Cobb, S., Tennent, P., & Houghton, R. (2019). Identifying aircraft passenger postures and factors influencing body part discomfort. *2nd International Comfort Congress*, 1–8.

Søndergaard, M. L. J., Ciolfi Felice, M., & Balaam, M. (2021). *Designing Menstrual Technologies with Adolescents*. 1–14. https://doi.org/10.1145/3411764.3445471

Tennent, P., Höök, K., Benford, S., Tsaknaki, V., Ståhl, A., Dauden Roquet, C., … Zhou, F. (2021). *Articulating Soma Experiences using Trajectories*. 1–16. https://doi.org/10.1145/3411764.3445482

Vink, P., & Brauer, K. (2011). *Aircraft Interior Comfort and Design* (Ed. 1).

Wetzel, R., Rodden, T., & Benford, S. (2017). Developing Ideation Cards to Support the Design of Mixed Reality Games. *Transactions of the Digital Games Research Association*, *3*(2), 175–211.