Social Virtual Reality Avatar Biosignal Animations as Availability Status Indicators

Abdallah El Ali
Centrum Wiskunde & Informatica (CWI)
Amsterdam, The Netherlands
aea@cwi.nl

Sueyoon Lee
Centrum Wiskunde & Informatica (CWI)
Amsterdam, The Netherlands
sueyoon@cwi.nl

Pablo Cesar
Centrum Wiskunde & Informatica (CWI)
Delft University of Technology
Amsterdam, The Netherlands
p.s.cesar@cwi.nl

ABSTRACT

In this position paper, we outline our research challenges in Affective Interactive Systems, and present recent work on visualizing avatar biosignals for social VR entertainment. We highlight considerations for how biosignals animations in social VR spaces can (falsely) indicate users' availability status.

CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI)**.

KEYWORDS

Biosignals, avatars, social virtual reality, availability status

1 OUR RESEARCH CHALLENGES

Within our Distributed & Interactive Systems research group, we focus on designing and developing **Affective Interactive Systems**, where we draw on Virtual Reality (VR) systems as an experimental testbed to delve deeper into the links between technologically-mediated human affect and physiological signals. One specific research challenge we focus on is exploring *Affective Augmentation* technology, where we ask: how can we develop systems that can augment our physical / virtual bodies and sensory perception to enhance our affective states and (social) interactions? As a step in this direction, we have recently started exploring biosignal sensing and visualization for avatars across social Virtual Reality (VR) spaces. In this position paper, we focus on visualizing avatar biosignals for social VR entertainment, and raise the question of how biosignals animations can (falsely) indicate users' availability status.
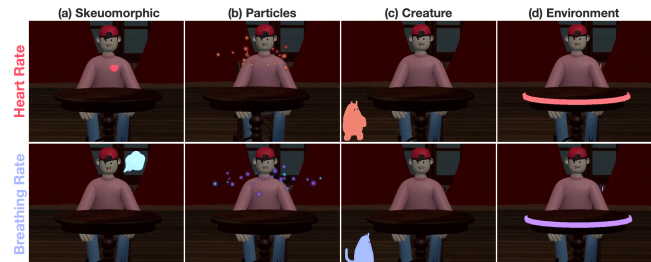
Figure 1: Unity-based visualizations for heart rate (top) and breathing rate (bottom).

2 VISUALIZING AVATAR BIOSIGNALS FOR SOCIAL VIRTUAL REALITY ENTERTAINMENT

During real social interactions, we typically draw on a wide range of visible non-verbal behavioral cues (facial expressions, gestures, etc.) to form impressions and facilitate communication with one another [5]. However this remains a challenge for digitally mediated communication where several such cues are missing [4, 11]. Recent technological advances have shown that it is possible to reveal previously invisible physiological data ("biosignals") about others to better inform our impressions. These biosignals can provide useful insights to others about our internal emotional and cognitive states, where social sharing of such data allows others to peek into our normally hidden experiences. To this end, researchers have shown that "expressive" biosignals [7], where an individual's biosignals are displayed as a social cue, can allow us to better recognize others' and helps express our own emotional and physical state [8, 10], and can result in heightened co-presence [3].

In our upcoming work [6], we explore how to design and visualize avatar biosignals in the context of social VR entertainment. Specifically, we asked: which are the most effective visualizations of Heart Rate (HR) and Breathing Rate (BR) biosignals in an immersive, virtual music event scenario? To answer this, we ran a controlled, within-subjects experiment (N=32) with pairs of users to investigate the effects of biosignals (Heart Rate vs. Breathing Rate), visualization (Skeuomorphic vs. Particles vs. Creature vs. Environment), and signal rate (Low vs. Rest vs. High) on perceived avatar arousal, user perceived distraction, and overall user attitudes and preferences. These visualizations can be seen in Fig. 1. We found that skeuomorphic visualizations for both biosignals allow differentiable arousal inference, skeuomorphic and particles were

least distracting for HR visualization, whereas all were similarly distracting for BR, and that biosignal perceptions often depend on avatar relations, entertainment type, and emotion inference of avatars versus spaces.

In our work, we found strong links between participants' responses towards avatar biosignals, and the role that visualizing biosignals on avatars (as animations) may play for increasing social presence. For this position paper, we focus on one aspect: availability status indicators. In our context mapping session, one theme that emerged was *Presence of Self and Other*. Here, participants mentioned that within social VR spaces, it was common for them to prove their presence in VR via any means (e.g., sending emoji), as it was not always apparent to them if they were present (*P5: "Let's just say someone's like daydreaming or like looking in the distance, it's kind of hard to see that in avatars."*). Similarly, participants complained about not being able to check the presence of others, where they had to actively engage with an avatar (*P3: "...making sure that I'm making people aware that I'm there and able to talk."*). In our semi-structured interviews, one of the themes that emerged was *Connecting with Others and Presence / Immersion*. Here, participants found biosignals as a means to better connect with others. For some, biosignal visualizations provided a feeling that who they spoke with is in fact a real person (*P16: "I feel like I'm in a video game...but if you show a heartbeat or breathing...I feel like more connected."*).

3 ANIMATED BIOSIGNALS CAN (FALSELY) INDICATE AVAILABILITY STATUS

From our study, it became apparent that biosignals can play a role as avatar online status indicators (cf., awareness displays [2]). This can provide another means for "idle" users to indicate their presence to others in a social virtual space, or even allow verifying humanness. However, this can also provide a new means to mislead others [1] in facilitating wasted interactions. Given this, one would need to consider freezing the biosignal when users are away (e.g., removing HMD), since the animations can provide the incorrect social cue at times. In this respect, the choice of how to visualize a biosignal and how it behaves through user interactions becomes paramount, where we caution that **biosignal animations can falsely indicate availability status.** While other non-verbal cues (e.g., fiddling motion, gaze) can also indicate online status, biosignals, by virtue of always being present, can falsely breathe life into an otherwise still avatar when the user is absent.

We believe that as more users enter social VR spaces (the so-called "metaverse"), further consideration needs to be given on the role of biosignals for social presence, specifically on how to effectively display online availability statuses without misleading others. If this is done through communicating biosignals, whether expressive (e.g., heart rate creature animations [8]) or through for example realistic blood flow animations [9], it warrants further study on what happens to subsequent social interactions and emotional connections when the user leaves (whether by choice or not) their avatar, for shorter or longer periods.

4 AUTHOR BIOGRAPHIES

Abdallah El Ali is a research scientist at Centrum Wiskunde & Informatica (CWI) in Amsterdam within the Distributed & Interactive Systems (DIS) group. He is leading human-computer interaction (HCI) research within the Affective Interactive Systems research area. His focus is on ground truth label acquisition techniques, affective state visualization across environments (mobile, wearable, XR), and bio-responsive interactive prototypes. He is also part of the executive board of CHI Nederland, the local SIGCHI chapter in the Netherlands. Website: https://abdoelali.com

Sueyoon Lee is a research assistant at Centrum Wiskunde & Informatica (CWI) in Amsterdam within the Distributed & Interactive Systems (DIS) group. She follows a user-centric design approach for creating immersive yet comfortable experiences with design and technology. She currently leads design research within the TRACTION EU project, where her focus is on building a social VR lobby for post-watching of opera experiences. Website: https://sueyoonlee.com

Pablo Cesar leads the Distributed and Interactive Systems Group, Centrum Wiskunde & Informatica (CWI) and is Professor with TU Delft, The Netherlands. His research combines HCI and multimedia systems, and focuses on modelling and controlling complex collections of media objects (real-time media, sensor data) that are distributed in time and space. He has received the prestigious 2020 Netherlands Prize for ICT Research on human-centered multimedia systems, and is the principal investigator from CWI on topics of social virtual reality and affective computing. Website: https://www.pablocesar.me

REFERENCES

[1] Camille Cobb, Lucy Simko, Tadayoshi Kohno, and Alexis Hiniker. 2020. *User Experiences with Online Status Indicators.* Association for Computing Machinery, New York, NY, USA, 1?12. https://doi.org/10.1145/3313831.3376240

[2] Anind K. Dey and Ed de Guzman. 2006. *From Awareness to Connectedness: The Design and Deployment of Presence Displays.* Association for Computing Machinery, New York, NY, USA, 899?908. https://doi.org/10.1145/1124772.1124905

[3] Milou A. Feijt, Joyce H.D.M. Westerink, Yvonne A.W. De Kort, and Wijnand A. IJsselsteijn. 2021. Sharing biosignals: An analysis of the experiential and communication properties of interpersonal psychophysiology. *Human–Computer Interaction* 0, 0 (2021), 1–30. https://doi.org/10.1080/07370024.2021.1913164

[4] S. Kiesler, J. Siegel, and T. McGuire. 1984. Social psychological aspects of computer-mediated communication. *Computer Supported Cooperative Work* (1984), 657–682.

[5] M.L. Knapp, J.A. Hall, and T.G. Horgan. 2013. *Nonverbal Communication in Human Interaction.* Cengage Learning.

[6] Sueyoon Lee, Abdallah El Ali, Maarten Wijntjes, and Pablo Cesar. 2022. Understanding and Designing Avatar Biosignal Visualizations for Social Virtual Reality Entertainment. In *Proc. CHI '22 (to be published)* (New Orleans, LA, USA). ACM, New York, NY, USA. https://doi.org/10.1145/3491102.3517451

[7] Fannie Liu, Laura Dabbish, and Geoff Kaufman. 2017. Can Biosignals Be Expressive? How Visualizations Affect Impression Formation from Shared Brain Activity. *Proc. ACM Hum.-Comput. Interact.* 1, CSCW, Article 71 (Dec. 2017), 21 pages. https://doi.org/10.1145/3134706

[8] Fannie Liu, Chunjong Park, Yu Jiang Tham, Tsung-Yu Tsai, Laura Dabbish, Geoff Kaufman, and Andrés Monroy-Hernández. 2021. Significant Otter: Understanding the Role of Biosignals in Communication. In *Proc. CHI '21* (Yokohama, Japan). ACM, NY, USA, Article 334, 15 pages. https://doi.org/10.1145/3411764.3445200

[9] Daniel J. McDuff and Ewa Magdalena Nowara. 2021. *?Warm Bodies?: A Post-Processing Technique for Animating Dynamic Blood Flow on Photos and Avatars.* ACM, New York, NY, USA. https://doi.org/10.1145/3411764.3445719

[10] Hyeryung Christine Min and Tek-Jin Nam. 2014. Biosignal Sharing for Affective Connectedness. In *CHI '14 Extended Abstracts on Human Factors in Computing Systems* (Toronto, Ontario, Canada) *(CHI EA '14).* ACM, New York, NY, USA, 2191?2196. https://doi.org/10.1145/2559206.2581345

[11] Joseph Walther. 2011. Theories of computer-mediated communication and interpersonal relations. *The Handbook of Interpersonal Communication* (01 2011), 443–479.