ABSTRACT

Mental well-being issues such as anxiety and depression are increasing, and as provisions by healthcare systems are insufficient to meet people’s needs, new technology is being used to improve mental well-being. In this doctoral thesis, we examine the iterative and user-centred design, implementation and evaluation of a robotic mental well-being coach—i.e., a robot that could help people maintain and focus on their well-being. In this article, we discuss the studies we have already conducted. These have examined coach and user preferences, the design of a robotic well-being coach, how to computationally implement such a coach, and how such a robot is experienced in the short (laboratory setting) and long term (workplace setting). We then discuss future work, which includes data analysis of a longitudinal study where a robotic coach interacted with a group, the implementation and testing of an longitudinal adaptation model for the robotic coach, and a survey of the state of the art in affective robotics for well-being.

CCS CONCEPTS

- Human-centered computing → User studies; User centered design; Participatory design.

KEYWORDS

robotic coach, well-being, design research, form, adaptation
modelling and user perceptions in the short term. Study 3 then re-examined user and coach expectations and design, and Study 4 examined computational modelling and user perceptions in the long term. Planned work includes one more iteration, and finally a survey on the state of the art of affective robots for well-being.

The methodologies we use are as follows. To examine user preferences and design the robot (i.e., its interactions, behaviour and form), we apply user-centred methods [20] such as Participatory Design (PD) [23]. We involve both users and coaches in this process. Our design is informed by pre-existing well-being practices such as Positive Psychology [18] and Mindfulness [22]. We adapt these practices to be appropriate for the robot together with well-being professionals. During implementation, we focus on the adaptation of robot behaviours to be appropriate to a well-being context. In order to examine user perceptions of the robotic coaches, we employ a mixed-methods approach, triangulating findings with both qualitative and quantitative data [15].

To work toward this vision, the thesis aims to answer the following research questions, which we are examining from the perspective of both short- and long-term interactions:

**RQ1**: What are coaches’ and coaches’ expectations and preferences for a robotic coach for well-being?

**RQ2**: How can we design a robot (incl. behaviour, interactions, form) that is appropriate and useful for well-being coaching?

**RQ3**: How can we computationally model existing well-being practices to be suitable for a robotic well-being coach?

**RQ4**: How do coachees perceive and experience the designed robotic well-being coach?

### 2 PREVIOUS WORK

**Study 1: Participatory Design of a Robotic Mental Well-being Coach** - We conducted interviews and focus group discussions with prospective users ($N_P = 8$) and coaches ($N_C = 3$), for the PD of a robotic mental well-being coach [2]. Based on a Thematic Analysis (TA) [9] of transcribed data, we developed themes regarding the use of a Robotic well-being Coach (RC). Results showed that users and coaches shared perspectives on RC advantages and disadvantages, and noted that RC form should match its function [13].

**Study 2: A Robotic Mental Well-being Coach for the Short Term** - Informed by study 1, we designed and implemented a robotic mental well-being coach to conduct a one-off Positive Psychology [18] (PP) exercise session with university students ($N_P = 20$) in a lab setting [3]. To implement personalisation affect perception, we used a Continual Learning model [10] to adapt the robot’s responses based on the participants’ facial affect, and compared 3 conditions: static, affect-based adaptation, and affect-based adaptation with continual personalisation. We found that participants preferred the personalisation condition, and that introverted people in particular could benefit from the RC.

**Study 3: Design and Ethical Recommendations for a Robotic Mental Well-being Coach** - We conducted a robotic coach PD study with participants ($N_P = 3$, $N_C = 2$) (study 3, Figure 1c). Participants edited a robotic interaction script and used a social robot design tool developed by the first author [4]. Based on the results of study 1, 2, and 3, we conducted a meta-analysis of convergences and divergences. Based on the analysis, we formalized 7 design and ethical recommendations for robotic mental well-being coaches [5].

**Study 4: A Robotic Mental Well-being Coach Conducting Positive Psychology in the Workplace for the Long Term** - Informed by study 3, we conducted a study of a robotic coach delivering PP exercises to employees ($N_P = 26$) of a company (Cambridge Consultants Inc.) over four weeks at their workplace [24]. We designed the robot to have a coach personality. We compared two robots, child-like QTrobot (QT) and toy-like Misty II (M), to examine which robotic form is more appropriate for this context. Employees felt more connection with M, and preferred its behaviour and personality (which did not differ from QT). Robotic form had a major impact on participant expectations and perceptions.

### 3 FUTURE WORK

In our future work, we are interested in developing a more comprehensive understanding of longitudinal interactions with the well-being coach, and how improved adaptive robotic capabilities affect participant experiences. We will continue to work with our target group of non-clinical adult populations.

**Study 5: A Robotic Mindfulness Group Coach in a Public Cafe in the Long Term** - We conducted a study of a robotic Mindfulness coach for groups, over four weeks in a cafe environment (Edge cafe). We will analyse data collected from this study, and distill it into findings to inform the future development of longitudinal, group-focused robotic coaches for mindfulness practice. Initial results are reported in a Late Breaking Report [6].

**Study 6: Adapting Robotic Coach Behaviours in the Long Term** - Based on study 3, and our findings from study 4, we found that active listening skills are important for a robotic coach for PP. We aim to develop a computational model to enable these skills, and test them in a longitudinal study. Using video and audio data from dyadic interactions, we will use machine learning to adapt the robotic coach’s backchanneling timing and intensity to each user. This robot will then be deployed in a workplace environment to examine user perceptions.

**A Survey of Affective Robotics for Well-being** - We will collaborate with other researchers working in the area to create a survey, which will inform the HRI community of the state of the art of affective robots for well-being. This survey will build on an existing survey [25], with a more comprehensive approach focusing on interdisciplinary research questions.

This research contributes to the robotic mental well-being coaches by iteratively examining user and coach preferences, design, implementation, and user perceptions. A future iteration will examine implemented adaptive behaviours in the long term, in a workplace context. This study will further inform us of users’ experiences with robotic coaches.

**ACKNOWLEDGEMENTS**: We thank our collaborators Dr I. Bodala and N. Chura-manai, as well as the study participants, well-being professionals, and the Cambridge Consultants Inc. and Edge cafe staff. M. Axelsson is funded by the Osk. Huttunen foundation and the EPSRC under grant EP/T517847/1. H. Gunes and M. Spitale are supported by the EPSRC/UKRI under grant ref EP/R030782/1.

**Data access**: Raw data related to this publication cannot be openly released due to anonymity and privacy issues.

---

1. https://luxai.com/
REFERENCES


