# Adaptive Robotic Mental Well-being Coaches

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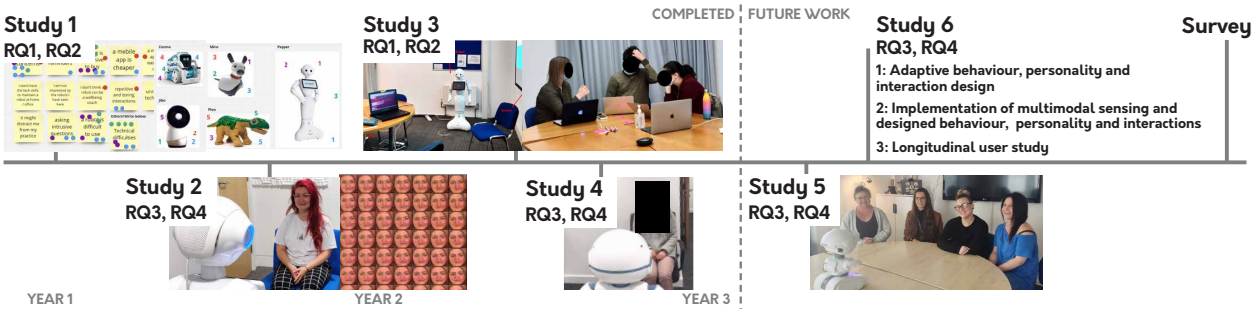


**Figure 1: Study set-ups: Study 1 - PD workshop excerpts from Miro board, Study 2 - mock interaction with Pepper and generation of imagined facial emotional expressions, Study 3 - set-up with Pepper, and group discussion with coach and coachees, Study 4 - participant with a QTrobot, and Study 5 - participants with a Misty robot.**

## 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


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## 1 INTRODUCTION, BACKGROUND, AND METHODOLOGY

Recently, mental health issues such as depression and anxiety have been increasing [7], and COVID-19 has added onto this effect [21]. Robots could address this issue by meeting challenges of lack in resources and accessibility in delivering mental well-being exercises to people, working in conjunction with (human) well-being professionals. Robots can provide the benefit of a physical presence (cf. mobile apps [19]). This thesis is part of a broader effort on working toward the vision of an autonomous, adaptive robotic mental well-being coach, with multimodal interaction capabilities that can sustain user engagement in the long term.

Currently, works in robotic mental well-being coaching are scarce, as the application area is new. Previous work in robotic coaching include a robot for addressing behaviour change for weight loss [17], physical exercise coaching [12, 26], and physical rehabilitation [11]. Studies on coaches for mental well-being have explored deploying a robotic interaction partner for positive psychology with students [14], and a teleoperated robot coach for mindfulness [8]. Outside of coaching, robots have been examined to e.g. assess the mental well-being of children [1], and for community-based mental health data visualization [16].

In this work, we aim to create a robotic coach iteratively (see Figure 1). With an iterative approach, we are able to inform each study with the results of the previous study. We have completed two rounds of iterations so far: Study 1 examined user and coach expectations and design, while Study 2 examined computational

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 quantitative and qualitative 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 coachees' 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 personalised 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) [1] and toy-like Misty II (M) [2], 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 toward 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.

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

[1] https://luxai.com/
[2] https://www.mistyrobotics.com/

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